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Education in Emergency

Self - Instructional Materials



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Key Stage 5 C1 - XI - XII
Vol. II

Self-Instructional Materials

Key-stage V
(Classes XI and XII)

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INFORMATION FOR STUDENTS

- i. The lessons on English, Dzongkha, and Mathematics subjects are meant for all the students of classes XI and XII, regardless of their stream.
- ii. The lessons for *Science, Arts, and Commerce* streams are provided in separate sections for students to choose depending on their areas of study.
- iii. The answers to questions that students need to solve in each activity are provided in the last section on ‘Answers’.
- iv. Each lesson is designed for fifty-five minutes.

ENGLISH

1.1 Science Fiction

Learning Objectives



- Explain the meaning of science fiction.
- Identify the features of science fiction in the stories ‘Too Bad’ and ‘Mirror Image’.
- Explain the theme, ‘Modern science is a boon as well as a bane’.

Introduction

1. Can you recollect the titles of the stories you have read so far?
2. Jot them down in your notebook. You will need the list of titles in Activity 1.

For now, let us look at THREE genres of a short story. Read the contents in the table and identify the features of each genre.

Contemporary Realistic Fiction	Science Fiction	Traditional Realistic Fiction
<ul style="list-style-type: none"> • Depiction of the real world. 	<ul style="list-style-type: none"> • Based on futuristic /times /scientific or technological advances. 	<ul style="list-style-type: none"> • Traditional setting • Age-old custom and culture is being depicted in the story.
<ul style="list-style-type: none"> • Fictional characters/real settings/ realistic human traits. 	<ul style="list-style-type: none"> • Outer space, other worlds, involving aliens/robots/ animations 	Fictional or real characters and settings. Realistic human traits.



ACTIVITY 1

Instruction: Now, refer to the list of the stories you have prepared in *Activity 1* and categorize them under different genres.

Are you able to categorise the stories?

The next activity will help you understand better about science fiction. We will review the story ‘Too Bad’ by Asimov for grade XI students and ‘Mirror Image’ by Lena Coakley for grade XII students.



ACTIVITY 2

Instruction: Read the descriptions and the features of science fiction given below.

What is a science fiction?

- Science fiction is a form of literature that consistently considers the nature of changes that face us, the possible consequences, and the possible solutions.
- The branch of literature which is concerned with the impact of scientific advancement upon human beings.
- Fiction based on imagined future scientific or technological advances and major social or environmental changes, frequently portraying space or time travel and life on other planets.



ACTIVITY 3

Instruction

If you are a grade XI student, read the story 'Too Bad' by Asimov, and 'Mirror Image' by Lena Coakley if you are a grade XII student.

Before you read the story on your own, go through the gist of the story given below for each story.

Too Bad

The story deals with the invention of a mini robot, named Mike, which has the capacity to miniaturize itself to get injected into the bloodstreams of the cancer patient. The inventor, who is also a cancer patient and the first recipient of the robot treatment uses his creation to cure himself of the cancer disease.

Mirror Image

The story is about a young girl called Alice, who undergoes a brain transplant after her body was badly damaged in a fatal accident. With the advancement of science and technology, Alice was brought back to life, but with a completely new body. With her brain transplanted in the body of a sixteen-year-old teenager called Gail, Alice became confused whether she belonged to the parent of the brain or the parent of the body?

Having seen the gist of the story, read further to see what remained as 'Too Bad' in the story by Asimov, or was Alice able to find her true identity in the story 'Mirror Image' by Lena?

Mirror Image - Lena Coakley

If only there were no mirrors, Alice sometimes thought, although she carried one in her backpack wherever she went. It was a silver-plated mirror her father had given her with the initials ACS on the back. Just you, Alice, she would say to herself, looking the way you've always looked. Then she'd pull out the mirror. The surprise and disbelief at seeing the reflection was a joke she played on herself over and over.

It was disquieting, however, to come upon a mirror without warning. She would say "excuse me" to her own reflection in shop windows. Mirrors in unexpected places would make her start and lose her nerve. She avoided the girls' bathroom altogether. Alice took to wearing sunglasses all the time, to remind herself, to keep something constantly in front of her eyes that would remind her that she looked different. Her teachers let her wear them. Maybe the word had come down from the top that she wasn't to be hassled for a while, but Alice thought it was more than that. She thought they were all a little afraid of her.

Of course her mind learned to ignore the glasses. The human mind is incredibly adaptable. Her mother was always telling her that.

"Do you think I move differently?" she asked her twin, Jenny, once identical. "Look how my feet kind of roll when I walk. And my hips, my hips feel totally different." Alice walked across the bedroom like a fashion model, wearing nothing but black bikini underwear.

"Actually, as bodies go, this one is a lot better. I mean, check it out," Alice grabbed a chunk of her thigh, "no cellulite."

Jenny watched from inside her own body. "You looked okay - before."

"Sorry, I didn't mean ... You're pretty. I can see that now. But I never used to think that I was. You know, my old body used to weigh much less than this body weighs but I still wouldn't have been able to walk around naked in it. No one ever told me that this body is ugly. For all I know it's never had zits. I haven't had one yet. I feel like I could do anything in this body. Hey, did I show you, I can almost touch my foot to the back of my head."

Alice had to re-learn how to move in the hospital, and to speak. At first the world was nothing but a mush of dark images, disconnected voices and prickly feelings all over her skin. If someone touched her arm she wasn't sure from which part of her body the sensation came. Colours seemed different. People's voices were pitched a tone higher. When she tried to speak she bit her tongue, which seemed enormous in her mouth and tasted funny. When she finally learned, the tone was different, but the inflections and the slight Maritime accent were the same. She'd had an accident, they said. But long before the psychiatrist told her, she knew. These weren't her hands. This wasn't her breath.

"Let me read your diary."

Alice and Jenny lay on top of their beds supposedly doing homework. Above each bed hung a charcoal portrait their father had drawn. He had finished them just before he died. Now, only Jenny's was a good likeness.

"Not now," said Jenny, closing the book and capping her ball point pen.

"You can't read mine."

"You can read mine."

"I know what your diary says Ooh, I found a new mole today on my new body. Ooh, don't my new armpits smell divine?"

"Come on. What do you have some big secret in there? We've always read each other's diaries."

"I have to get to know you better." Jenny slipped her diary between her mattress and box spring.

"Yeah, right," Alice laughed. Then she realized her sister wasn't joking. "What, fourteen years wasn't enough?"

"You were in the hospital a long time, that's all I mean."

Alice swung her legs over the side of her bed and looked at Jenny. At one time looking at her was like looking in the mirror, and Alice still found her sister's coppery red hair and masses of freckles more familiar than her own reflection. "Jenny, we're still twins. I have the same memories: Camp Wasaga, moving to Toronto ... Dad. You know, when I draw I can still make the shadows, just the way he showed us. Isn't that amazing? Even though I have a different hand. And my signature is the same too. This is me in here, Jenny. My brain is me."

Jenny rolled over on her bed. "Whatever. You still can't read it." Alice was in the hospital for months. She saw doctors, interns, psychiatrists, physical therapists, speech therapists. Once a reporter, who had actually scaled the building, poked his head through the window to ask, "Hey, Alice, how do you feel?" and snapped a few photos.

All the mirrors had been removed, of course, from her room and bathroom, but Jenny and her mother brought the hand mirror with her initials when the doctors thought Alice was ready.

"They couldn't have saved your old body," her mother said. "This was the only way to keep you alive."

"No one knows what it will be like," said Jenny. "You're the only one who's ever survived before."

"I know all that," Alice slurred. The doctors had taken the precaution of giving her a mild sedative. It made her feel like everything was happening to someone else, far away. She held the silver mirror in one hand. With the other, she pulled at her face, squeezed it as if it were clay.

Alice was mesmerized by the unfamiliar eyes, big and brown and dark. Whenever her father painted her he'd spend most of his time on the eyes. The eyes are the mirror of the soul, he used to say. Whose soul is that? Alice wondered. For a moment she considered screaming, but it was too much trouble. Besides, it wouldn't be her scream. "It's okay, Mom," she said.

"Maybe I'll start looking like myself again. If I try hard enough. If

I concentrate hard enough. Very slowly, over the course of years, my eyes will change colour ... my face. It might ..."

Alice's mother stroked her hair. "We'll get through this," she said, "the human mind is incredibly adaptable."

"Mrs. Jarred's on TV again," Alice called.

"Turn it off," her mother said, "it's time for birthday cake," but Alice and Jenny kept watching.

Above the television, the faces of the family portrait Alice's father had painted smiled out into the room.

“A new development in the story of Girl X,” said the newscaster, “first surviving recipient of a brain transplant ...”

Alice’s mother stood in the doorway wiping her hands on a tea towel. She had fewer freckles than Jenny, and the long braid which hung down her back wasn’t quite so bright a red, but the family resemblance was unmistakable. “I don’t want you to worry about the Jarred’s, girls. My lawyer says they don’t have a legal leg to stand on.”

Mrs. Jarred, a middle-aged woman in a red checked coat, stood on a suburban lawn. She had dark hair just beginning to gray and Alice’s large, dark eyes. A short man with a pot belly smiled self-consciously beside her.

“Is that your family?” Jenny asked. “I don’t even know them.”

“Mrs. Jarred,” said a female reporter with a microphone “has science gone too far?”

“She’s our daughter,” the woman replied with emotion. “When we signed the release form donating her body, we didn’t know they were going to bring her back to life with some new brain. Our Gail is alive and living somewhere in Toronto and I’m not even allowed to see her.” Mrs. Jarred began to cry and the camera cut away to Alice and her mother leaving the hospital amid crowds of journalists. Since she was under eighteen, Alice’s face was covered with a round, black dot. The girls had both seen this footage many times before.

“Gail. Wow. That’s so weird.”

“That’s not my name.”

The TV flashed pictures of the Jarreds before the accident. A girl with a dog. A smiling teenager wearing a party dress.

“Ooh, nice outfit, Gail.”

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“Darn those TV people,” said Alice’s mother. “They protect our privacy by not showing what you look like, and then they show pictures of your body before the accident. That makes a lot of sense.”

“The Jarreds probably gave permission,” said Alice. “Anyway, it doesn’t matter. Everyone at school knows. The whole world knows.”

Alice’s mother continued as if she was talking to herself. “Those Jarreds ... If we start having reporters all over the lawn again ...” She twisted her face in disgust, strode across the room, and turned off the television with a sharp flick of her wrist.

“Hey.”

“Come on, cake time. I made it from scratch. Alice’s favourite, chocolate with mocha cream.”

In the dining room a huge and elaborate cake was waiting on the table. Rich, white chocolate piping swirled over dark mocha. Ornate candy violets decorated the cake’s tall sides.

“Awesome, Mom,” said Alice. She couldn’t remember her mother ever making a home-made cake before. “You blow first,” she said to Jenny as she sat down. “You’re the oldest.”

“By two minutes,” said Jenny, “and anyway, maybe I’m not the oldest anymore.”

“What do you mean?”

“You might be older than me now with your new body. You might be old enough to drive for all we know.”

Alice's brown eyes widened. "Mom, if my body is sixteen, does that mean I can get my license?"

"Forget it." her mother said as she lit the cake. "You could barely walk six months ago." She switched out the lights.

In the yellow glow of the candles Alice and Jenny followed a tradition that their father had started long ago. First Alice and her mother sang Happy Birthday to Jenny. Then, after Jenny had blown them out, the candles were lit again for Alice, and the song was sung a second time.

Alice blinked and squinted when the lights came on again. "I forgot to make a wish," she said. Her mother smiled and handed a slice of the beautiful cake to each of the girls. "I guess you have to share your wish with Jenny."

Alice and Jenny laughed. One year, when they were little girls, the suggestion that they would have to share a wish sent them into fits of crying which their parents could only resolve by fitting the cake slices back into the cake and lighting the candles for a third and fourth time.

Alice cut the cake with the edge of her fork, happy that the tension brought on by the newscast had begun to melt away. She put a large bite into her mouth. Bitter. Alice tried hard to swallow, tried hard not to let her face show any reaction to the cake, but the taste of the mocha forced her mouth into a grimace. Jenny didn't miss it.

"I guess Gail doesn't like chocolate with mocha cream." "No, it's good," said Alice, forcing it down. Jenny pushed her own piece away. "I'm not hungry."

"Jeez, Jenny, why are you angry at me for not liking a piece of cake? I can't help it,"

"Who is angry?"

"I have different taste buds now, and they're sending different messages to my brain. They're saying, this cake tastes gross. Sorry Mom."

"Okay" said Jenny. "You're always saying that you are still you because you have the same brain, but who is to say that your whole personality is in your head?"

"Where else would it be?"

"I don't know; maybe there was some other part of your body where part of your self-lived. Maybe it was your big toe."

Alice's mother set down her fork. "Jenny, people have their big toes cut off and they're still themselves. People have heart transplants and they're still themselves."

"Right," said Alice. She smiled at her mother, but her mother looked away.

"Maybe not," Jenny said, "maybe they're a little bit different but they just don't notice. You're a lot different. You're a morning person. You never see your old friends. You hang out with Imogen Smith and those snobs. Now you're going out for cheerleading, for goodness sake. And what is with those sunglasses? Sometimes ... I don't know ... Sometimes I think my sister is dead." Jenny pushed her chair back and ran out of the room.

Alice sat where she was, poking at her cake with her fork, trying not to cry.

Her mother got up and began to gather the plates. "I think," she began, her voice wavering, "I think cheerleading would be very good for your coordination."

Alice stared at her mother, but again her mother avoided her eyes. Suddenly Alice thought she understood the elaborate cake. She made it because she felt guilty, Alice thought, guilty for thinking, way down deep, that I'm not really the same daughter she knew before.

The first thing Alice saw when her eyes could focus was the white hospital ceiling, but the white had a slightly unnatural blueness to it, the way white looks on TV. Sometimes things were exquisitely clear and sharp, although she wasn't wearing her contacts, and she hadn't yet learned to ignore her eyelashes that seemed longer and darker than they had been before. When Alice saw her mother for the first time she cried and cried. Her skin had a different texture. Her hair hardly seemed red at all. She even had a different smell. And Jenny. Why was everyone she knew so different? Why wasn't her father there? Would he be different too? When Alice met Mr. Jarred, it was in the middle of the street. A new sidewalk had just been poured on Bedford Avenue, so Alice had to walk in the street to go around the construction on the way home from school. A light rain was falling, preventing the concrete from setting.

Mr. Jarred held an oversized umbrella, striped red and yellow, above his head. He might have walked right by her, but Alice was staring hard at him trying to remember something anything about him besides the newscast.

"Gail," he said in a soft mumble and then, "I'm sorry ... I mean Alice ... Do you know me?" "I saw you on TV."

"Ah, yes." The two stood in silence for a moment.

"You should have an umbrella," he said. "This one's a ridiculous thing, my wife's. Here."

"No, no, it's just sprinkling, really," but Alice took the umbrella Mr. Jarred offered her holding it upside down, its point in the road.

"This is very strange for me, very strange," he said, staring at her. "We knew you were in Toronto, but, well, to be honest, it was my wife who wanted to contact you. I...I thought it would be better not to see you. It's very strange," he repeated, then added, "You look so different."

"I do?"

"Your hair. The way you stand, even. Our Gail, she was an early bloomer, always slouched. Your accent is different too." he paused. "I understand, you know. My wife, she thinks our daughter is still alive, but I ... I know." A car turned onto the street and honked at them. "I'd better go."

On impulse. Alice grabbed Mr. Jarred's hand. It was warm and big and rough and Alice knew she had never felt it before. "I knew I wouldn't remember you," she said, "but I was hoping, when you walked by, that I'd know you somehow."

Mr. Jarred took his hand away. "But you don't."

"No." Alice slid her dark glasses to the top of her head. "My dad I guess you know he died in the accident."

"Yes."

"Sometimes I think if he were alive, he would just look into my eyes and know who was in here." The two stood in silence. Then Alice said, "What will you tell your wife?"

"I'll tell her," Mr. Jarred's voice began to falter, but he looked at her straight on, "I'll tell her I looked into your eyes and that I didn't see my daughter."

"I'm sorry." said Alice. She didn't ask the question that immediately came to her, but the words rang in her mind: who did you see?

Alice gripped the umbrella as she watched Mr. Jarred hurry around the corner. She stepped up to the curb and pressed her waist to the wooden barrier that protected the sidewalk. Then she folded the umbrella and secured the strap. In a small corner of the sidewalk she wrote her initials, ACS, with the tip of the umbrella.

Alice was here, she thought. And then she walked towards home.

Too Bad - Issac Asimov**THE THREE LAWS OF ROBOTICS**

- A robot may not injure a human being or through inaction, allow a human being to come to harm.
- A robot must obey the orders given it by human beings except where that would conflict with the First Law.
- A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

Gregory Arnfeld was not actually dying, but certainly there was a sharp limit to how long he might live. He had inoperable cancer and he had refused, strenuously, all suggestions of chemical treatment or of radiation therapy.

He smiled at his wife as he lay propped up against the pillows and said, "I'm the perfect case. Tertia and Mike will handle it"

Tertia did not smile. She looked dreadfully concerned "There are so many things that can be done, Gregory. Surely Mike is a last resort. You may not need it."

"No, no. By the time they're done drenching me with chemicals and dowsing me with radiation, I would be so far gone that it wouldn't be a reasonable test.... And please don't call Mike 'it'."

"This is the twenty-second century, Greg. There are so many ways of handling cancer." "Yes but Mike is one of them, and I think the best. This is the twenty-second century, and we know what robots can do. Certainly, I know. I had more to do with Mike than anyone else. You know that."

"But you can't want to use him just out of pride of design. Besides, how certain are you of miniaturization? That's an even newer technique than robotics."

Arnfeld nodded. "Granted, Tertia. But the miniaturization boys seem confident. They can reduce or restore Planck's constant in what they say is a reasonably foolproof manner, and the controls that make that possible are built into Mike. He can make himself smaller or larger at will without affecting his surroundings."

"Reasonably foolproof," said Tertia with soft bitterness.

"That's all anyone can ask for, surely. Think of it, Tertia. I am privileged to be part of the experiment. I'll go down in history as the principal designer of Mike, but that will be secondary.

My greatest feat will be, that of having been successfully treated by a mini robot by my own choice, by my own initiative."

"You know it's dangerous."

"There's danger to everything. Chemicals and radiation have their side effects. They can slow without stopping. They can allow me to live a wearying sort of half-life. And doing nothing will certainly kill me. If Mike does his job properly, I shall be completely healthy, and

if it recurs" Arnfeld smiled joyously "Mike can recur as well."

He put out his hand to grasp hers. "Tertia, we've known this was coming, you and I. Let us make something out of this a glorious experiment. Even if it fails and it won't fail-it will be a glorious experiment,"

Louis Secundo, of the miniaturization group, said, "No, Mrs Arnfeld. We can't guarantee success. Miniaturization is intimately involved with quantum mechanics, and

there is a strong element of the unpredictable there. As MIK-27 reduces his size, there is always the chance that a sudden unplanned re-expansion will take place, naturally killing the patient. The greater the reduction in size, the tinier the robot becomes, the greater the chance of re-expansion.

And once he starts expanding again, the chance of a sudden accelerated burst is even higher.

The re-expansion is the really dangerous part.”

Tertia shook her head. “Do you think it will happen?”

“The chances are it won’t, Mrs Arnfeld. But the chance is never zero. You must understand that.”

“Does Dr Arnfeld understand that?”

“Certainly. We have discussed this in detail. He feels that the circumstances warrant the risk.” He hesitated. “So do we. I know that you’ll see we’re not all running the risk but a few of us will be, and we nevertheless feel the experiment to be worthwhile. More important, Dr Arnfeld does.”

“What if Mike makes a mistake or reduces himself too far because of a glitch in the mechanism? Then re-expansion would be certain, wouldn’t it?”

“It never becomes quite certain. It remains statistical. The chances improve if he gets too small. But then the smaller he gets, the less massive he is, and at some critical point, mass will become so insignificant that the least effort on his part will send him flying off at nearly the speed of light.”

“Well, won’t that kill the doctor?”

“No. By that time, Mike would be so small he would slip between the atoms of the doctor’s body without affecting them.”

“But how likely would it be that he would re-expand when he’s that small?”

“When MIK-27 approaches neutrino size, so to speak, his half-life would be in the neighbourhood of seconds. That is the chances are fifty-fifty that he would re-expand within seconds but by the time he re-expanded, he would be a hundred thousand miles away in outer space and the explosion that resulted would merely produce a small burst of gamma rays for the astronomers to puzzle over. Still, none of that will happen. MIK-27 will have his instructions and he will reduce himself to no smaller than he will need to be to carry out his mission.”

Mrs Arnfeld knew she would have to face the press one way or another. She had adamantly refused to appear on holovision, and the right-to-privacy provision of the World Charter protected her. On the other hand, she could not refuse to answer questions on a voice-over basis. The right-to-know provision would not allow a blanket blackout.

She sat stiffly, while the young woman facing her said, “Aside from all that, Mrs Arnfeld, isn’t it a rather weird coincidence that your husband, chief designer of Mike the Microbot, should also be its first patient?”

“Not at all, Miss Roth,” said Mrs Arnfeld wearily. “The doctor’s condition is the result of a predisposition. There have been others in his family who have had it. He told me of it when we married, so I was in no way deceived in the matter, and it was for that reason that we have had no children. It is also for that reason that my husband chose his lifework and laboured so assiduously to produce a robot capable of miniaturization. He always felt he would be its patient eventually, you see.”

Mrs Arnfeld insisted on interviewing Mike and, under the circumstances that could not be denied. Ben Johannes, who had worked with her husband for five years and whom she knew well enough to be on first-name terms with, brought her into the robot’s quarters.

Mrs Arnfeld had seen Mike soon after his construction, when he was being put through his primary test, and he remembered her. He said, in his curiously neutral voice, too smoothly average to be quite human, "I am pleased to see you, Mrs Arnfeld."

He was not a well-shaped robot. He looked pinheaded and very bottom heavy. He was almost conical, point upward.

Mrs Arnfeld knew that was because his miniaturization mechanism was bulky and abdominal and because his brain had to be abdominal as well in order to increase the speed of response. It was an unnecessary anthropomorphism to insist on a brain behind a tall cranium, her husband had explained. Yet it made Mike seem ridiculous, almost moronic. There were psychological advantages to anthropomorphism, Mrs Arnfeld thought, uneasily.

"Are you sure you understand your task, Mike?" said Mrs Arnfeld.

"Completely, Mrs Arnfeld," said Mike. "I will see to it that every vestige of cancer is removed."

Johannes said, "I'm not sure if Gregory explained it, but Mike can easily recognize a cancer cell when he is at the proper size. The difference is unmistakable, and he can quickly destroy the nucleus of any cell that is not normal."

"I am laser equipped, Mrs Arnfeld," said Mike, with an odd air of unexpressed pride.

"Yes, but there are millions of cancer cells all over. It would take how long to get them, one by one?"

"Not quite necessarily one by one, Tertia," said Johannes. "Even though the cancer is widespread, it exists in clumps. Mike is equipped to burn off and close capillaries leading to the clump, and a million cells could die at a stroke in that fashion. He will only occasionally have to deal with cells on an individual basis."

"Still, how long would it take?"

Johannes's youngish face went into a grimace as though it were difficult to decide what to say. "It could take hours, Tertia, if we're to do a thorough job. I admit that."

"And every moment of those hours will increase the chance of re-expansion."

Mike said, "Mrs Arnfeld, I will labour to prevent re-expansion."

Mrs Arnfeld turned to the robot and said earnestly, "Can you, Mike? I mean, is it possible for you to prevent it?"

"Not entirely, Mrs Arnfeld. By monitoring my size and making an effort to keep it constant,

I can minimize the random changes that might lead to a re-expansion. Naturally, it is almost impossible to do this when I am actually re-expanding under controlled conditions."

"Yes, I know. My husband has told me that re-expansion is the most dangerous time. But you will try, Mike? Please?"

"The laws of robotics ensure that I will, Mrs Arnfeld," said Mike solemnly.

As they left, Johannes said in what Mrs Arnfeld understood to be an attempt at reassurance,

"Really, Tertia, we have a holo-sonogram and a detailed cat scan of the area. Mike knows the precise location of every significant cancerous lesion. Most of his time-will be spent searching for small lesions undetectable by instruments, but that can't be helped. We must get them all, if we can, you see, and that takes time. Mike is strictly instructed, however, as to how small to get, and he will get no smaller, you can be sure. A robot must obey orders."

"And the re-expansion, Ben?"

“There, Tertia, we’re in the lap of the quanta. There is no way of predicting, but there is a more than reasonable chance, that he will get out without trouble. Naturally, we will have him re-expand within Gregory’s body as little as possible just enough to make us reasonably certain we can find and extract him. He will then be rushed to the safe room where the rest of the re-expansion will take place. Please, Tertia, even ordinary medical, procedures have their risks.”

Mrs Arnfeld was in the observation room as the miniaturisation of Mike took place.

So were the holovision cameras and selected media representatives. The importance of the medical experiment made it impossible to prevent that, but Mrs Arnfeld was in a niche with only Johannes for company, and it was understood that she was not to be approached for comment, particularly if anything untoward occurred.

Untoward! A full and sudden re-expansion would blow up the entire operating room and kill every person in it. It was not for nothing the observation room was underground and half a mile away from the viewing room.

It gave Mrs Arnfeld a somewhat grisly sense of assurance that the three miniaturists who were working on the procedure (so calmly, it would seem so calmly) were condemned to death as firmly as her husband was in case of anything untoward. Surely, she could rely on them protecting their own lives to the extreme; they would not, therefore, be cavalier in the protection of her husband.

Eventually, of course, if the procedure were successful, ways would be worked out to perform it in automated fashion, and only the patient would be at risk. Then, perhaps, the patient might be more easily sacrificed through carelessness but not now, not now. Mrs

Arnfeld keenly watched the three, working under imminent sentence of death, for any sign of discomposure.

She watched the miniaturization procedure (she had seen it before) and saw Mike grow smaller and disappear. She watched the elaborate procedure that injected him into the proper place in her husband’s body. (It had been explained to her that it would have been prohibitively expensive to inject human beings in a submarine device instead. Mike, at least, needed no life-support system.)

Then matters shifted to the screen, in which the appropriate section of the body was shown in holosonogram. It was a three-dimensional representation, cloudy and unfocused, made imprecise through a combination of the finite size of the sound waves and the effects of Brownian motion. It showed Mike dimly and noiselessly making his way through Gregory

Arnfeld’s tissues by the way of his bloodstream. It was almost impossible to tell what he was doing, but Johannes described the events to her in a low, satisfied manner, until she could listen to him no more and asked to be led away.

She had been mildly sedated, and she had slept until evening, when Johannes came to see her. She had not been long awake and it took her a moment to gather her faculties. Then she said, in sudden and overwhelming fear, “What has happened?”

Johannes said, hastily, “Success, Tertia. Complete success. Your husband is cured. We can’t stop the cancer from recurring, but for now he is cured.”

She fell back in relief. “Oh, wonderful.”

“Just the same, something unexpected has happened and this will have to be explained to Gregory. We felt that it would be best if you did the explaining.”

“I?” Then, in a renewed access of fear, “What has happened?” Johannes told her.

It was two days before she could see her husband for more than a moment or two. He was sitting up in bed, looking a little pale, but smiling at her.

“A new lease of life, Tertia,” he said buoyantly.

“Indeed, Greg, I was quite wrong. The experiment succeeded and they tell me they can’t find a trace of cancer in you.”

“Well, we can’t be too confident about that. There may be a cancerous cell here and there, but perhaps my immune system will handle it, especially with the proper medication and if it ever builds up again, which might well take years we’ll call on Mike again.

At this point, he frowned and said, “You know, I haven’t seen Mike.”

Mrs Arnfeld maintained a discreet silence.

Arnfeld said, “They’ve been putting me off.”

“You’ve been weak, dear, and sedated. Mike was poking through your tissues and doing a little necessary destructive work here and there. Even with a successful operation you need time for recovery.”

“If I’ve recovered enough to see you, surely I’ve recovered enough to see Mike, at least long enough to thank him.”

“A robot doesn’t need to receive thanks.”

“Of course not, but I need to give it. Do me a favour, Tertia. Go out there and tell them,

I want Mike right away.”

Mrs Arnfeld hesitated, then came to a decision. Waiting would make the task harder for everyone. She said carefully, “Actually, dear, Mike is not available.”

“Not available! Why not?”

“He had to make a choice, you see. He had cleaned up your tissues marvelously well; he had done a magnificent job, everyone agrees; and then he had to undergo re-expansion. That was the risky part.”

“Yes, but here I am. Why are you making a long story out of it?”

“Mike decided to minimize the risk.”

“Naturally. What did he do?”

“Well, dear, he decided to make himself smaller.”

“What! He couldn’t. He was ordered not to.”

“That was Second Law, Greg. First Law took precedence. He wanted to make certain your life would be saved. He was equipped to control his own size, so he made himself smaller as rapidly as he could, and when he was far less massive than an electron he used his laser beam, which was by then too tiny to hurt anything in your body, and the recoil sent him flying away at nearly the speed of light. He exploded in outer space. The gamma rays were detected.”

Arnfeld stared at her. “You can’t mean it Are you serious? Mike is dead?”

“That’s what happened. Mike could not refuse to take an action that might keep you from harm.”

“But I didn’t want that. I wanted him safe for further work. He wouldn’t have re-expanded uncontrollably. He would have gotten out safely.”

“He couldn’t be sure. He couldn’t risk your life, so he sacrificed his own.”

“But my life was less important than his.”

“Not to me, dear. Not to those who work with you. Not to anyone. Not even to Mike.” She put out her hand to him. “Come, Greg, you’re alive. You’re well. That’s all that counts.”

But he pushed her hand aside impatiently. “That’s not all that counts. You don’t understand.

Oh, too bad. Too bad!”

**ACTIVITY 4**

Instruction: You have now read the story as well as the features of science fiction. Based on the story, answer the following questions.

- i. Comment on the story 'Too Bad' and 'Mirror Image' as a science fiction by making a close reference to the features you have already explored.
- ii. How is science seen as a boon in both the stories?
- iii. How is science also seen as a bane in both the stories?

**Summary**

- Science fiction is a genre of literature that deals with the impact of science and technology on human beings.
- Science fiction comprises the following features:
 - Futuristic in nature.
 - Deals with the impact of science and technology.
 - It includes the use of very modern technologies or ideas that do not belong to the time in which it appears.
- The stories 'Too Bad' and 'Mirror Image' are science fiction stories.
- Modern science offers both benefits and harm to a human.

**Self-check for Learning**

Instruction: We have seen the features of science fiction and also read a science fiction story. Write an original science fiction story employing the features of a short story.

ཚོང་ལ།

1. ། རྟེན་ཚུངས།

ལས་དོན།



- རག་ཚུལ་ལུ་བརྟེན་ཏེ་ ཚུམ་རིག་གོང་འཕེལ་གཏང་ཚུགས།
- རག་ཚུད་ཀྱི་མོ་བཏབ་ཐོག་ མཐུན་འབྲེལ་རིག་ཚུལ་ལྷབ་ཚུགས།
- སློབ་རིག་ལས་བརྟེན་ཏེ་ རིག་ཚུལ་གོང་འཕེལ་གཏང་ཚུགས།
- ལམ་སྲོལ་རྒྱུ་སྐྱོང་དང་ ཉམས་སྲུང་འབད་ཚུགས།
- ཚོང་ལའི་མིང་ཚོག་ ལྷབ་སྲུང་འབད་ཚུགས།

དོ་སློབ།

ཚུང་མོ་ཟེར་མི་འདི་ རུམ་ལུ་བརྟེན་ཏེ་ མོ་བཏབ་མི་ཅིག་ལུ་སྤྲོབ་ཨིན།

ཚུང་མོ།

ང་བཅས་ར་ དཔལ་ལྷན་འབྲུག་པའི་རྒྱལ་ཁབ་ཀྱི་ རྒྱལ་ཡོངས་སྐད་ཡིག་འདི་ཚོང་ལ་ཨིན། ཚོང་ལ་འདི་གིས་རྒྱལ་ཁབ་ཀྱི་ རང་དབང་རང་བཙན་བཞག་ཐབས་དང་ སྲུང་སྐྱོབ་འབད་ནི་གི་དོ་རྟལ་ས་རོ་མ་ཅིག་ཨིན།

དེ་འབད་ནི་འདི་གིས་ ང་བཅས་རའི་ ལམ་སྲོལ་གྱི་རིག་ཚུལ་ཚུ་ རག་ཐོག་ལུ་ཉེ་མ་ལས་ར་དར་ཏེ་ཡོད་མི་ཚུ་ མར་ཉམས་ འགྱུ་མི་ཉེན་ཁག་ཡོད་པ་ལས་ འབྲུག་རྒྱལ་ཁབ་ཀྱི་གཡུ་སྡེ་གསལ་སོ་སོའི་ནང་ཡོད་པའི་ཚུང་མོ་ཚུ་ ཚོང་ལའི་སྤྱོད་ཚུམ་གྱི་ རིག་ཚུལ་རོ་མ་ཅིག་ཨིན་པ་ལས་ དེ་ཚུ་མ་ཉམས་པར་བཞག་ཐབས་ལུ་ སློབ་རིམ་ཆེ་ཚུང་གི་རིམ་པ་དང་འབྲེལ་ཏེ་ ཚུང་མོ་ ལྷབ་སྲུང་འབད་དགོས་འབད་བཅུགས་ཏེ་ཡོད་པ་ཨིན།

དགོས་པ།

ཚུང་མོ་འདི་ ལྷབ་དགོ་མི་དེ་ཡང་ དང་པ་རྒྱལ་ཡོངས་ཀྱི་ སྐད་ཡིག་བདག་འཛིན་འཐབ་ཚུགས་པ་གིས་མ་ཚད་ གཉིས་པ་ ཟེར་ཕྱད་ ཚོང་ལའི་མིང་ཚོག་ཚུ་ ཡར་རྒྱས་གཏང་ཚུགས། དེ་ལས་སྤྱོད་ཚུམ་འབྲི་ཐངས་ ཚུང་མོ་འཐེན་ཐངས་ མ་འདྲམ་ ཚུ་ གོང་འཕེལ་གཏང་ཚུགས། དེ་འབད་ནི་འདི་གིས་ཚུང་མོ་འདི་ སློབ་གི་ཐོག་ལས་འབད་ལྷབ་དགོས་ཨིན། ད་ ང་བཅས་ཀྱིས་ ལྷ་ལས་མར་ ཚུང་མོ་གི་སྐོར་ལས་ལྷབ་གོ།

དང་པ་རང་ ཚུང་མོ་ལུ་དབྱེ་བ་གསུམ་ཡོད།



རྩེ་མོ་འབྲི་བའམ་གྱི་སློབ་ལྷན།

རྩེ་མོ་འདི་རང་གིས་འབད་ གསར་པ་འབྲི་བའི་སྐབས་ལུ་ འོག་གི་གནད་དོན་ཚུ་སེམས་ཁར་བཞག་སྟེ་འབྲི་དགོ།

- ཚོགས་བཅད་འབད་འབྲི་དགོ།
- ཚོག་རྒྱུ་རེ་འེའི་ནང་ལུ་ ཚོག་འབྲུ་ལས་ལྟེ་ གྱི་བར་ན་ འབྲི་སློབ་ཡོད་པ་ཨིན།
- དཔྱེ་དང་ དོན་སྐྱར་ཉེ་འབྲི་ཚུགས་དགོ།

མཐུན་ཚོག་ ཡང་ན་ གཉེན་སྲུ།

རྩེ་མོའི་ཚོག་ནང་ དཔེ་ལོགས་ཤོམ་ཚུ་བཅུགས་ཞེན་མ་ལས་ སར་ལོགས་མའི་སེམས་ཁར་འབབ་བརྟུབ་ཅིག་དང་ རྩེ་བར་གོམ་ཅིག་ ཉན་པའི་ཚོག་ དཔེར་ན། སྐྱུང་གི་སྐོམ་སྐོང་དོ་བཟུམ་གྱི་ རྩེ་ཚོག་གི་སྐོག་ལས་ སེམས་ཁ་ལུ་དགའ་སློའ་འབྱུང་བཅུག་མི་གི་ ཚོག་ཡོད་མི་ཅིག་ལུ་སྐྱབ་ཨིན།

དཔྱེ་འབད་ན།

ཁྱོད་ནི་མ་བྱའི་མདོངས་སློ། །ར་ནི་ཚོ་དབང་བུམ་པ། །
ལས་དང་གནམ་བསྐྱེས་ཡོད་ན། །མཚོད་བཤམ་ཁྲ་མོར་འཛོམས་ཤོག །

ཚོད་ཚོག་ ཡང་ན་ དག་སྲུ།

ཚོད་ཚོག་ཟེར་མི་འདི་ རང་དང་མ་མཐུན་པའི་མི་དང་ ཡང་ན་ ཚོད་འབྲན་འབད་བའི་སྐབས་སུ་ སྟེ་ཚོན་གཞན་མི་འདི་ སེམས་བཅུག་ནིའི་དོན་ལུ་ སྐྱུང་ཚོག་དང་ ཚོག་ས་ཀ་ཚུ་བཅུགས་ཉེ་ ལན་སྐྱབ་མ་ཚུགས་པ་བཟོ་ནི་དང་ སར་ལོགས་མ་དེ་གི་ སེམས་ཁར་སོག་པའི་ཚོག་ཚུ་བཅུགས་ཉེ་ སྐྱབ་ནི་ལུ་གོམ་ཨིན།

ཚོད་ཚོག་ ཡང་ན་ དག་སྲུ།

འབྱུང་ན་གསེར་གྱི་མཚུབ་དཀྱི། །མ་འབྱུང་དདུལ་གྱི་མཚུབ་དཀྱི། །
ལྷས་རན་རག་གི་མཚུབ་དཀྱི། །བདག་ལ་དགོས་པ་མིན་འདུག །

དག་གཉེན་འབྲེས་མ།

དག་གཉེན་འབྲེས་མ་ཟེར་མི་འདི་ ཚོགས་བཅད་གཅིག་ནང་ རྩེ་ཚོག་དང་རྩེ་ཚོག་ ཡང་ན་ གཉེན་སྲུ་དང་དག་སྲུ་ གཉེས་ཆ་ར་སྐྱབ་བསྟེ་སྟེ་འོངམ་ཨིན།

དཔྱེ་འབད་ན།

མཐོ་བའི་རི་ལས་འབབ་མི། །ཚུ་མོ་འུར་སྐྱེ་ཤིག་ཤིག །
མཚོད་བཤམ་བུམ་པའི་ནང་གི། །ལྷས་ཚུ་བརྟུབ་བརྟུབ་མ་འབྲ། །

དགུང་དང་སྤྱིན་གྱི་མཚམས་ལས། །བྱུ་རུའི་མཚོད་རྟེན་བཞེངས་ཡི། །
ཉིམ་དང་ལྷ་བས་མ་གཏོགས། །གཞན་གྱིས་མངལ་ས་མིན་འདུག །

ཕྱང་མོ་ཁྱད་བརྗེ་བྲངས།

ཕོ་མོ་གཉིས་རེ་འབད་དེ་ དྲི་བ་དྲིས་ལན་གྱི་ཐོག་ལས་འབད་ འཐེན་ནི་ཡང་ཡོད་པའི་ཁར།
སྡེ་ཚན་གཉིས་འབད་བཅོ་སྟེ་ཡང་འཐེན་བཏུབ། དེ་ལས་ ཤར་ཕྱོགས་ལ་ཐུག་ལུ་འབད་བ་ཅིན་ ཚོས་བཅུ་གི་སྐབས་ལུ་
ལྷ་ཁང་ཚུ་སྐོར་ར་རྒྱབ་ད་ཡང་ ཕོ་དང་མོ་གི་བར་ན་འགྲན་བསྐྱར་འབད་དེ་ཡང་འཐེན་སྲོལ་ཡོད།

ཕྱང་མོའི་ཚིག།

ཕྱང་མོ་ཁྱད་བརྗེ་བྲངས་ སར་ལོགས་མ་གིས་ མཐུན་ཚིག་ཨིན་པ་ཅིན་ འདི་གི་ལན་ཡང་མཐུན་པའི་ལན་སྐབ་
དགོ།
སར་ལོགས་མ་གིས་ ཕྱོད་ཚིག་ཨིན་པ་ཅིན་ རང་གི་ལན་ཡང་ ཕྱོད་ཚིག་གི་ཐོག་ལས་སྐབ་དགོ།

ཕྱང་མོ་ མོ་བཏབ་བྲངས།

ཕྱང་མོ་གི་ཐོག་ལས་ མོ་བཏབ་ནི་དེ་ཡང་ ན་གཞོན་ཕོ་མོ་འདུ་འཛོམས་འབད་ས་ལུ་ ག་དང་ག་ ལས་འཕྲོ་ཡོད་པ་ཨིན་ན་
བཟླ་ནིའི་དོན་ལུ་ རེ་རེ་ལས་ཅ་ལ་རེ་བསྐྱ་སྟེ་ བཀའ་བཞག་ཞིན་མ་ལས་ ཅ་ལ་ངོ་མ་ཤེས་མི་ཅིག་གིས་ ཕྱང་དུམ་ལག་པར་
བཤེད་དེ་ ཕྱང་མོའི་ཚིག་རེ་ལུ་ ཕྱང་དུམ་ཚར་རེ་ ཅ་ལ་རེ་ལུ་དཔག་ཞིན་མ་ལས་ ཚིག་འགོ་བརྩུགས་པ་ད་ཕོག་མི་ཅ་ལ་དང་
མཐུག་བསྐྱེད་ད་ཕོག་མི་ཅ་ལ་གི་ཚེ་བདག་གཉིས་ གནམ་བསྐོས་ཡོད་པ་འབད་བ་ཅིམ་ཨིན།
དེ་སྟེ་ འབད་དགོ་མི་ཡང་ གནམ་བསྐོས་ཡོད་མེད་བཟླ་ནི་ རྒྱུམ་ཅིག་གིས་མ་དོ་བར་ ང་བཅས་རའི་སྐར་སྲོལ་
ལམ་ལུགས་བདག་འཛིན་འབབ་ནི་གི་དོན་ལུ་ཡང་ཨིན།

ཕྱང་མོ་ མོ་བཏབ་བྲངས་ཀྱི་དབྱེ་སྦྱོར།

ཁྱོད་ནི་རྒྱ་མཚོའི་སར་ལ། །ང་ནི་རྒྱ་མཚོའི་ཚུར་ལ། །
ལས་དང་སློན་ལམ་ཡོད་ན། །རྒྱ་མཚོའི་སྐྱུག་ལུ་འཛོམས་ཤོག །

ཕྱང་མོའི་གདངས་ཀྱི་དབྱེ་བ།

ཕྱང་མོ་ཚུ་ ལྷ་ཆེ་ཤོས་གདངས་འཐེན་མ་ཨིན། གདངས་འཐེན་བྲངས་ཡང་ ལུང་ཕྱོགས་དང་བསྐྱེད་པའི་ གདངས་འཐེན་
བྲངས་མ་འདྲམ་ལེ་ཤུ་ཡོད།

དབྱེ་འབདན་

བྱ་མོ་གནས་ལ་འཕུར་སོང་། །སློབ་དོ་ས་ལ་ལུས་སོང་། །
བྱ་མོ་དམ་ཚིག་ཡོད་ན། །སློབ་དོ་གཡས་སྐྱར་རྒྱབ་ཤོག །



སློབ་ལཱ་ ༡ པ།

སློབ་ལཱ་བཅད་ཐིག་ ༡ པ།	སློབ་ལཱ་བཅད་ཐིག་ ༢ པ།
<p>སློབ་ལཱ་འགོ་དུག་གྱ། སློབ་ལཱ་ཚུ་རང་མོའི་འབྲི་དེབ་ནང་ལུ་ བྲི་ནི།</p>	<p>༡༽ སློབ་དེབ་ནང་ཡོད་པའི་ རྩལ་མོའི་དབྱེ་ཚུ་ལྷག་ཞིན་མ་ལས་ དབྱེ་བ་དཔུང་? རྩལ་མོ་ལུ་དབྱེ་བ་ ག་དེ་འབད་ར་འདུག་གམ་? བྲིས། ༢༽ རྩལ་མོའི་གདངས་འཐེན་ཐངས་མ་འབྲུག་ཡོད་མི་ཚུ་ རྩོད་རྒྱུ་ཡང་ འཐེན་ཏེ་ སླུང་བ་འབད། ༣༽ རྩལ་མོ་ལྷག་སླུང་ལུ་བརྟེན་ཏེ་ རང་གི་མི་ཚེའི་ནང་ བན་ཐོགས་ ག་ཅི་ར་འབྱུང་ནི་ཡིན་པས། དབྱེ་བ་དཔུང།</p>



བཅུད་བསྟུས།

ད་རེས་ཀྱི་ རང་ཉིད་སློབ་སྟོན་མཁོ་ཆས་འདི་གི་ཐོག་ལས་ ག་ཅི་རང་ལྷབ་ཅི་གོ་བཟེར་བ་ཅིན་ རྩལ་མོ་ལྷག་དགོ་པའི་དགོས་པ་
རྩལ་མོའི་དབྱེ་བ། རྩལ་མོའི་ཚིག་འབྲི་ཐངས། དག་སྲུ་དང་གཉེན་སྲུ། དག་གཉེན་འབྲེས་མ། དེ་ལས་རྩལ་མོའི་ཐོག་ལས་ མོ་
བཏབ་ཐངས་ལ་སོགས་པ་ལྷབ་ཅི། དེ་ཚུ་རྩོད་རྒྱུ་ལེགས་ཤོམ་འབད་ཤེས་ལུག་གམ་? བཟུ་ཞིན་མ་ལས་ སླུང་བ་འབད་གནང།



རང་ཉིད་ལྷག་སླུང་ དབྱེ་ཞིབ།

- ལྷག་ལུ་ཡོད་མི་ རྩལ་མོ་ཚུ་ལས་ དག་སྲུ་གི་ ཚིག་བཅུམ་ཐངས་ག་དེ་འབད་འདུག་? དབྱེ་བ་དཔུང་དེ་
བཟུ།
- དེ་ལས་ རྩོད་ར་གིས་ཡང་ འདི་བཟུམ་གྱི་ རྩལ་མོ་ཅིག་འབྲི་ཞིན་མ་ལས་ ག་བསྟུར་འབད་དེ་བཟུ།
- རྩོད་རྒྱུ་ གཉེན་སྲུ་ཅིག་ འབྲི་བ་ཅིན་ ཚིག་ག་ཅི་རང་ཚང་དགོས་འདུག་?

MATHEMATICS

1. TRIGONOMETRY

1.1 Angles and Arc Lengths I

Sub Topic:

- Meaning of Trigonometry and Angle
- Convention of Signs of Angles
- Magnitude of Angles
- System of Measuring Angles

Learning Objectives



- Identify the conventional signs of an angle.
- Determine the magnitude of an angle.
- Identify two fundamental systems of measuring angles.

Introduction

Trigonometry deals with the study of angles, triangles and trigonometric functions (sin, cos, tan, cosec, sec and cot). We use it in daily lives and in different professions for measuring height, distances, sounds, light waves, and creating maps.

According to Greek mathematician Hipparchus, *Trigonometry* is derived from the Greek word 'trigonon' means *triangle* and 'metron' means *measurement* which literally means Triangle Measurements.



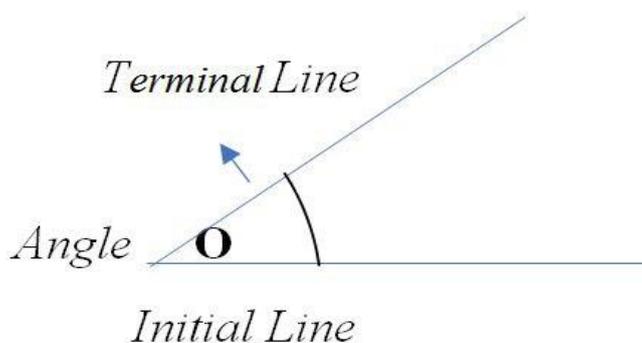
ACTIVITY 1

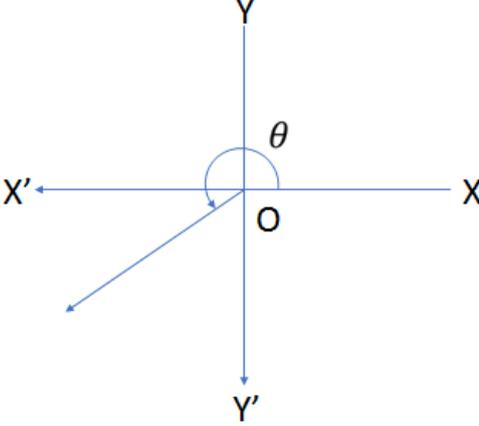
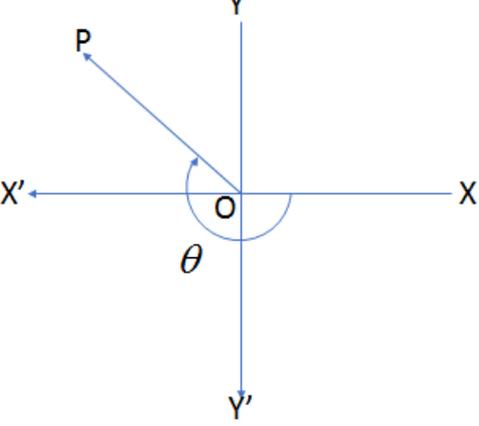
Instruction;

Read the information given below and answer the questions.

An angle is the traces made by rotation of a line from initial position OX to a terminal position OP. O is an angle made by two lines OP and OX as shown in the figure below:

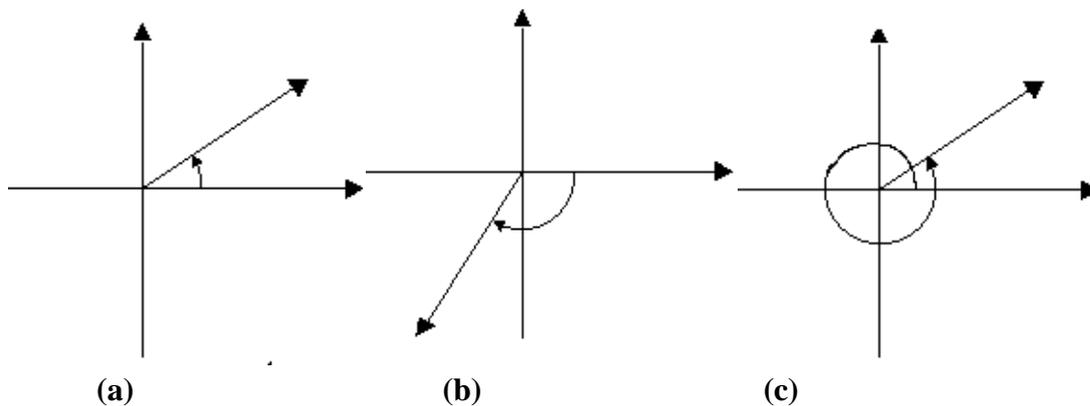
Convention of signs of angles.



Positive Angles	Negative Angles
<p>The angle traced out by counterclockwise rotation is regarded as a positive angle</p>  <p>θ is positive</p>	<p>The angle traced out by clockwise rotation is regarded as a negative angle</p>  <p>θ is negative</p>

Question:

What are the signs of angle given in the diagram below?



ACTIVITY 2

Instruction: Read the notes given below to answer the following questions.

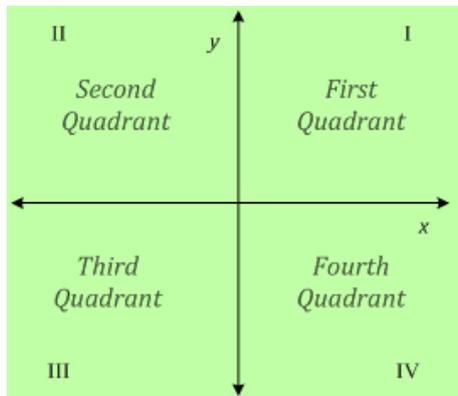
Magnitudes of an Angle

Every angle is measured from the positive part of the x-axis to its *terminal line*. To measure the angle, you have to understand the quadrants.

Quadrants

A rectangular coordinate system consists of the x-axis and y-axis that divide a plane into four regions called quadrants. Each quadrant is 90° and it is measured in an anti-clockwise direction. The point where the two axes intersect is called origin and is denoted by O.

Quadrants are usually denoted by roman letters I, II, III and IV as shown in the figure below:



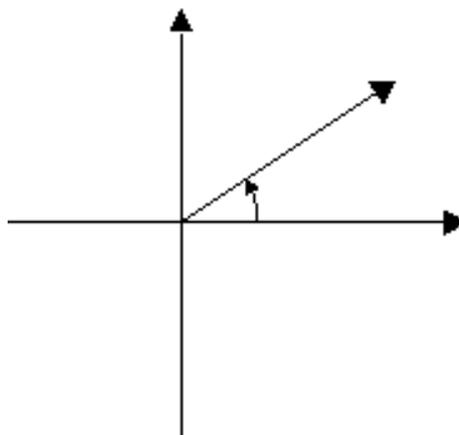
- Angles between 0° and 90° are in I quadrant.
- Angles between 90° and 180° are in II quadrant.
- Angles between 180° and 270° are in III quadrant.
- Angles between 270° and 360° are in IV quadrant.

Key Note:

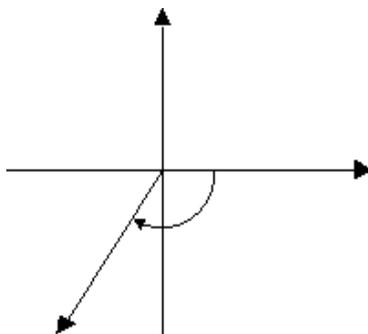
- The measures of angles can be more than 360° depending on the number of rotations. For one rotation, the angle is 360° , for two rotations it is $2 \times 360^{\circ}$, for three rotations it is $3 \times 360^{\circ}$ and so on.
- Thus, to measure the angles, we have to measure both the magnitude and the direction.

Examples:

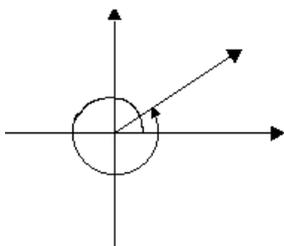
- This represents an angle of 45° , it lies quadrant I and the terminal line is half of quadrant I. An angle is positive because it is measured in anticlockwise direction.



- b) This represents an angle of -135° , it lies in III quadrant the angle is the sum of 90° from IV quadrant and 45° to the terminal line in III quadrant (i.e $90^\circ + 45^\circ = 135^\circ$). An angle is negative because it is measured in clockwise direction.



- c) This represents an angle 405° , it lies in I quadrant. It is the sum of one rotation and 45° in I quadrant (i.e $360^\circ + 45^\circ = 405^\circ$). An angle is positive because it is measured in anticlockwise direction.



Questions

Illustrate the following angles and state in which quadrant does it lie.

- -45°
- 300°
- 765°



ACTIVITY 3

Instruction: Read the information on two fundamental systems of measuring the angles and answer the questions that follow.

There are two fundamental systems of measuring angles. We know that angles are measured in degrees and this is one of the systems that you have already learnt. We are going to learn about two fundamental systems to measure angles.

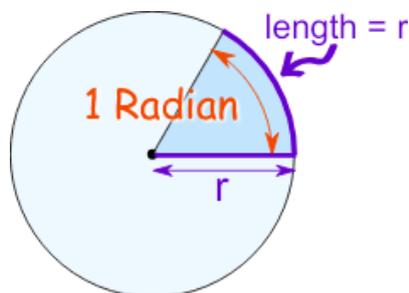
i. Sexagesimal System

In this system, angles are measured in degree, minutes and seconds. We have been using this system in lower classes because you know how to measure the angles in degrees.

- One complete rotation is 360 degree ($^\circ$).
- Each degree is divided into 60 equal parts called minutes ($'$).
- Each minute is divided into 60 equal parts called seconds ($''$).
 - Example: $35^\circ 34' 56''$ is read as 35 degrees 34 minutes and 56 seconds.

ii. Circular System

Angles are measured in radians. A radian is the measure of the central angle subtended by an arc equal in length to the radius of the circle.



Question: Fill in the blanks.

- a) The unit of measuring an angle in sexagesimal system is.....
- b) Radian is used as the unit to measure angle in system.
- c) $135^{\circ} 45' 14''$ is read as



Summary

- Sign of angle depends on the direction of the rotation.
- Angles can be more than 360° depending on the number of rotations.
- A rectangular coordinate system can be divided into four quadrants of an angle 90° each.
- To measure the angles, we have to measure both the magnitude and the direction.
- There are two systems to measure angles (via sexagesimal and circular system).



Self-check for Learning

Instruction: Answer the self-check questions. To answer the following questions refer activities I, II and III. If you are not able to answer it, refer the answers given in the next page.

1. What is the difference between negative and positive angles?
2. Can there be an angle greater than 360° ? Justify?
3. What are the two systems to measure the angles?

1.2 Angle and Arc Length II

Sub Topic:

- Relations between Radians and Degrees
- Length of an Arc of a Circle
- Area of a Sector of a Circle

Learning Objectives



- Determine the relationships between circumference and diameter of a circle, and between radians and degrees.
- Convert the angle from degree to radian measures.
- Convert the angle from radian to degree measures.

Introduction

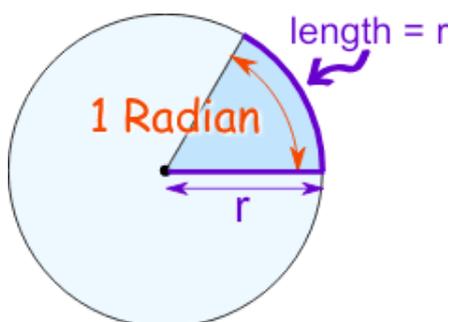
We know that there can be different units of measurement to measure the same thing. For example, length can be measured in feet and meters and temperature can be measured in degrees of **Celsius** and **Fahrenheit**. We often use formulas to convert between different units of measurement.

There are also two ways to measure angles. From lesson 1, we learned how to measure them in degrees. Now we will learn how to measure them in radians and how to convert between these two measurements. While measurements of degrees are used in everyday activities such as building construction and surveying land, **radian measure** is used for many calculations, such as the speed and distance travelled by satellites above the Earth's surface and also to solve problems about angular speed. It is important to be able to measure angles in radians as well as in degrees and to be able to convert between the two systems.

- **A degree** is the unit of the **sexagesimal system**.
- **Radian** is the unit of an angle in the **circular system**.

For us to be able to define radians, it is necessary to introduce the concept of a **central angle**. A **central angle** is an angle whose vertex is at the centre of a circle.

The angle subtended at the centre of a circle by an arc equal in the length to the radius of that circle is called a radian.





ACTIVITY 1

Instruction: Answer the following questions.

1. What are the two principal systems of angle measurement?
2. Name the unit of angle in circular system.
3. Define radian.

The Relation between Radians and Degrees

Explain and demonstrate how radians and degrees are related.

$$\frac{\text{arc } AB}{\text{Circumference}} = \frac{1 \text{ radian}}{360^\circ}$$

$$\therefore \frac{r}{2\pi r} = \frac{1 \text{ radian}}{360^\circ} \quad \text{or} \quad \frac{1}{\pi} = \frac{1 \text{ radian}}{360^\circ}$$

$$\therefore 1 \text{ radian} = \frac{360^\circ}{\pi} = a \text{ constant number}$$

or π radians = 180 degrees

A circular measure of any angle in radian = arc ÷ radius.

Area of a Sector of a Circle

Referring to the adjacent figure, let us try to understand how to find the area of a sector of a circle.

Let **AOB** be a sector of a circle, having centre **O** and radius **r**.

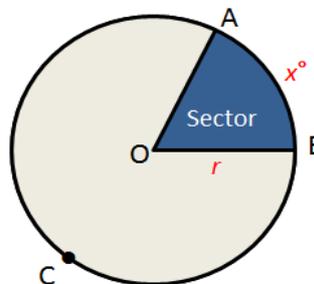
Let $\angle AOB = \theta$ radian and arc $AB = s$.

Now $\frac{\text{area of sector } AOB}{\text{area of the circle}} = \frac{\theta}{2\pi}$

$$\frac{\text{area of sector } AOB}{\pi r^2} = \frac{\theta}{2\pi}$$

$$\therefore \text{area of sector } AOB = \frac{\theta}{2\pi} \times \pi r^2 = \frac{1}{2} r^2 \theta = \frac{1}{2} r^2 \cdot \frac{s}{r} = \frac{1}{2} rs.$$

$$\therefore \theta = \frac{s}{r}$$



ACTIVITY 2

Instruction: Solve the following problems in the notebook.

1. Find the area of a sector of a circle, radius 4 cm bounded by an arc of length 5 cm.
2. The area of a sector is 7.85 cm^2 and its angle is $\frac{\pi}{5}$ radians. Find the radius of the circle (use $\pi = 3.14$).

Conversion Procedures

- i) To convert angles into radians to its equivalent degrees, we have to multiply the number of radians by $180^\circ/\pi$.
- ii) To convert an angle in degrees to its equivalent radians, we have to multiply the number of degrees by $\pi/180^\circ$.

**ACTIVITY 3**

Instruction: Solve the following problems in a notebook.

1. Convert the following radians into degrees.

i) π ii) $\frac{\pi}{5}$ iii) $\frac{5\pi}{6}$

2. Convert the following degrees into radians.

i) 90° ii) 210° iii) 405°

**Summary**

Radian is the unit of an angle in the *circular system*.

- A *degree* is the unit of the *sexagesimal system*.
- The angle subtended at the centre of a circle by an arc equal in the length to the radius of that circle is called a *radian*.
- π *radians* = 180 *degrees*.
- A circular measure of any angle in radian = arc \div radius.

$$\text{area of sector} = \frac{1}{2} r^2 \theta = \frac{1}{2} rs$$

- To convert angle into radian to its equivalent degrees, multiply the number of radians by $180^\circ/\pi$.
- To convert an angle in degrees to its equivalent radians, multiply the number of degrees by $\pi/180^\circ$.

**Self-check for Learning**

Solve the questions below to check your understanding of the concepts. Answers can be written in the notebook.

- 1) Express the following angles in degrees: i) $\frac{\pi}{6}$ ii) $\frac{14\pi}{15}$ iii) $\frac{11\pi}{18}$ iv) $\frac{7}{90}\pi$.
- 2) Express the following angles in radians: i) 20° ii) 135° .
- 3) Find the length of an arc of a circle of 3 cm radius if the angle subtended at the centre is 30° ($\pi = 3.14$).

1.3 Ratios, Identities, and Relationships

Sub Topics:

- Trigonometric Ratios
- Relationship between Trigonometric Ratios
- Proving simple Trigonometric Identities
- Signs of Trigonometric Ratios and Allied Angles
- Graphs of Trigonometry Ratios
- Angles of Elevation and Depression

Learning Objectives



- Identify trigonometric ratios.
- Establish relationship between trigonometric ratios.
- Prove simple trigonometric identities.
- Determine signs of trigonometric ratios and allied angles.
- Plot a simple graph of trigonometric-ratios.
- Solve problems based on angle of elevation and depression.

Introduction

According to Greek mathematician Hipparchus, *Trigonometry* is derived from two Greek words, ‘trigonon’ meaning *triangle*, and ‘metron’ meaning *measurement* which literally means measurements of triangles. The early application of trigonometry was in astronomy, surveying, navigation and engineering. In modern times, it finds wide application in warfare, all sorts of vibratory phenomena, sounds, lights, and electricity.



ACTIVITY 1

1. Trigonometry Ratios (t-ratios)

Trigonometric ratios are the ratios between sides of a right-angled triangle. There are six trigonometric ratios in total. Let us assume a right-angle triangle ABC with an angle “ θ ” and the sides a, b and c as shown in Figure 1.

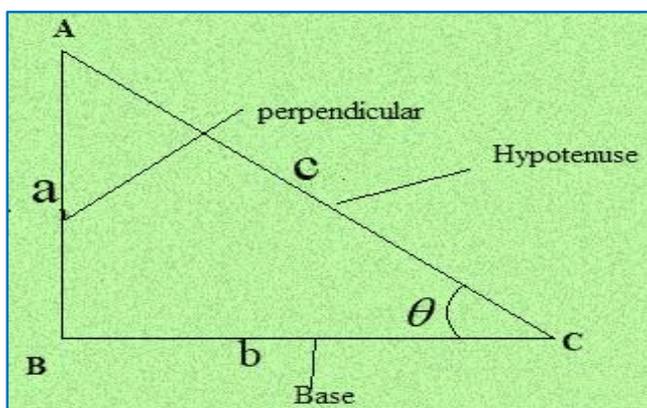


Figure 1: Right-angled Triangle

The six trigonometric ratios are as follows.

$$i. \text{ sine } \theta = \frac{\text{perpendicular}}{\text{hypotenuse}} = \frac{a}{c}$$

$$ii. \text{ cosine } \theta = \frac{\text{base}}{\text{hypotenuse}} = \frac{b}{c}$$

$$iii. \text{ tangent } \theta = \frac{\text{perpendicular}}{\text{base}} = \frac{a}{b}$$

$$iv. \text{ cosecant } \theta = \frac{\text{hypotenuse}}{\text{perpendicular}} = \frac{c}{a}$$

$$v. \text{ secant } \theta = \frac{\text{hypotenuse}}{\text{base}} = \frac{c}{b}$$

$$vi. \text{ cotangent } \theta = \frac{\text{base}}{\text{perpendicular}} = \frac{b}{a}$$

Keynote: The first three ratios are known as primary ratios (sin, cos, tan) and the next three ratios are known as reciprocal ratios (cosec, sec, cot). T-ratios are applicable only for the right-angled triangle.

2. Relationship between Trigonometric Ratios

i. *Reciprocal relations*

$$\text{cosec } \theta = \frac{1}{\sin \theta}, \text{ sec } \theta = \frac{1}{\cos \theta}, \text{ cot } \theta = \frac{1}{\tan \theta}$$

ii. *Quotient relations*

$$\tan \theta = \frac{\sin \theta}{\cos \theta}, \text{ cot } \theta = \frac{\cos \theta}{\sin \theta}$$

iii. *Square relations*

$$\sin^2 \theta + \cos^2 \theta = 1, \text{ sec}^2 \theta = 1 + \tan^2 \theta, \text{ cosec}^2 \theta = 1 + \cot^2 \theta$$

3. Proving Simple Trigonometric Identities

Each identity has two sides namely the left-hand side (LHS) and the right-hand side (RHS).
Follow the following steps to prove trigonometric identities.

Step1: Study both sides carefully and chose the side that is complicated as it is easier to reduce this side to the simple side.

Step2: Use the square relations mentioned above in point 2 (iii) to make the necessary substitution to reach to a simple side.

Let us now look at a few examples to get the clear idea of proving simple trigonometric identities.

Examples:

Prove that:

$$i. \quad 1 - \cos^2 \theta = \sin^2 \theta$$

ii. $\cos\theta = \sqrt{1 - \sin^2\theta}$

Solutions:

i. Taking LHS since it is complicated compared to RHS of the given identities.

$$\begin{aligned}
 &1 - \cos^2\theta \\
 &= \sin^2\theta + \cos^2\theta - \cos^2\theta \text{ -----substituting } 1 = \sin^2\theta + \cos^2\theta \\
 &= \sin^2\theta + \cancel{\cos^2\theta} - \cancel{\cos^2\theta} \\
 &= \sin^2\theta = \text{RHS, hence proved.}
 \end{aligned}$$

ii. Taking RHS since it is complicated compared to RHS.

$$\begin{aligned}
 &\sqrt{1 - \sin^2\theta} \\
 &= \sqrt{\sin^2\theta + \cos^2\theta - \sin^2\theta} \text{ -----substituting } 1 = \sin^2\theta + \cos^2\theta \\
 &= \sqrt{\cancel{\sin^2\theta} + \cos^2\theta - \cancel{\sin^2\theta}} \\
 &= \sqrt{\cos^2\theta} \\
 &= \cos\theta = \text{LHS, hence proved.}
 \end{aligned}$$

Instruction	Identities
1. To check whether you have understood this method. Prove the given identities in the notebook.	i) $1 - \cos^2\theta - \sin^2\theta = 0$ ii) $\frac{\sec^2\theta - 1}{\tan^2\theta} = 1$ iii) $\cos^2\theta(\operatorname{cosec}^2\theta - \cot^2\theta) = \cos^2\theta$



ACTIVITY 1

1. Signs of t-ratios in Quadrants

Quadrants: A rectangular coordinate system consists of the x-axis and y-axis that divide a plane into four regions called quadrants. Each quadrant is 90° and it is measured in an anti-clockwise direction. The point where the two axes intersect is called origin and is denoted by O. Quadrants are usually denoted by roman letters I, II, III and IV. The signs of each t-ratios are different in different quadrants. Study the *figure* given below to understand the sign of t-ratios.

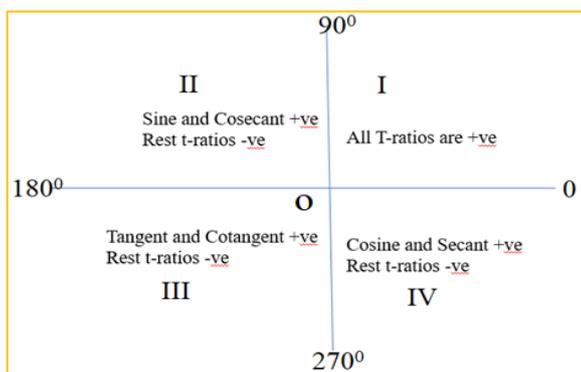


Figure: Sign of t-ratios in Different Quadrants

2. T-ratios of Standard Angles and Allied Angles

Standard Angles	Allied Angles
Standard angles are those angles for which t-ratios can be easily determined. There are 5 standard angles for which t-ratios can be easily determined. The standard ratios are $0^\circ, 30^\circ, 45^\circ, 60^\circ$ and 90° .	Two angles are said to be allied when their sum or difference is either zero or a multiple of 90° . The angles $-\theta, 90^\circ \pm \theta, 180^\circ \pm \theta, 270^\circ \pm \theta, 360^\circ \pm \theta, \dots$ are angle allied to the angle θ , if the angle θ is measured in degree. Any angle other than standard angles is allied angles.

The table below shows the value of t-ratios of sine, cosine, and tangent for the standard angles.

Angle	0°	30°	45°	60°	90°
Sin	0	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$	1
Cos	1	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$	0
Tan	0	$\frac{1}{\sqrt{3}}$	1	$\sqrt{3}$	∞

t-ratios for $(-\theta)$

- i) $\sin(-\theta) = -\sin \theta$
- ii) $\cos(-\theta) = \cos \theta$
- iii) $\tan(-\theta) = -\tan \theta$
- iv) $\operatorname{cosec}(-\theta) = -\operatorname{cosec} \theta$
- v) $\sec(-\theta) = \sec \theta$
- vi) $\cot(-\theta) = -\cot \theta$

3. Graphs of t-ratios

We can draw the graph of all t-ratios but let us focus only on the graph of 3 primary ratios. In the note below you will learn to draw the graph of $\sin \theta, \cos \theta$ and $\tan \theta$ as θ increases from 0° to 360° . We need to follow the following steps to draw the graph of t-ratios.

Step 1: Take θ as $0^\circ, 30^\circ, 60^\circ, 90^\circ, \dots, \text{upto } 360^\circ$ (at the interval of 30°) and find the corresponding values of the t-ratio using a calculator. Correct it to two decimal places.

Example: $\sin 30^\circ = 0.50, \sin 60^\circ = 0.87, \dots$ so on.

Step 2: Construct a table of values and plot the points accordingly in the coordinate system.

Step 3: Draw the smooth curve through the points to obtain the required graph.

Example: Sketch the graph of $\sin \theta$ as θ increases from 0° to 360° .

Creating the table of values

θ	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°	360°
$\sin \theta$	0	0.50	0.87	1	0.87	0.5	0	-0.5	-0.87	-1	-0.87	-0.5	0

Now, let us plot these points in a graph paper and join the points with a smooth curve to obtain the graph for $\sin \theta$. The graph of $\sin \theta$ obtained is shown in Figure 3.

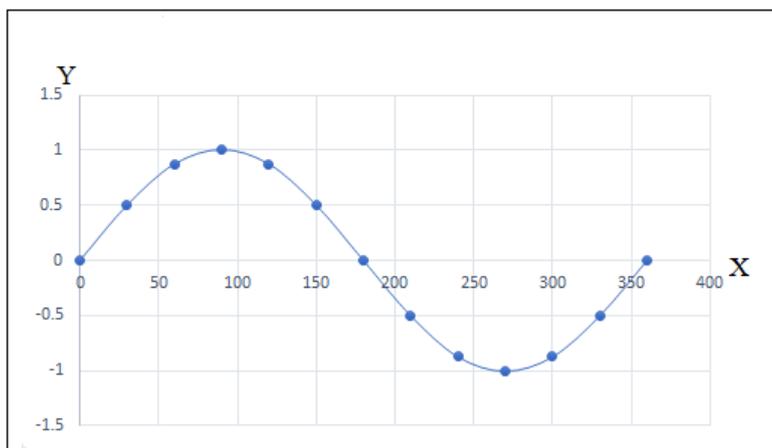


Figure: The Graph of $\sin \theta$



ACTIVITY 1

Instruction: Sketch the graph of $\cos \theta$ and $\tan \theta$ as θ increases from 0° to 360° .

1. Angles of Elevation and Depression

Angle of Elevation	Angle of Depression
<p>The angle of elevation is the angle between the horizontal line and the line of sight to the object that is above the horizontal line.</p>	<p>The angle of depression is the angle between the horizontal line and the line of sight to the object that is below the horizontal line.</p>

2. Practical Problems based on the Angle of Elevation and Depression (in 2 D)

Example 1: The angle of elevation of the top of a tower at a distance of 150 meters from its foot on a horizontal plane is found to be 30° . Find the height of the tower correct to one place of decimal.

Solution:

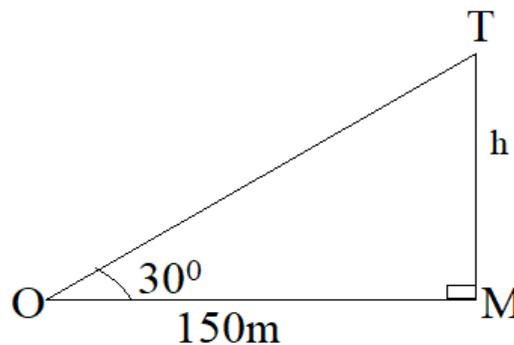
Let TM, the tower, be h meters high. Then

$$\tan \theta = \frac{\text{perpendicular}}{\text{base}}$$

$$\tan 30^\circ = \frac{h}{150}$$

$$h = 150 \times \tan 30^\circ$$

$$h = 150 \times \frac{1}{\sqrt{3}} = \frac{150}{\sqrt{3}} \approx 86.6 \text{ metres}$$



Example 2: The angle of depression of a boat B from the top K of cliff HK, 300 metres high, is 40° . Find the distance of the boat from the foot H of the cliff.

Solution:

Let the required distance BH be equal to x meters.

HK is the cliff and angle LKB is the angle of depression of B from K. Then

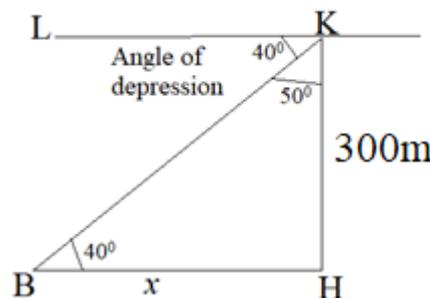
Angle KBH = angle LKB

$$\therefore \text{angle BKH} = 90^\circ - 40^\circ = 50^\circ$$

From ΔBKH , we get

$$\frac{x}{300} = \tan 50^\circ$$

$$x = \tan 50^\circ \times 300 = 357.53 \text{ metre}$$



∴ Distance of boat from foot H of the cliff = 357.53 metres

Refer to the above examples to answer the following questions.

1. A tower stands vertically on the ground. From the point on the ground, which is 15m away from the foot of the tower, the angle of elevation of the top of the tower is found to be 60° . What is the height of the tower?
2. The angle of depression from the top of a building to the base of a car is 45° . If the building is 10 meters tall, how far away is the car from the base of the building?



Summary

- Trigonometric ratios are the ratios between sides of a right-angled triangle. There are six t-ratios.
- Square relations of t-ratios can be used to prove the trigonometric identities.
- T-ratios have different signs in different quadrants.
- Standard angles of t-ratios are those angles for which t-ratios can be determined easily. There are 5 standard angles in total.
- Allied angles are all the angles other than standard angles.
- All t-ratios have their respective graph.
- T-ratios are applied in finding the height and distance of the object.



Self-check for Learning

Instruction: To answer the following questions, refer to the above activities.

1. Write down the formula to calculate all the t-ratios.
2. What is the sign of $\sin \theta$ in III quadrants?
3. Which t-ratios are positive in II quadrants?
4. Which t-ratios are negative in IV quadrants?
5. What is the difference between the angle of elevation and angle of depression?

2. ALGEBRA

2.1 Determinants

Sub Topic:

- Determinants of Order 2 and 3
- Expansion or Value of Determinants
- Prefix Sign of Elements in 3rd Order Determinants
- Minors and Cofactors of Determinants

Learning Objectiv



- Define determinant.
- Differentiate between 2nd and 3rd order determinants.
- Calculate the values of determinants.
- Identify the minors and cofactors of elements in determinants.

Introduction

The word ‘determinant ‘was invented by Gauss in the 1800s in the context of the discriminant of homogeneous polynomials. The early concept of ‘determinant’ was used by Chinese scholars in the early third century BC. However, the use of the concept in modern mathematics, starting around the 1700s, is attributed to the Japanese mathematician Seki Takakazu. The concept of determinant arose as a means of determining the solution of a linear system of equation.

The determinant is a scalar value that can be computed from the elements of a square matrix. It is denoted as $\det(A)$ or $|A|$.

2nd Order Determinants

Any four members a, b, c and d arranged in two rows and two columns between two vertical bars form second order determinants. Thus, the symbol $\begin{vmatrix} a & b \\ c & d \end{vmatrix}$ represents the 2nd Order

Determinant and its value is defined as $ad - bc$.

The figure below demonstrates the methods of finding the value of 2nd Order Determinants. The members a, b, c, and d are called elements of the determinant and the expression $ad - bc$ is called values of determinants or expansion of determinants.

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$$

The example of finding the value of determinant using the above method is given below.

$$\begin{vmatrix} 5 & -3 \\ 2 & 1 \end{vmatrix} = 5 \times 1 - (2 \times -3) = 5 - (-6) = 11$$



ACTIVITY 1

Instruction: Based on the above lesson on the expansion of the 2nd Order Determinant, solve the following questions.

1. Evaluate the following determinants.

$$i.) \begin{vmatrix} 2 & 5 \\ 1 & 4 \end{vmatrix} \quad ii.) \begin{vmatrix} 3 & 5 \\ -1 & -2 \end{vmatrix}$$

2. If $\begin{vmatrix} 3 & m \\ 4 & 5 \end{vmatrix} = 3$, find the value of m .

3. Determine the value of k for which $\begin{vmatrix} k & k \\ 4 & 2k \end{vmatrix} = 0$

3rd Order Determinants

An expression of the form $\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$ is called the determinant of the third order. It contains

3 rows, 3 columns, and 9 elements.

Value of 3rd Order Determinants

The value of 3rd order determinants can be found by using the elements of any row or column with the prefix signs as given below.

$$\begin{vmatrix} + & - & + \\ - & + & - \\ + & - & + \end{vmatrix}$$

The signs of the elements alternate or change starting with (+) in the upper left-hand corner.

For the determinant $A = \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$.

If we expand the determinant by the elements of 1st row(R_1), i.e. finding the value of determinant using elements of R_1 , we have

$$\det(A) = a_1 \begin{vmatrix} b_2 & c_2 \\ b_3 & c_3 \end{vmatrix} - b_1 \begin{vmatrix} a_2 & c_2 \\ a_3 & c_3 \end{vmatrix} + c_1 \begin{vmatrix} a_2 & b_2 \\ a_3 & b_3 \end{vmatrix}$$

And similarly, if we expand the determinant by the elements of 2nd column (C_2), we have:

$$\det(A) = -b_1 \begin{vmatrix} a_2 & c_2 \\ a_3 & c_3 \end{vmatrix} + b_2 \begin{vmatrix} a_1 & c_1 \\ a_3 & c_3 \end{vmatrix} - b_3 \begin{vmatrix} a_1 & c_1 \\ a_2 & c_2 \end{vmatrix}$$

Multiply each element of row or column you have chosen by the sub-determinant obtained by deleting the rows and column in which that elements lies. Take sign of product as per the prefix sign given above.

To get the clear idea of expansion of 3rd order determinant, let us see the following examples.

Example 1: Evaluate

$$\begin{vmatrix} 1 & 3 & -1 \\ 4 & 1 & -2 \\ 5 & -3 & 2 \end{vmatrix}$$

Solution: Let us find the value of this determinant by using the first row,

$$\begin{aligned} \det(A) = |A| &= 1 \begin{vmatrix} 1 & -2 \\ -3 & 2 \end{vmatrix} - 3 \begin{vmatrix} 4 & -2 \\ 5 & 2 \end{vmatrix} + (-1) \begin{vmatrix} 4 & 1 \\ 5 & -3 \end{vmatrix} \\ &= 1(2 - 6) - 3(8 + 10) - 1(-12 - 5) \\ &= -4 - 54 + 17 = -41 \end{aligned}$$

Example 2: Find the value of

$$\begin{vmatrix} 3 & 2 & 1 \\ 0 & 1 & -8 \\ 0 & -5 & 7 \end{vmatrix}$$

Solution: It is always convenient to expand using a row or a column that has more zeros. The calculation will be easy with zeros. For this example, let us expand using the first column since there are two zeros in C₁

$$\begin{aligned} |A| &= 3 \begin{vmatrix} 1 & -8 \\ -5 & 7 \end{vmatrix} - 0 \begin{vmatrix} 2 & 1 \\ -5 & 7 \end{vmatrix} + 0 \begin{vmatrix} 2 & 1 \\ 1 & -8 \end{vmatrix} \\ &= 3(7 - 40) - 0 + 0 = 3 \times -33 = -99 \end{aligned}$$



ACTIVITY 2

Instruction: Evaluate the following determinants and write your answer in your notebook.

1. $\begin{vmatrix} 1 & 3 & -1 \\ 2 & 1 & 4 \\ 6 & 1 & 1 \end{vmatrix}$

2. $\begin{vmatrix} 3 & 5 & -2 \\ 2 & 0 & -1 \\ 5 & 0 & 1 \end{vmatrix}$

Minors and Cofactors

1. Minors

The minor of an element is the determinant that is left after removing the row and the column which intersects at the element. The minor will have order one less than that of a given determinant. Consider the determinant:

$$\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$$

The minor of a_1 is $\begin{vmatrix} b_2 & c_2 \\ b_3 & c_3 \end{vmatrix}$, similarly, the minor of b_1 is $\begin{vmatrix} a_2 & c_2 \\ a_3 & c_3 \end{vmatrix}$,

and that of c_1 is $\begin{vmatrix} a_2 & b_2 \\ a_3 & b_3 \end{vmatrix}$

Minors are denoted as M_{ij} , where i represents the number of rows and j represents the number of columns. Considering the above example,

Minor of a_1 is denoted as M_{11} since a_1 is an element in first row and first Column, similarly minor of b_1 is denoted as M_{12} and c_1 as M_{13}

2. Cofactors

The Cofactor of an element is denoted as A_{ij} , where i represents the number of the row, and j represents the number of the column as mentioned above. Cofactors are obtained by applying an appropriate sign to the minors. Thus, cofactors are obtained using the formula given below:

$$A_{ij} = (-1)^{i+j} \times M_{ij}$$

From the above example,

The cofactor of a_1 (A_{11}) is $\begin{vmatrix} b_2 & c_2 \\ b_3 & c_3 \end{vmatrix}$, similarly, the cofactor of b_2 (A_{12}) is $-\begin{vmatrix} a_2 & c_2 \\ a_3 & c_3 \end{vmatrix}$,

and that of c_1 (A_{13}) is $\begin{vmatrix} a_2 & b_2 \\ a_3 & b_3 \end{vmatrix}$

Let us now look at the following examples to understand the concepts of minors and cofactors of the determinants.

Example 1: 2nd Order Determinants

Write down the minors and cofactors of each element in the determinant $\begin{vmatrix} 1 & -2 \\ 5 & 4 \end{vmatrix}$

Solution:

Minors

$$\text{Minor of } 1 = M_{11} = 4$$

$$\text{Minor of } -2 = M_{12} = 5$$

$$\text{Minor of } 5 = M_{21} = -2$$

$$\text{Minor of } 4 = M_{22} = 1$$

Cofactors

$$A_{11} = (-1)^{1+1} \times 4 = 4$$

$$A_{12} = (-1)^{1+2} \times 5 = -5$$

$$A_{21} = (-1)^{2+1} \times -2 = 2$$

$$A_{22} = (-1)^{2+2} \times 1 = 1$$

Example 2: 3rd Order Determinants

Find the minors and cofactors of the elements of the determinant $\begin{vmatrix} 2 & -2 & 3 \\ 1 & 4 & 5 \\ 2 & 1 & -3 \end{vmatrix}$

Solutions:

The minors are;

$$M_{11} = \begin{vmatrix} 4 & 5 \\ 1 & -3 \end{vmatrix} = -12 - 5 = -17 \quad M_{12} = \begin{vmatrix} 1 & 5 \\ 2 & -3 \end{vmatrix} = -3 - 10 = -13 \quad M_{13} = \begin{vmatrix} 1 & 4 \\ 2 & 1 \end{vmatrix} = 1 - 8 = -7$$

$$M_{21} = \begin{vmatrix} -2 & 3 \\ 1 & -3 \end{vmatrix} = 6 - 3 = 3 \quad M_{22} = \begin{vmatrix} 2 & 3 \\ 2 & -3 \end{vmatrix} = -6 - 6 = -12 \quad M_{23} = \begin{vmatrix} 2 & -2 \\ 2 & 1 \end{vmatrix} = 2 + 4 = 6$$

$$M_{31} = \begin{vmatrix} -2 & 3 \\ 4 & 5 \end{vmatrix} = -10 - 12 = -22 \quad M_{32} = \begin{vmatrix} 2 & 3 \\ 1 & 5 \end{vmatrix} = 10 - 3 = 7 \quad M_{33} = \begin{vmatrix} 2 & -2 \\ 1 & 4 \end{vmatrix} = 8 + 2 = 10$$

The cofactors are;

$$A_{11} = (-1)^{1+1} \cdot M_{11} = 1 \times -17 = -17 \quad A_{12} = (-1)^{1+2} \times -13 = 13 \quad A_{13} = (-1)^{1+3} \times -7 = -7$$

$$A_{21} = (-1)^{2+1} \cdot M_{21} = -1 \times 3 = -3 \quad A_{22} = (-1)^{2+2} \times -12 = -12 \quad A_{23} = (-1)^{2+3} \times 6 = -6$$

$$A_{31} = (-1)^{3+1} \cdot M_{31} = 1 \times -22 = -22 \quad A_{32} = (-1)^{3+2} \times 7 = -7 \quad A_{33} = (-1)^{3+3} \times 10 = 10$$



ACTIVITY 3

Instruction: Find the minors and cofactors of the elements in the following determinants.

$$1. \begin{vmatrix} 1 & 5 \\ 2 & -3 \end{vmatrix} \quad 2. \begin{vmatrix} 1 & -1 & 0 \\ 4 & 3 & -1 \\ -5 & 2 & 6 \end{vmatrix}$$



Summary

- Determinants are the scalar values computed from the elements of a square matrix.
- Determinants of **2nd order** have two rows and two columns, and 4 elements.
- Determinants of **3rd order** have three rows and three columns, and 9 elements.
- Value of a determinant of **3rd order** can be obtained by expanding the elements from any row or column but we need to take care of the prefix signs.
- The minor of an element is the determinant that is left after removing the row and the column which intersects at the element. The minor will have order one less than that of a given determinant.
- Cofactors are obtained by applying an appropriate sign to the minors.

**Self-check for Learning**

Instruction: To answer the following questions refer to the above activities.

1. What is 'determinant'?
2. What is the difference between the **2nd** and **3rd** order determinants?

3. What is the cofactor of element 2 in the determinant $\begin{vmatrix} 3 & -2 & 4 \\ -1 & 0 & 2 \\ 5 & 4 & 0 \end{vmatrix}$?

4. What is the minor of element b in the determinant $\begin{vmatrix} a & b \\ c & d \end{vmatrix}$?

5. Solve for x:

$$i.) \begin{vmatrix} x & 0 & 0 \\ 2 & 1 & 3 \\ 0 & 1 & 4 \end{vmatrix} = 3$$

$$ii.) \begin{vmatrix} x^2 & x & 1 \\ 0 & 2 & 1 \\ 3 & 1 & 4 \end{vmatrix} = 28$$

SCIENCE STREAM

1. PHYSICS

1.1 Newton's Third Law of Motion

Learning Objectives



- State Newton's Third Law.
- Explain the applications of Newton's Third Law in daily activities.

Introduction

You have learned in Newton's First Law that the presence of an unbalanced force will accelerate or decelerate a moving object: - changing either its speed, direction, or both.

Newton's Second Law explains the relationship between force, mass, and acceleration of a moving body.

$$\text{Force} = \text{mass} \times \text{acceleration}$$

This is what you have seen in our previous lessons.

Now, you will be learning Newton's Third Law. You have already seen in classes IX and X that this law explains action-reaction forces. This means forces always exist in pairs.

Newton's Third Law of Motion

Try lifting a heavy bag from the ground, you will feel that the bag is pulling you down. Force you apply to lift the bag is the action and the force you experience due to the weight of the bag is the reaction, which acts in pairs.

Sir Isaac Newton recognized that the forces always act in pairs in his third law of motion, which is most commonly stated as:

For every action, there is an equal and opposite reaction.

Definition: According to Newton's Third Law of Motion, whenever an object applies a force (an action) on a second object, the second object also applies an equal and opposite force (a reaction) on the first object.

Application of Newton's Third Law of Motion

- When you swim, you push the water backwards with your hands, arms, and legs. The water pushes you in the opposite direction, propelling you forward.
- When you walk or run, you push your feet backward and down on the ground. You will experience force on your feet in the opposite direction which will help you to move forward.

- When an aeroplane starts, its engine pushes the air backward with a large amount of force. The aeroplane will experience a reaction force in the opposite direction which helps the motion of the aeroplane.
- When a basketball player bounces the ball, the player hits the ground with a large amount of force and an equal amount of force is experienced by the ball but in the opposite direction and that is why the ball bounces back.



ACTIVITY 1

1. As you have gone through the examples above, draw simple sketches to show the action-reaction pairs to prove that you have understood the concept of Newton's third law of motion.
2. How would Newton's Third Law explain the phenomenon of firing a bullet from a gun and the air released from an inflated balloon?



Summary

- For every action, there is always an equal and opposite reaction directed along the same straight line.
- If we understand and apply this law in our day to day activities, it will make our work easier and faster.

1.2 Projectile Motion

Learning Objectives



- Define projectile.
- Describe and draw the motion of a projectile.
- Apply projectile equations to find maximum height, Range and Time of flight during projectile motion.

Introduction

Have you ever observed the path taken by basketball when the player is to make a score or when a football player kicks the ball in the air? The path described in the above

Projectile

Projectile means a particle or an object sent in space with the help of an external force. Motion is the path described by the projectile is known as its trajectory. It is basically a parabolic in nature. The study of it in detail is given under the branch of physics known as *ballistics*.

Projectile motion is a motion described by a particle or a projectile when displaced in the air (space) against the force of gravity.

Examples:

- The path followed by an arrow before it hits the target.
- The motion of a space shuttle.

One Dimensional Projectile Motion

When a projectile is thrown in space at an angle of 90 degrees, there is a change in terms of a single variable. The projectile undergoes changes in one dimension only i.e. in terms of distance travelled along one axis.

Example:

- When a ball is dropped from the top of the building/free fall.

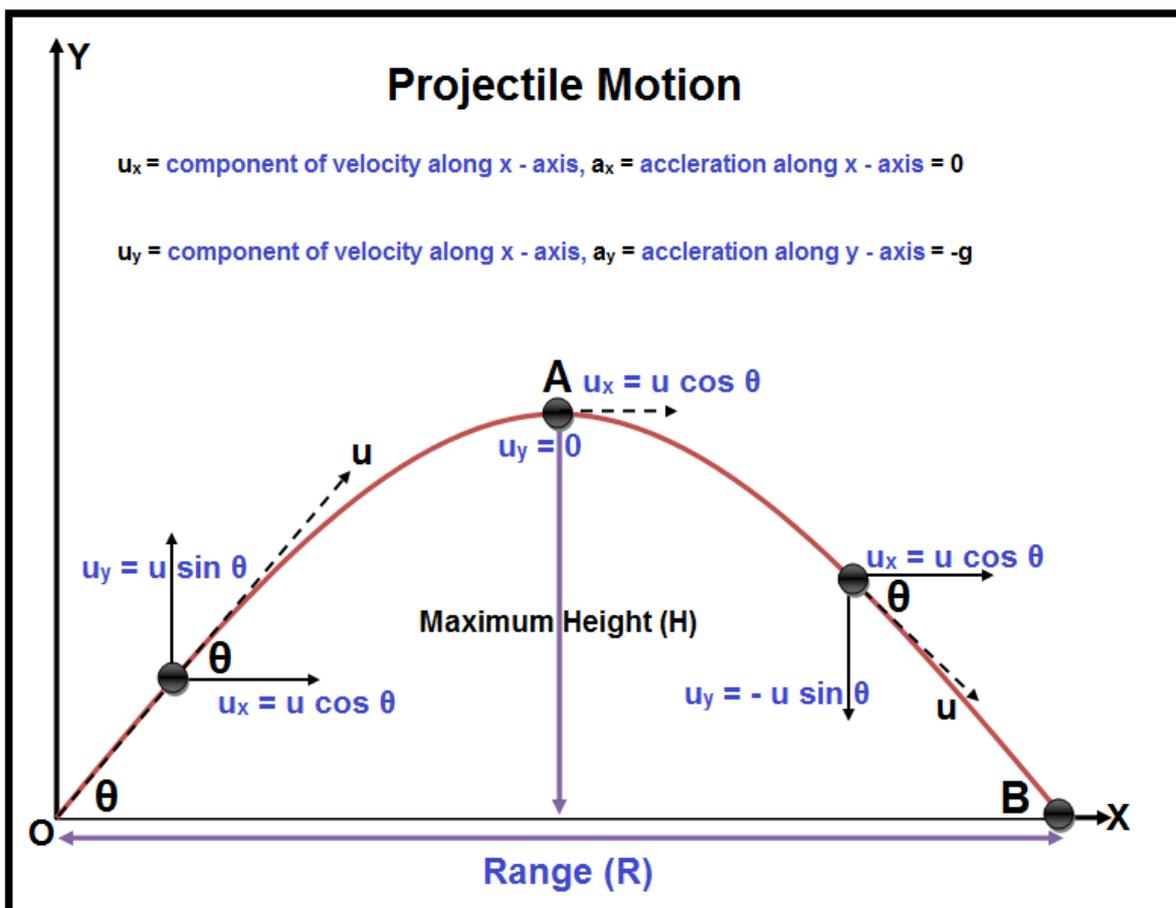
Two-dimensional Projectile Motion

The projectile position is determined by change in terms of two variables i.e. x and y variables.

Description of Projectile Motion

Consider a particle fired with a velocity at an angle θ with the horizontal. The projectile rises to the highest point A and falls back at B lying on the level of projection.

The initial velocity (u) can be resolved as the sum of two components i.e. horizontal component ($u \cos \theta$) and the vertical component $u \sin \theta$. The horizontal component of the velocity is uniform because the acceleration due to gravity has no impact in this direction whereas the vertical component is not uniform because the acceleration due to gravity is acting opposite to it.



These two components are independent of each other since they are perpendicular to each other. The only significant force that acts on the object is gravity, which acts downward, thus imparting a downward acceleration to the object.

Path of Projectile

The displacement of the body along the horizontal direction after the time (t) is given by $x = (u \cos \theta) \times t$

The displacement along the vertical direction is derived using the equation of kinematics and is given by the equation:

$$y = (\tan \theta)x - \frac{1}{2} \frac{g}{u^2 \cos^2 \theta} x^2$$

The equation is similar to $y = ax \pm bx^2$ which is quadratic in nature, therefore the path of the projectile is parabolic in nature.

The maximum vertical distance travelled during the flight is known as maximum height and the time taken by the projectile to come back to the same level after reaching the maximum height is known as the time of flight. The horizontal distance covered by the projectile during the flight is known as the range.

If the angle of projection i.e. θ and the initial velocity is given then, using the projectile motion equation, the maximum height, range, time of ascent and time of flight can be calculated.

- *Maximum Height:* The maximum vertical height attained by the projectile during its flight is known as Maximum Height.

$$H = \frac{u^2 \sin^2 \theta}{2g}$$

- *Horizontal Range (R):* The maximum horizontal distance covered by the projectile during its flight.

$$R = \frac{u^2 \sin 2\theta}{g}$$

- *Time of Flight:* The total time for which the projectile is in flight.

$$T = 2t = \frac{2u \sin \theta}{g}$$

- *Time of Ascent (t):* It is the time taken by the projectile to rise to the highest point i.e.

$$t = \frac{u \sin \theta}{g}$$

The horizontal distance covered by the projectile is maximum when the projectile is projected at an angle of $\theta = 45^\circ$ from the ground. A football player can kick the ball at an angle of 45° to obtain maximum range.

Example: Javelin, discus and shot-put players should, therefore, take an angle of projection equal to 45° to achieve maximum horizontal range.



ACTIVITY 1

1. An athlete throws a javelin to a maximum distance of 80 m. How long is it in air and to what height does it rise? Neglect the height of the athlete.

Solution.

Given: Maximum range = 80m, angle (θ) = 45°

Therefore: a) Maximum range, $R = \frac{u^2 \sin 2\theta}{g}$

$$= \frac{(u^2 \sin 2 \times 45^\circ)}{g} \quad \text{since } \sin 90^\circ = 1$$

$$= \frac{u^2}{g}$$

$$80 = \frac{u^2}{9.8}$$

$$u^2 = 9.8 \times 80$$

$$u = 28 \text{ m/s}$$

b) Time of flight (T) = $2 u \sin \theta / g$

$$= 2 \times 28 \sin 45^\circ / 9.8$$

$$T = \frac{2 \times 28}{9.8 \times \sqrt{2}}$$

$$T = 4.04 \text{ s}$$

$$\begin{aligned} \text{c) Maximum Height (H)} &= u^2 \sin^2\theta / 2g \\ &= \frac{(28)^2 \times (\sin 45^\circ)^2}{2 \times 9.8} \\ &= \frac{(28)^2 \times 1}{2 \times 9.8 \times 2} \\ &= 20 \text{ m} \end{aligned}$$



Summary

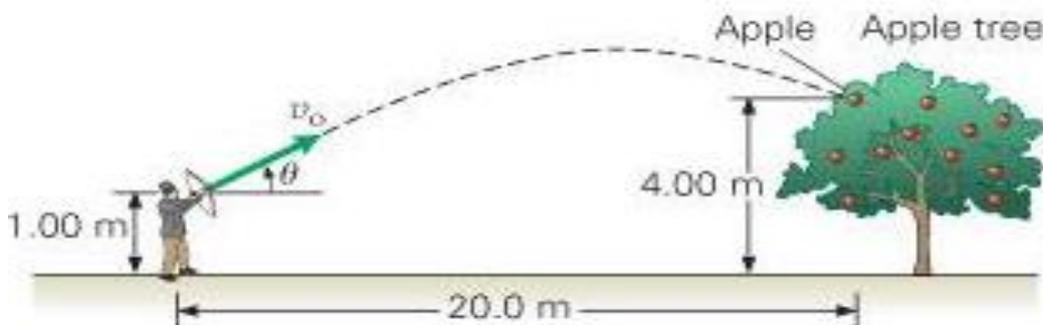
- Projectile motion helps us to understand the motion of an object in a parabolic path.
- It helps us to find the horizontal and vertical distance covered, time taken during the flight.
- We can calculate the horizontal and vertical components.
- It helps us to find the angle at which the projectile should be released to obtain the maximum high and cover the longest range.
- It also helps us to find the time to hit a distant target.
- The projectile covers the maximum range if it is fired/released at an angle of 45° .
- The range of the projectile is the same for two complementary angles, i.e. θ and $(90^\circ - \theta)$.



Self-check for Learning

Instruction: Solve the following questions to check your understanding of the lessons.

- 1 The horizontal range of a projectile is $4\sqrt{3}$ times its maximum height. Its angle of projection will be:
 A. 45° B. 60° C. 90° D. 30°
- 2 Dorji tries to hit the apples using a catapult as shown in the figure below. Calculate the angle (θ) and the initial velocity?



1.3 Bernoulli’s Principle

Learning Objectives



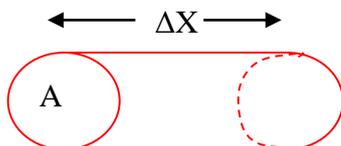
- Explain the relationship between the velocity and the pressure of a fluid.
- Explain the equation of continuity.
- Explain Bernoulli’s Principle.
- Utilize the scientific process to predict, observe and conclude phenomena.
- Prove the fact that the water tower should be kept at a greater height.
- List some applications of Bernoulli’s Principle.

Introduction

You should have a fair knowledge about different types of energy and kinematics. You must have observed the phenomena of watering the plants or washing cars. When you partially block the water hose or pipe with your thumb, the water comes with greater speed and can reach a far distance. Have you ever wondered why this happens? You will get to know the answer to this question in this lesson.

Equation of Continuity

Suppose a fluid is flowing through a tube of cross-sectional area (A) with speed (v) and takes time Δt to cover a distance ΔX.



In this case, we can write the formula for the speed of fluid as:

$$Speed = \frac{distance}{time}$$

$$v = \frac{\Delta X}{\Delta t} \text{ (Substituting the values)}$$

On cross-multiplication, we get:

$$\Delta X = v \times \Delta t \text{-----(1)}$$

Now the formula for the volume of fluid flow (ΔV) can be written as:

$$Volume = Area \text{ of cross section} \times Length$$

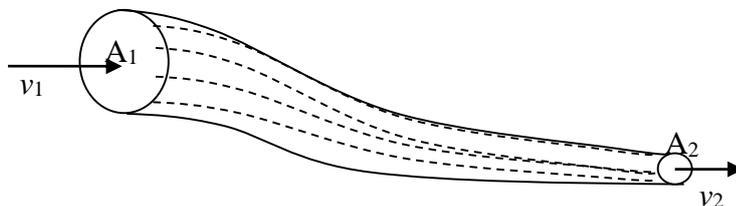
On substituting we get:

$$\Delta V = A \times \Delta X \text{-----(2)}$$

Substituting the value of ΔX from equation (1) in equation (2) we have:

$$\Delta V = A \times v \times \Delta t \text{-----(3)}$$

Now, let us take a tube of non-uniform cross-section having a cross-sectional area of A_1 at the left end and cross-sectional area of A_2 at the other end. Let the speed of the liquid at the left end and right end be v_1 and v_2 respectively.



Applying the equation (3) to both the left and right ends of the non-uniform tube, we get

$$\Delta V = A_1 \times v_1 \times \Delta t = A_2 \times v_2 \times \Delta t$$

On cancelling Δt on both the sides of the equation, we get:

$$A_1 v_1 = A_2 v_2 \text{------(4)}$$

This relation is called the *equation of continuity*. According to this equation, the product of the area of cross-section (A) and the speed (v) remains constant at all points of a tube of flow.

$$Av = \text{constant}$$

On rearranging equation (4), we get:

$$\frac{A_1}{A_2} = \frac{v_2}{v_1}$$

Or $A \propto \frac{1}{v}$

Therefore, the rate of flow (speed) is inversely proportional to the cross-sectional area of the tube. The fluid flows with greater speed in the narrow part of the tube and flows with a slower speed at the wider part of the tube. This is the reason that the water comes out with greater speed when the pipe is partially blocked with your thumb.

Examples:

- i The flow of river changes with change in the width of the river. The river flows more slowly as it passes through a wider area and speeds up as it enters a narrow region.
- ii The lawn sprinkler has many tiny holes of small cross-section. Since the area of cross-section of each hole is small, the water comes out with high speed from the sprinkler and reaches far distance.



Bernoulli’s Principle

Daniel Bernoulli, a Swiss scientist, discovered that as a velocity of the fluid increases, the pressure within the fluid decreases and vice versa.

According to Bernoulli’s principle, the *total energy* for a *streamlined flow* of an *ideal liquid* (or incompressible fluid) per unit volume remains constant at every cross-section throughout the liquid flow. The *total energy* is equal to the sum of pressure energy, potential energy and kinetic energy of the liquid.

Let us first derive the expressions for different types of energy before going for Bernoulli's equation.

i **Kinetic Energy**
$$\text{Kinetic energy} = \frac{1}{2}mv^2$$

Kinetic energy per unit volume = $\frac{1}{2} \frac{mv^2}{V}$ ('v' represents speed and 'V' represents volume.)

Since, density(ρ) = $\frac{\text{Mass (m)}}{\text{Volume(V)}}$

Kinetic energy per unit volume = $\frac{1}{2}\rho v^2$ -----(5)

ii **Potential Energy**

$$\text{Potential energy} = mgh$$

('h' represents the elevation or height of the fluid from the ground.)

Potential energy per unit volume = $\frac{mgh}{V}$

Since, density(ρ) = $\frac{\text{Mass (m)}}{\text{Volume(V)}}$

Potential energy per unit volume = ρgh -----(6)

iii **Pressure Energy**

Pressure energy = $P \times V$

Pressure energy per unit volume = $\frac{P \times V}{V}$

On cancelling 'V' we get,

Potential energy per unit volume = P -----(7)

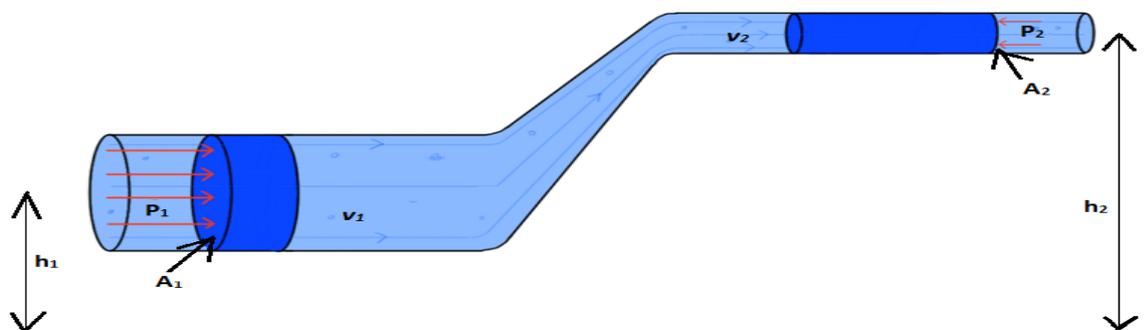
According to Bernoulli's principle, the *pressure energy* per unit volume + *Kinetic energy* per unit volume + *Potential energy* per unit volume = a constant

Substituting the values from equations (5), (6) and (7), we get:

$$P + \frac{1}{2}\rho v^2 + \rho gh = a \text{ constant} \text{ -----(8)}$$

This is known as Bernoulli's equation.

Here, P, ρ , v and h are pressure, density, velocity, and elevation of the fluid respectively.



Applying Bernoulli's equation at the lower end and upper end of the given tube, we get

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho gh_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho gh_2$$

This is also a form of Bernoulli's equation.

If we take $h=0$ in equation (8) so that the fluid does not change elevation as it flows, then the equation becomes:

$$P + \frac{1}{2}\rho v^2 = a \text{ constant}$$

From this equation, we can say that if the velocity of a fluid at a given cross-sectional area is more, then the pressure of the fluid must be less and vice versa to maintain the sum of pressure (P) and kinetic energy per unit volume $\left(\frac{1}{2}\rho v^2\right)$ constant.

Examples of Bernoulli's Principle:

- i. Roofs of houses are usually blown off during a storm. It is due to the difference in pressure and velocity of the wind above and below the roof. The velocity of the wind is high above the roof due to which a low pressure is created above the roof. The velocity of air below the roof that is inside the house is very low. So, the pressure below the roof, inside the house is higher than outside. Therefore, the roof is pushed outward due to high pressure below the roof and it is blown off the house.
- ii. Bernoulli's Principle is the underlying concept of how devices like jets and nozzles work.
- iii. It also explains the motion of a spinning ball while playing cricket and ball games.
- iv. The working of the Bunsen burner is based on Bernoulli's principle.
- v. Water tanks are usually placed at the top of buildings.

Using Bernoulli's equation:

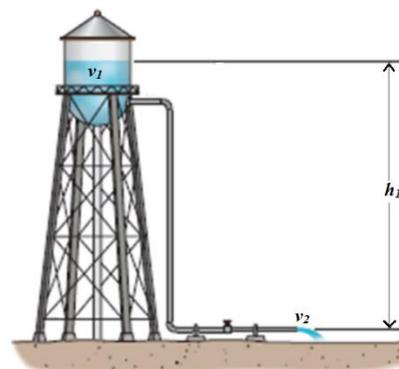
$$P_1 + \frac{1}{2}\rho v_1^2 + \rho gh_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho gh_2$$

If we take h_2 as the reference point (ground level) then $h_2 = 0$. The velocity of the water (v_1) at ground level will be

very small and the term $\frac{1}{2}\rho v_1^2$ can be neglected compared to other terms. Again the pressures P_1 and P_2 are both atmospheric pressure, therefore we get

$$\rho gh_1 = \frac{1}{2}\rho v_2^2 \qquad v_2 = \sqrt{2gh_1}$$

Thus, we can conclude from this equation that velocity (v) is directly proportional to the square root of height (h) when pressures P_1 and P_2 are equal. Thus, the water flows with greater speed when it falls from a tank placed on top of buildings.



ACTIVITY 1

Instruction: Carry out the following activity following the steps explained below. You will need a piece of paper, straw and a flat surface (table).

Step 1: Fold the paper into V-shape and keep it on a flat surface or table.

Predict what will happen when you blow underneath the paper.

Step 2: Gently blow through the straw, underneath the V-shaped paper.

What did you conclude from the above experiment after your careful observations?
 The expected outcome of the experiment: The paper will flatten because as we blow, the velocity of air underneath the paper increases and hence the pressure decreases as compared to the pressure on top of the paper.

Tips for the successful conduct of the experiment: blow gently and keep the straw about one inch away from the V-shaped paper.



Summary

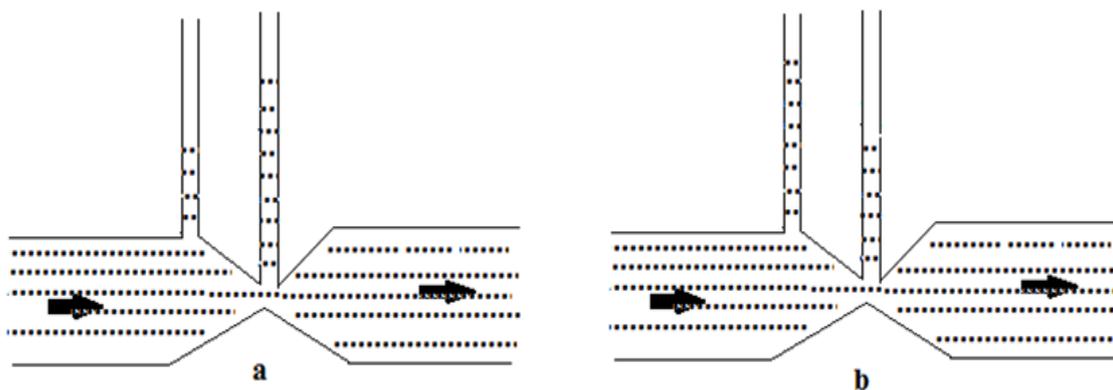
The relation between speed and cross-sectional area is called the equation of continuity. The equation of continuity represents the conservation of mass in the case of moving fluids. In Bernoulli's Principle, we consider pressure energy, potential energy, and kinetic energy per unit mass.

An ideal fluid is one that is incompressible and has no viscosity. It is also called a perfect fluid.



Self-check for Learning

1. The given figures *a* and *b* show a steady flow of an incompressible, non-viscous liquid. Which of the two figures is incorrect? Why?



Hint: You may consider area cross-section, pressure, and velocity of the fluid.

2. Each wing of an aeroplane is an aerofoil, how does it help to lift the plane off the runway? Explain with the help of Bernoulli's Principle.
3. A garden hose with an internal radius of 0.02 m is connected to a lawn sprinkler that consists of 10 holes each of radius 0.0025 m. If the speed of water in the hose is 2 m/s, at what speed does it leave the sprinkler holes?
4. Explore for more applications of Bernoulli's Principle around us.

1.4 Addition of Coplanar Vectors

Learning Objectives



- Explain addition of coplanar vectors.
- State triangle’s law of vector addition.
- Determine the magnitude of resultant vector.
- Determine the direction of resultant vector.
- Apply the concept of vector addition to real life situations.

Introduction

When we add two scalar quantities like 2 kg of potatoes and 1kg of tomatoes, we simply add their magnitudes i.e. $2\text{kg} + 1\text{ kg} = 3\text{ kg}$. This type of addition is called the algebraic sum. If you have two velocities 30 km/h due north and 20 km/h due west, the sum of these two velocities is not equal to 50 km/h (i.e. $30\text{ km/h} + 20\text{ km/h} = 50\text{ km/h}$). This is because velocity is a vector quantity.

Vector quantities cannot be added algebraically like scalar quantities. You need to consider the magnitude as well as the direction of vector quantities.

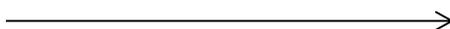
So, through this lesson you will be learning how to add vector quantities using the triangle’s law of vector addition.

A symbolic Representation of Vectors

Vector A is represented as \vec{A} and magnitude of vector A is represented as $|\vec{A}|$

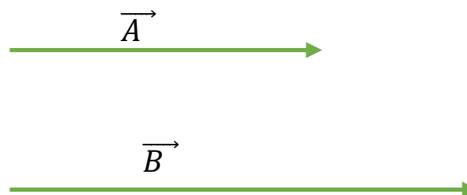
Diagrammatic Representation of a Vector

A vector is represented diagrammatically by an arrow.



The length of the arrow gives the magnitude of the vector and the tip of the arrow shows the direction of the vector. The longer the length of the arrow, the greater is the magnitude of the given vector.

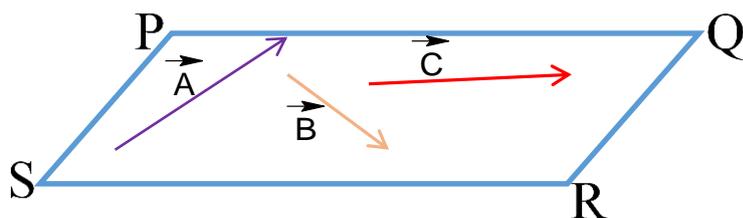
The magnitude of \vec{B} is greater than that of \vec{A} since \vec{B} is longer than \vec{A} . The directions of both the vectors are towards the east.



Coplanar Vectors

Vectors lying on the same plane are called coplanar vectors.

Let vectors \vec{A} , \vec{B} and \vec{C} be on a plane PQRS as shown in the figure. These three vectors \vec{A} , \vec{B} and \vec{C} are called coplanar vectors.



Addition of Coplanar Vectors

- Vectors cannot be added algebraically like scalar quantities.
- We use the triangle’s law for the addition of vectors.

Triangle’s Law of Vector Addition

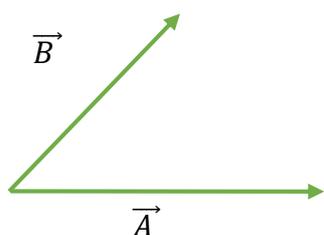
It states that if two vectors are represented in magnitude and direction by the two sides of a triangle taken in the same order, the third side of the triangle, taken in the opposite order, represents the resultant in magnitude and direction of the two vectors.

There are two ways of using the triangle’s law in determining the magnitude and direction of the resultant vector. They are the graphical method and the analytical method.

i. Graphical Method

The magnitude and direction of the resultant of two vectors can be determined by drawing a scaled triangle using the triangle’s law of vector addition. If the actual value of the vector is 40 km/h then you can draw 4 cm in your diagram. Such diagrams are called scaled diagrams. You have to choose an appropriate scale in such diagrams so that your diagram fits in your notebook or chart paper. The same scale should be applied for all the sides of the triangle.

Suppose you are given two vectors \vec{A} and \vec{B} of given magnitudes. The direction of \vec{A} is towards east and vector \vec{B} is directed towards north-east.

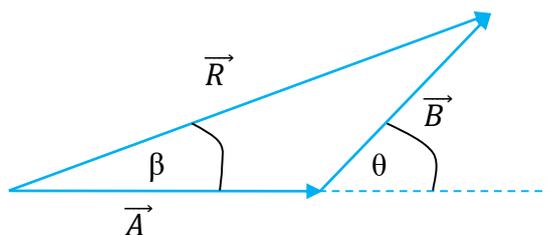


The following steps are used for drawing the triangle.

Step 1: Draw vector \vec{A} of given magnitude in the given direction.

Step 2: Draw the second vector \vec{B} of given magnitude at a given angle from the tip of the vector \vec{A} in the same order. (You may also draw \vec{B} first and then \vec{A} because the order of drawing the two vectors does not affect the resultant vector.

Step: Draw vector \vec{R} from the tail of the vector \vec{A} till the head of the vector \vec{B} in the opposite order.



This triangle is also called a vector triangle. The third side of the triangle drawn in opposite order represents the magnitude and direction of the resultant vector, \vec{R} . The resultant vector is the vector sum of the two given vectors \vec{A} and \vec{B} . The length of the vector \vec{R} gives the magnitude of the resultant vector and its arrowhead shows its direction.

The angle (θ) between the two given vectors is usually given in questions. Sometimes, it can be determined from the direction of the vectors. For instance, if two vectors are directed towards the north and east directions then the angle between them is 90° .

The angle (β) between the resultant vector and the first vector \vec{A} gives us the direction of the resultant vector.

So we can write,

$$\vec{A} + \vec{B} = \vec{R}$$

We can read it as ‘vector sum of vector A and vector B is equal to vector R’.

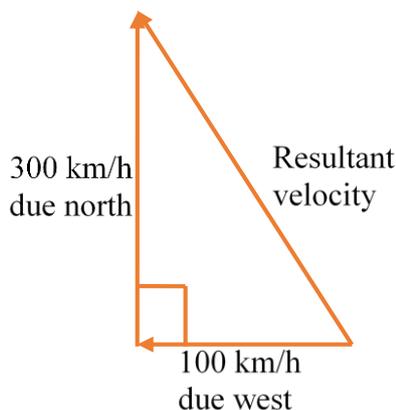
ii. Analytical Method

In an analytical method, the magnitude of the resultant vector is determined by using the formula for the magnitude of the resultant vector (\vec{R}).

The formula for the magnitude of the resultant vector is:

$$|\vec{R}| = \sqrt{|\vec{A}|^2 + |\vec{B}|^2 + 2|\vec{A}||\vec{B}|\cos\theta}$$

Example: An aeroplane is flying at a velocity of 300 km/h towards north cutting through a wind blowing from the east towards the west at a velocity of 100 km/h. What will be the resultant velocity of the plane?



Always draw a sketch diagram before solving a problem. It will guide you in solving the problem.

Given: $|\vec{A}| = 300\text{km/h}$, $|\vec{B}| = 100\text{ km/h}$ and $\theta = 90^\circ$

$$|\vec{R}| = \sqrt{|\vec{A}|^2 + |\vec{B}|^2 + 2|\vec{A}||\vec{B}|\cos\theta}$$

Substituting the values, we get:

$$|\vec{R}| = \sqrt{(300)^2 + (100)^2 + 2 \times 300 \times 100 \times \cos 90^\circ}$$

$$|\vec{R}| = 316.2\text{km/h}$$

Therefore, the resultant velocity of the aeroplane is:

$$|\vec{R}| = 316.2\text{km/h due north - west}$$

Examples of the addition of vectors from real-life situations

- i. Every day you come to school from your home. You follow your path in different directions. You can find your displacement by taking the vector sum of the paths that you have taken.
- ii. It is a common experience that when you cross a high current river, you will not be able to cross the river straight to the other bank. It is because the velocity of the high current river will oppose you. As a result, your resultant velocity will change and you will reach somewhere diagonally on the other side of the river.



Summary

- A vector can be represented by a magnitude and a direction.
- Vectors are of different types.
- A position vector gives the position of a point with reference to the origin.
- A displacement vector represents the displacement.
- Vectors can be added or subtracted, or multiplied by real numbers.
- Vectors are added or subtracted if they are of the same nature, two-position vectors can be added/subtracted or two displacement vectors can be added/subtracted. But a displacement vector and a force vector cannot be added/ subtracted.
- Vectors lying in the same plane are called coplanar vectors. We cannot add or subtract vectors like real number addition or subtraction which we use in daily life. Therefore, we use the triangle law or the parallelogram law of vector addition or some other methods.



Self-check for Learning

1. Deki is going to her relative's place from her home. She first walks 2 km towards the east and then 1 km towards north-east. What is her displacement when she reaches her destination?
2. Explore some more applications of the triangle's law of vector addition in our day-to-day life.

1.5 Force and Motion in Fluids*Sub Topic:*

- Fluid Resistance and Surface Resistance and Tension

Learning Objectives

- Define fluid and fluid resistance.
- Define surface tension.
- Derive terminal velocity.
- State the impact of solute on surface tension.
- Explain capillarity and its applications.

Introduction*What is a fluid?*

The fluid is a substance that begins to flow when an external force is applied to it. Examples of fluid include water, honey, water vapour, oxygen, etc. A fluid can adjust or adapt to the boundaries of any container in which it is put.

Motion of a Body Falling in a Uniform Gravitational Field with Fluid (air) Resistance*Imagine yourself skydiving, or jumping off the aeroplane. What would you experience?**Let us see.*

When you jump off the plane you will be pulled down because of the earth's gravitational pull. This pull is the force due to gravity which is your body weight, ie.

$$F_g = mg$$

Now as you fall, you experience a resistive force (F_a) due to air, also called drag force. As you fall your velocity increases (give an example of hair blowing while cycling). As speed increases resisting force also increases till it is equal to body weight.

At this point, the drag force becomes equal to the body weight (or gravitational force).

Now the acceleration of the body becomes zero, which means the body is moving with constant velocity as the 2 forces cancel each other and the net force acting on it is zero. This maximum constant velocity is called terminal velocity.

Mathematically, $F_a \propto v$

For small speeds, this force f is taken to be approximately proportional to the falling speed v , that is:

$$F_a = -kv$$

Where k is the proportionality constant. The negative sign indicates that the friction force opposes the motion of the body.

Neglecting any forces associated with buoyancy in the fluid, we find the net vertical component of force as $mg + f$. From Newton's second law of motion, we can write:

$$mg + f = ma$$

$$\text{when } v = 0, a = g \quad mg - kv = m \frac{dv}{dt}$$

As speed increases resisting force also increases till it is equal to body weight. At this point $mg - kv = 0$, then $a = 0$, . This implies that the velocity remains the same.

$$mg - kv_t = 0 \Rightarrow v_t = \frac{mg}{k}$$

The final velocity, also known as the terminal velocity, is given by the above equation.

Take a ball and an inflated balloon of the same size and dropped them from the same height.

Which one will reach the ground faster? Why would this happen?

You have learned about flying an aeroplane. Now you will learn about walking on water. You must have seen that some insects walk on the water surface.

How is it possible? Why can't we humans walk on the water surface?

The free surface of the liquid behaves similarly to the stretched membrane trying to minimize the surface area. So surface behaving like a stretched membrane is not due to gravity but is of molecular origin.

This is due to a strong cohesive force between the water molecules. The force of cohesion represents the attractive force of two similar molecules.

Surface Tension

The property of a liquid by virtue of which the free surface of the liquid at rest tends to have a minimum surface area, and as such, it behaves as if covered with a stretched membrane, is known as surface tension.

Surface tension is a property by which the free surface of a liquid possesses a tendency to contract to acquire a minimum surface area.



ACTIVITY 1

Instruction: Carry out an experiment and observe it.

- i. Take water in a container.
- ii. Add chilli flakes.
- iii. Then add a drop of liquid soap.

What did you observe in the experiment? Think about the reasons for the phenomenon you have just observed?

Observations: The chilli flakes move towards the corner of the container because the soap reduces the surface tension of the water, thereby increases the area. Also, it decreases the cohesive force of water molecules.

Capillary Rise

A tube having very thin and uniform bore throughout its length is called a capillary tube. The phenomenon of rising or falling of liquid in a capillary tube is called capillarity.

Rise of Liquid in a Capillary (ascent formula) action is a result of both adhesion and surface tension.

Some of the applications of capillarity in day-to-day life are listed below:

- Oil rises through a wick due to capillarity. The narrow pores in the threads of a wick act like tiny capillaries through which oil rises.
- The ink spreads on a blotting paper as the pores in the blotting paper act like tiny capillaries.
- Water rises to the tip of the plants through the tiny fibres in the plant.
- A towel gets soaked with water on account of capillary action.
- Ploughing of fields is essential for preserving moisture in the soil. By ploughing, the fine capillaries in the soil are broken. This ensures that water does not rise to the surface of the soil due to capillary action and evaporate.

**ACTIVITY 2**

Instruction: Demonstrate the rise of coloured liquid in a different sized capillary tube.

- i. Dip two different sized capillary tubes in a coloured liquid.
- ii. Observe the rise in the liquid level in the two tubes.

In this experiment, you will observe that there is more rise in the tube with a smaller diameter. This is due to cohesive and adhesive forces.

**Summary**

- When we say the acceleration of a body is zero, the body is either at rest or it is moving with uniform velocity (constant velocity).
- The constant velocity finally attained by a body moving through a fluid under gravity when there is a zero resultant force acting on it is called terminal velocity.
- Surface tension is the property that helps to maintain a minimum surface area.
- Capillarity is the phenomenon of rising and falling of liquids in a uniformly bore tube.

**Self-check for Learning**

Instruction: Answer the following and check your answer referring to the lesson.

1. As soon as a parachute of a falling soldier opens, his acceleration decreases and soon becomes zero. Why?
2. Why do you think hot soup tastes better than cold soup?
3. Do you think ploughing the field will make the soil retain the moisture within? How?

1.6 Huygens' Principle, Wave and WaveFront

Learning Objectives



- Define wave and wavefront.
- List different types of wavefront.
- State Huygens' Principle.
- Explain the significance of Huygens' Principle.
- Verify laws of reflection of light based on Huygens' Principle.
- Verify laws of refraction of light based on Huygens' Principle.
- Define refractive index.

Introduction

We are able to see objects around us and hear the sounds produced in the surroundings. Do you have any idea about how all these are possible?

It is due to the various phenomena related to light waves and sound waves that we can see and hear respectively. In this lesson you will learn about the wave nature of light and Huygens' Principle.

In the late 17th century, scientists debated the fundamental nature of light. Some supported the wave nature of light and some believed in the particle nature of light. Dutch Physicist Christian Huygens proposed the wave theory of light in 1678. Sir Isaac Newton came up with the corpuscular (particle) theory of light in the seventeenth century. However, when some experiments were conducted on light theory, it was found that both the theories had some unexplained phenomena. Wave theory could not explain some phenomena like the photoelectric effect, whereas corpuscular theory could not explain some phenomena like interference. Later in 1905, Albert Einstein proposed that light has characteristics of both wave and particle. Therefore, light has a dual nature.

To understand Huygens' Principle, we must first understand the concepts of wave and wavefront.

Wave

It is the disturbances of a medium that propagate from one point to another in the medium. The particles of the medium remain in the same position and the energy transfers from one point to another.



© L.Perera

Wavefront

If we draw a surface in a medium such that all the medium particles lying on the surface are in the same phase of oscillations, then the surface is called a wavefront.

1. Properties of Wavefront

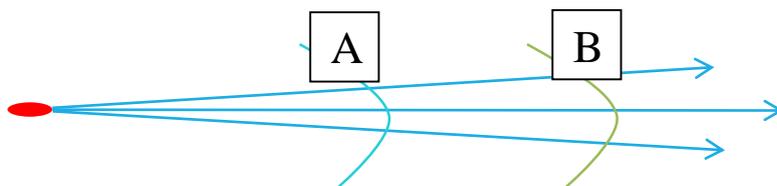
- All the particles of the medium which are on the same wavefront are in the same phase. This means all the particles are in sync with each other or they are synchronised.
- The particles on the same wavefront have equal distance from the source.
- Wavefront is perpendicular to the direction of propagation of the wave in isotropic medium (the value of physical property like velocity is the same when measured in different directions in such medium).
- The phases of consecutive wavefronts are different. This means the particles in consecutive wavefronts are not in sync with each other.

2. Types of Wavefronts

There are three types of wavefront depending upon the nature of the source of light.

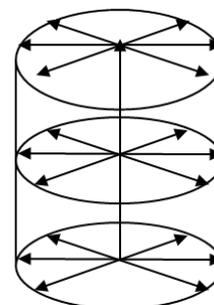
1. Spherical Wavefront

Spherical wavefront is formed when the source of light is a point source. e.g. light from a bulb passed through a pinhole.



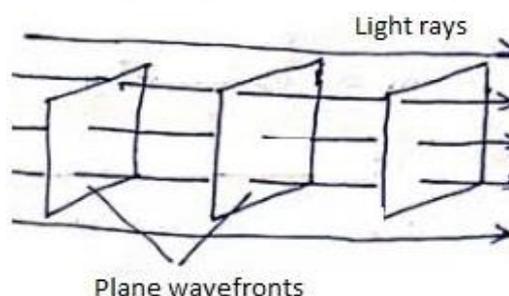
2. Cylindrical Wavefront

Cylindrical wavefront is formed due to a line source of light e.g. light through a slit. The axis of the cylinder shows the line source of light. Since the disturbance travels outward all around the line source (in sideways direction not up and down in the given figure), it forms a cylindrical wavefront.



3. Plane Wavefront

Plane wavefront is formed due to distant sources of light (light source at infinity) e.g. light from the Sun. The rays coming from a source at infinity are parallel to each other and the wavefronts should be perpendicular to these rays. Thus, the plane surfaces shown in the figure are the wavefronts originating from a distant source.

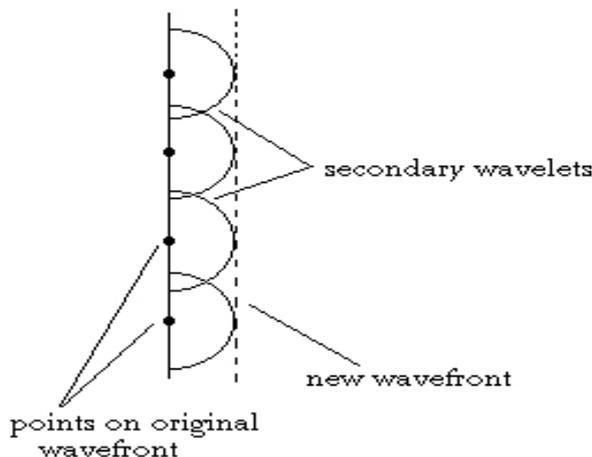


Huygens' Principle

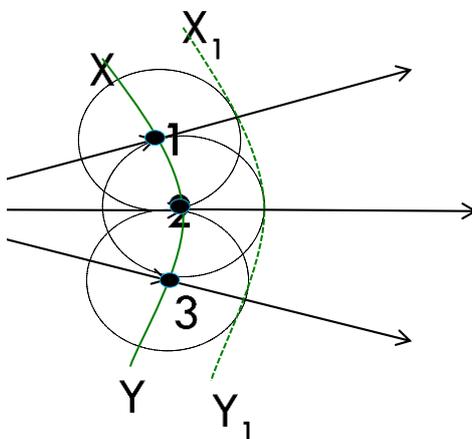
First Statement: Every particle of the medium situated on the wavefront acts as a new wave-source from which fresh waves originate.

Second Statement: The secondary wavelets travel in all directions with the speed of the original wave. (Wavelets are the disturbance coming out of the wavefronts not directly from the source.)

Third Statement: The envelope of the secondary wavelets in the forward direction at any instant gives the new wavefront at that instant.



Construction of Secondary Wavefront



Let XY be the primary wavefront formed due to disturbance coming from a point source of light. The points 1, 2 and 3 on the wavefront are taken as the centre around which a sphere is drawn with a radius equal to $c\Delta t$ ('c' is the velocity of light and $c\Delta t$ is the distance travelled by light in Δt second).

The tangent X_1Y_1 drawn in the forward direction which touches all the circumference of the sphere gives the position of the new wavefront.



ACTIVITY 1

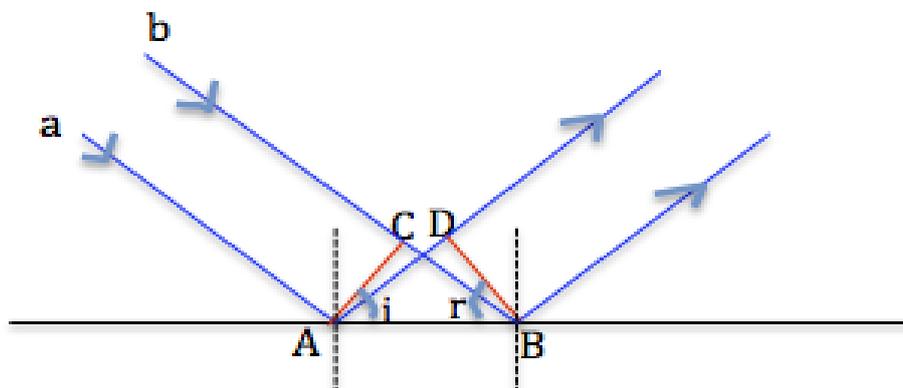
Instruction: Answer the following questions.

1. Can Huygens' principle explain the propagation of sound waves? Why?
2. Imagine you are reading your favourite novel in a dark room dimly lit by a candle. What would be the nature of the wavefront of light coming from the candle?

Reflection and Refraction Using Huygens's Principle

The concept of reflection and refraction of light can be explained using Huygens' Principle.

i. Reflection of a Plane Wave from a Plane Surface using Huygens' Principle



In the above diagram, when disturbance from 'a' reaches 'A', disturbance from 'b' reaches at 'C' because they should travel equal distance in equal time in the same medium.

When disturbance from 'a' is reflected and reaches 'D', disturbance from 'b' reaches at 'B'. Then perpendiculars AC on bB and BD on AD are drawn. Perpendicular AC is the incident wavefront and perpendicular BD is the reflected wavefront (as they are perpendicular to the direction of propagation).

In ΔACB and ΔADB ,

$AD = CB$ (distance covered in same time)

Angle $ACB = \text{Angle } ADB = 90^\circ$ (by construction)

AB is common for both the triangles

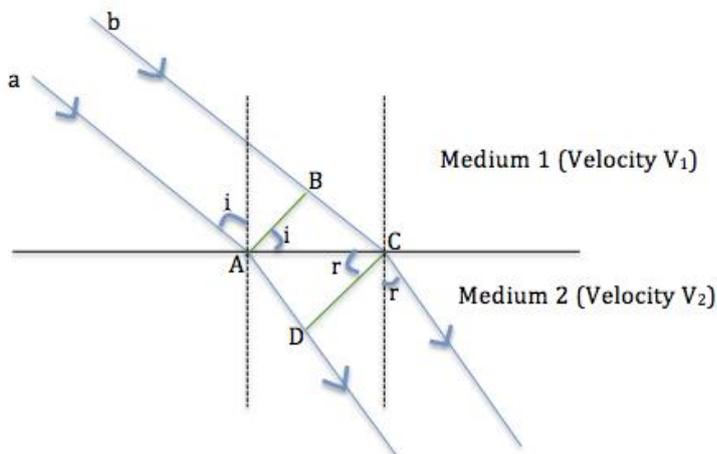
$\therefore \Delta ACB \cong \Delta ADB$ (The triangles are congruent because two sides and one angle are equal in the two triangles.)

Therefore, the angle $i = \text{angle } r$. (Since all the corresponding sides and angles are equal in two congruent triangles.)

Since the angle of incidence 'i' and the angle of reflection 'r' are equal, the first law of reflection is verified. Thus, we have a law of reflection: when a plane wavefront gets reflected from a plane surface, the angle of incidence is equal to the angle of reflection, and a reflected wave is a plane wave.

The second law of reflection is verified from the construction which states that incident wavefront, reflected wavefront and normal all lie on the same plane.

ii. Refraction of Plane wave at a Plane Surface using Huygens' Principle



Let light rays 'a' and 'b' travel from medium 1 to medium 2. When the disturbance (light wave) from B reaches C in medium 1, the disturbance from A reaches D in medium 2. AD and BC are the distance covered by the disturbance in the same time interval 't'. AD is shorter than BC because medium 2 is denser than medium 1 and the velocity of light in a denser medium is lesser than in rarer medium. Let the velocity of light in medium 1 be V_1 and in medium 2 be V_2 .

$$\therefore BC = V_1 \times t \text{ and } AD = V_2 \times t$$

Then perpendicular AB is drawn on bC and perpendicular CD is drawn on AD. The perpendicular AB is the incident wavefront and perpendicular CD is the refracted wavefront. In medium 1,

$$Velocity = \frac{Displacement}{time}$$

$$V_1 = \frac{BC}{t} \quad \therefore t = \frac{BC}{V_1} \text{ -----(1)}$$

In medium 2,

$$V_2 = \frac{AD}{t} \quad \therefore t = \frac{AD}{V_2} \text{ -----(2)}$$

Since equation (1) = equation (2)

$$\frac{BC}{V_1} = \frac{AD}{V_2}$$

On rearranging we get,

$$\frac{BC}{AD} = \frac{V_1}{V_2} \text{ -----(3)}$$

In triangle ABC,

$$\sin i = \frac{BC}{AC}$$

$$\therefore AC = \frac{BC}{\sin i} \text{ -----(4)}$$

In triangle ACD,

$$\sin r = \frac{AD}{AC}$$

$$\therefore AC = \frac{AD}{\sin r} \text{ ----- (5)}$$

Comparing equation (4) and equation (5) we get,

$$\frac{BC}{\sin i} = \frac{AD}{\sin r} \text{ (Since the left-hand side of both the equations are equal to 'AC')}$$

On rearranging we get,

$$\frac{\sin i}{\sin r} = \frac{BC}{AD}$$

Substituting the values of BC and AD we get,

$$\frac{\sin i}{\sin r} = \frac{V_1}{V_2}$$

$$\therefore \frac{\sin i}{\sin r} = \mu \text{ (since refractive index, } \mu = \frac{V_1}{V_2} \text{)}$$

This is Snell's law: The ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant for a given pair of media.

The constant (μ) is called the refractive index of the medium. In the given diagram, μ is the refractive index of medium 2 with respect to medium 1 (written as ${}_1\mu_2$).

The refractive index describes the ability of a medium to refract the light.



Self-check for Learning

- List a few examples of reflection and refraction in your surroundings.
- If the waves are diverging from a point source, what is the shape of the wavefront?
- Name three different wavefronts in your surroundings.

COMMERCE STREAM

1. COMMERCE

1.1. Business Organisations

Sub Topic:

- Objectives of Business Organisation
- Sole Trader and Partnership.

Learning Objectives



- Explain the meaning and objectives of the business organization.
- Describe the features, advantages and disadvantages of a sole trader business.
- Describe the features, advantages and disadvantages of the partnership business.

Introduction

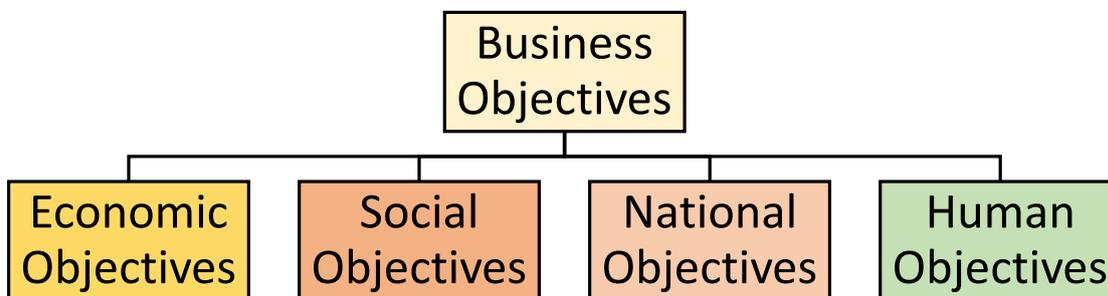
In the first session, we discussed the human activities, economic activities, commerce, trade and functions of commerce, and aids to trade.

In this session, let us discuss the objectives of the business and other forms of business particularly the sole trader and the partnership types of business.

Before we explore the contents in detail, let us discuss the meaning of business organisation. It refers to an institutional arrangement to carry on any kind of business activities that may be owned and controlled by a single individual or a group of individuals who come into a contract to conduct business.

1. Business Objectives

Every business organisation has certain objectives identified and the functions of the business directed to achieve it. One of the prime objectives of the business organisation is to earn profit that will keep it running. The chart below shows four types of business objectives.



In the next section, let us understand how the four types of business objectives are different and similar.

1. Economic Objectives

Creating customers and earning profits are the most important objectives of a business. A matter of fact is that every economic activity is profit-oriented.

Let us discuss more on the economic objectives of a business, which are explained in the following points.

- i *Profit*: The primary objective of every business enterprise is to earn a profit. Profit is required for the enterprise's growth, reputation and expansion and survival.
- ii *Creating Market*: An enterprise cannot exist without finding out new markets for its product. Business enterprise can survive for long if it has a substantial share in the competitive market. For example, the Samsung phone has substantial market share because most of the people use Samsung phone compared to other phones.
- iii *Innovation*: It refers to the introduction of new ideas or new methods of production. No business can flourish in a competitive world without innovation. A business organization has to respond to the change through the latest development of technology in production and way of doing business.
- iv *Optimum Utilization of Resources*: Refers to the best use of men, material, money and machinery. Resources should be utilized in the best possible manner to bring down the cost of production of goods and services.

2. Social Objectives, National Objectives and Human Objectives

To understand the concept of social objectives the national and human objectives are clubbed together with social objectives because they are parts of society and serve the same purpose.

Social objectives deal with the commitment of business towards society. A business enterprise uses resources of a society and earns profits by selling products or services to the members of the society. Therefore, this concept is also known as the Corporate Social Responsibility (CSR), i.e. business giving back to society through various activities like Bhutan National Bank sponsoring Druk Super Star shows, and Pepsi Bhutan sponsoring football tournaments.

Now, you know the concept of social objectives of the business, let us discuss some of the main social objectives of a business enterprise:

- i *Supply of Quality Goods at Fair Prices*: Business should ensure that there is a supply of useful products of good quality at a reasonable price. Quality of goods such as durability, safety, purity must be ensured to maintain a long-term relationship with the consumers.
- ii *Avoidance of Unfair Trade Practices*: Business enterprises should not indulge in undesirable activities like black marketing, hoarding, adulteration, overcharging, and exaggerating in an advertisement about the product. Such practices lead to loss of goodwill of the business.

- iii *Generation of Employment:* Every business enterprise should create employment opportunities and also look after the welfare of their workers.
- iv *Protection of the Environment:* A business should carry out its activities by adopting environmentally friendly techniques to ensure the conservation of natural resources.
 - a) *Development of Underdeveloped or Backward Areas:* The business enterprise must ensure balanced regional development by setting up a business in underdeveloped areas as a part of social responsibility.
 - b) *Self-sufficiency:* Businesses must aim at the achievement of self-sufficiency. It is through the growth and development of a business that countries try to achieve self-sufficiency.

2. Sole Trader

What do you understand by the term sole trader or sole proprietorship?

“Sole” implies single and “trader” implies a person doing business. “Proprietorship” implies ownership.

However, a sole trader does not refer to a person but a specific form of business organisation. Therefore, a sole trader or sole proprietorship is a form of business organisation which is owned by a single person who bears the entire business risk.

i. Features or Characteristics of a Sole Trader

- *Individual Ownership:* Business is owned by an individual, he invests his funds or borrow finances on his guarantee and bears risks.
- *One-man Control:* The proprietor manages the whole business himself. There may be some persons to help him/her, but ultimate control lies with the owner.
- *No Distribution of Profits:* Being a single owner, he/she takes all the profits himself, thus there is a direct relationship between his/her efforts and rewards.
- *Unlimited Liability:* The business owner is personally liable for all debts and loans of the business. The liability is not limited to his/her investment in the business, but his/her private property is also liable for the business.
- *Continuity of Business:* Sole trader business depends on the existence of the owner. The sole trader business ceases to exist in the event of death, insolvency (bankruptcy), insanity, etc. of the sole trader.
- *Legal Formalities:* Fewer requirements of legal formalities to start a business.

Now, we are familiar with the meaning and features of a sole trader from the above discussion. Let us discuss the advantages and disadvantages of a sole trader.

ii. Advantages of a Sole Trader

- *Easy Formation and Closure:* Sole proprietorship is the only form of business where no legal formalities are required to set up and closure of the business is easy.

- *The Incentive to Earn More:* There is a direct relationship in efforts and reward. The proprietor takes a keen interest in the working of the business. He/she tries to put heart and soul in the business to earn a profit.
- *Secrecy:* Being a sole proprietor, he/she is not expected to publish his books of accounts to the general public.
- *Promptness of Decisions:* All important decisions are taken by one person. He/she can take a prompt decision. He/she will not let the opportunity slip away. Quick decision improves the efficiency of business operations.
- *Flexibility:* A sole trader business is usually small in operation and the proprietor can expand his/her business or modify his/her business to suit the changing market situations.

iii. Disadvantages of a Sole Trader

- *Limited Financial and Managerial Resources:* The financial resources of a sole trader are limited since he/she cannot offer much security to raise finance.
- *Unlimited Liability:* The business owner is personally liable for all debts and loans of the business. The liability is not limited to his investment in the business, but his private property is also liable for the business.
- *Limited Opportunities:* Due to unlimited liabilities and limited resources, a sole proprietor cannot undertake bigger risks.
- *Uncertain Life:* The life of the business is linked with the life of the proprietor. Death, incapacity or insolvency of sole trader may bring termination of business.

3. Partnership Business

Let us look at the picture on the right side of the page.
What does it signify?

It looks like two individuals have some idea and got some money to do something out of it.

Now, let us define partnership drawing some information from the picture.



A partnership may be defined as a voluntary association of two or more persons who agree on some joint business: contribute money, share its profits and losses at an agreed ratio.

i. Features of Partnership

- *Agreement between Two or More Persons:* Partnership is the result of an agreement between two or more persons in oral or writing.
- *Sharing of Profit and Losses:* The partnership profits and losses are shared according to the agreed ratio as per the agreement.
- *Lawful Business:* The business carried out by the partners must be lawful.

- *Unlimited Liability:* The liability of partners is unlimited. Every partner is liable both personally and jointly for all debts and loans on the business. If the properties or assets of the business are not enough to the liabilities, the personal properties of the partners may be used for paying off the debts.
- *Mutual Agency:* Every partner is an implied agent of the other partners. Any partner can carry out the business on behalf of the other partners and each partner is held liable for acts performed by other partners on behalf of the firms.

Before venturing into any partnership business individuals need to understand the advantages and disadvantages of Partnership.

ii. Advantages of Partnership

- *More Resources Available Compared to a Sole Trader:* Necessary resources are pooled together from partners.
- *Combined Abilities, Skills, Expertise, Talents, and Ideas of Partners:* The partners will have the flexibility in operations of the business.
- *Encourage Cooperation and Direct Motivations:* There is a direct relationship between efforts and rewards.
- *Better Creditworthiness:* Unlimited liability of each partner gives the partnership an excellent credit. The creditors can expect to realise the dues from the private property of the partners in case of a failure of the firm.
- *Risk Sharing:* The business risk like a loss is shared as per the agreed terms and conditions.
- *Business Secrecy:* The books of accounts of the business need not be published publicly. Thus, business secrecy is maintained among the partners.

iii. Disadvantages of Partnership

- *Delay in Decision Making:* Partners may have differences in opinion and disputes which may lead to delay in making decisions for the business.
- *Risk of Dishonest Partners:* Dishonest partners may cause harm to other partners and the business.
- *Restricted Transferability of Interest:* No partner can transfer his share in the partnership without the prior consent of the other partners.
- *Uncertain Life or Instability of the Business.* Death, insolvency, insanity, and the retirement of partners may bring about the dissolution of the business firm. Besides, the lack of team spirit among partners may harm the reputation of the firm and lead to the closure of the firms.
- *Unlimited Liability:* As stated above, the liability of partners is unlimited and personal properties must be attached in the event of winding up of business and such that the business assets are not enough to pay off the debts.



Summary

- Business Organisation refers to an institutional arrangement to carry on any kind of business activities that may be owned and controlled by a single individual or a group of individuals who come into a contract to conduct business.
- The primary objective of every business enterprise is to earn a profit. Profit is required for the enterprise's growth, reputation, expansion and survival.
- The business enterprise also has other objectives towards the society and the nation apart from making a profit. It has the responsibility to provide quality goods, generate employment opportunities and protection of environments.
- Sole trader business is easy to form without legal formalities. Its owner has complete control over the business and enjoys total profit and bears all risks.
- Partnership business has larger resources compared to a sole trader. Partners share the profits and risks.



Self-check for Learning

1. Under what situations the sole trader business is suitable?
2. How can a sole-trade business be expanded?
3. Assume that you completed high school and are going to start a business. What kind of business would you prefer? Why would you choose that particular type of Business?

1. 2. Company Forms of Business

Sub Topic:

- Formation of Companies
- Types of Companies

Learning Objectives



- Define the term company.
- Explain steps involved in the formation of a company.
- Explain different types of companies and characteristics with relevant examples.

Introduction

Company is another form of business organisation that operates its business on a large scale compared to sole trader and partnership firms. This form of business organisation is usually referred to as Joint Stock companies. A joint-stock company can be of either private companies or public companies. They are classified based on the nature of formation and operation. The formation of a company involves four stages.

Definition of Company

Company is a voluntary association of persons formed to carry on a business for profit and registered under the Companies Act.

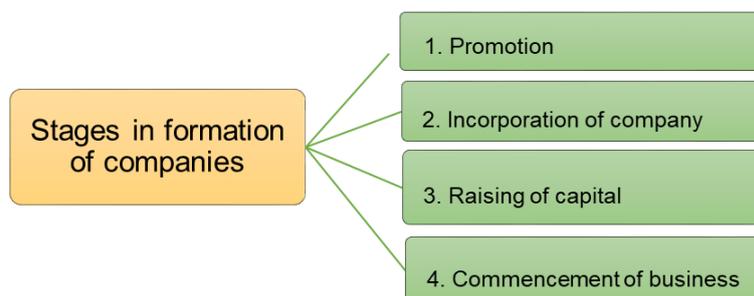
In Bhutan, companies are incorporated under the Companies Act of Bhutan, 2016. A company form of business organisation is the most popular form of large-scale businesses. It does not come into existence on its own. A company is brought into existence by the efforts of the promoters and involves several legal formalities.



Source: Druk Holding and Investments Limited, Bhutan (DHI)

Formation of a Company

There are four stages in the formation of a company. Let us discuss this in detail.



1. Promotion

Promotion is the initial stage in the formation of a company. A person who takes the initiative of starting a company is called a promoter. It involves discovering business opportunities, carrying out a detailed investigation of the proposed project, and planning the required finances.

2. Incorporation

The incorporation of a company implies the registration of a company.

The promoter of a company must file necessary documents with the Registrar of Companies and pay prescribed registration fees as per the Companies Act. If the Registrar is satisfied that all requirements for incorporation have been complied with, a Certificate of Incorporation is issued, and the name of the company is registered.

3. Raising of Capital

A public company raises funds from the general public by selling its shares and securities.

Steps Required to Raise Fund from the Public

- a. Issue of a prospectus or a Statement in Lieu of Prospectus.
- b. Appointment of bankers for the underwriting of shares.
- c. Appointment of brokers to float shares.
- d. Listing of shares on a stock exchange.
- e. Obtaining approval for the issue of the prospectus from the Ministry of Economic Affairs [MoEA] and the Royal Securities Exchange of Bhutan Limited [RSEBL].

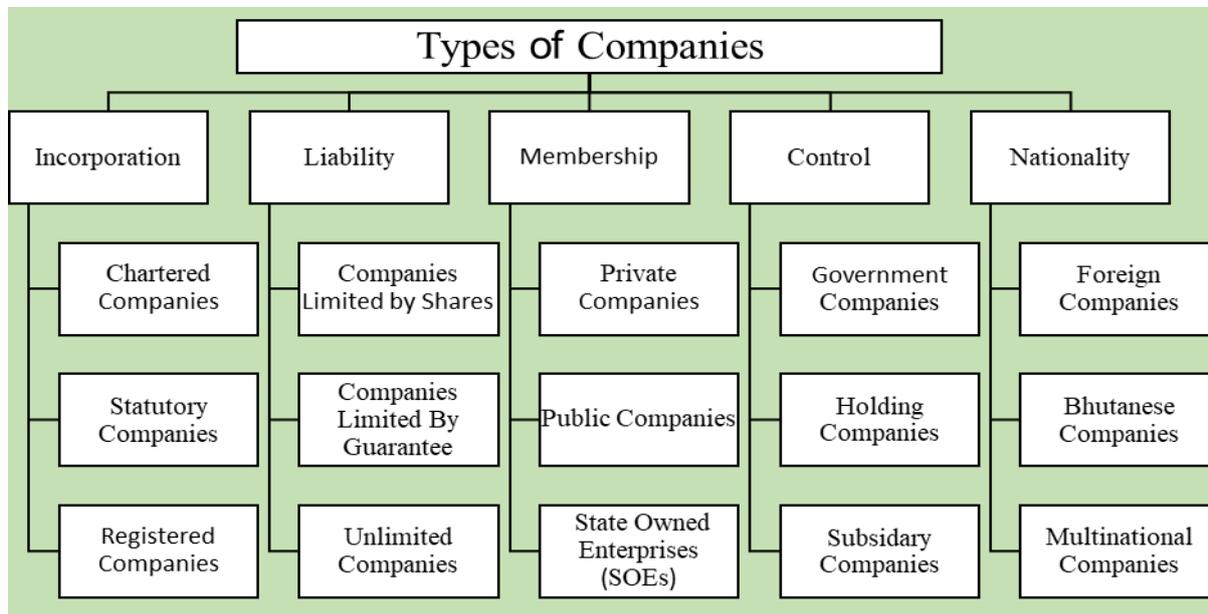
4. Commencement of Business

Commencement of business is the final stage in the formation of a company. A public company will need to obtain a Certificate of Commencement from the Registrar of Companies to commence its business.

This certificate is obtained after meeting the minimum subscription of share and obtaining a trade license from the Ministry of Economic Affairs. In case the minimum subscription is not

met by a certain amount, the underwriters subscribe to the remaining shares to meet the requirements.

Joint-stock companies may be classified based on (i) Mode of Incorporation (ii) Extent of Liability (iii) Transferability of shares/membership (iv) Control (v) Jurisdiction/Nationality.



Companies on the basis of Incorporation

1. Chartered Companies

This type of companies is created by the Royal Charter. The companies are incorporated under Royal Charter issued by the King or Queen. The Bank of Bhutan Limited, established in 1968, is the first chartered company in Bhutan. The Druk Holding and Investments Limited (DHI) is another example of a chartered company formed in 2007.

Picture source: DHI: Royal Charter for the Formation of DHI



2. Statutory Companies

Such companies are formed under a Special Act passed in the Parliament of Bhutan. State Mining Corporation Limited, Royal Bhutan Helicopter Services Limited, and Rural Enterprise Development Corporation Limited are some examples of such companies in Bhutan. These companies are formed with certain objectives to carry out the activities of the nation.

3. Registered Companies

These companies come into existence after having incorporated under the Companies Act of Bhutan, 2016. Some of the registered companies in Bhutan are Bhutan Power Corporation Limited, State Mining Corporation Limited, Thimphu Tech Park Limited, Druk Air Corporation Limited, and Bhutan Telecom Limited.

On the Basis of the Extent of Liability

1. Companies Limited by Shares

These are the companies in which the liability of shareholders is limited to the extent of the unpaid value of shares held by them. Most of the companies in Bhutan are limited by shares.

Unpaid value of shares: remaining amount due to the company by shareholders; e.g. If a share is worth of Nu.100 and the shareholder had paid Nu.60 and the unpaid value of the

2. Companies Limited by Guarantee

These are the companies in which the liability of the shareholders is limited to the extent of the amount guaranteed to be contributed in the event of winding up the companies. These companies are not as popular as those companies limited by shares.

3. Companies with Unlimited Liability

In this type of companies, there is no limit on the liabilities of the shareholders. In case of liquidation, the shareholders have to even pay from their personal assets to cover the liabilities of the company. In Bhutan, such company does not exist.

On the basis of Transferability of Shares or Membership

1. Private Companies

According to the Companies Act of Bhutan, 2016, a private company means a company which:

- Is not permitted to offer its shares to the public, and shall have at least two directors.
- The name of a private company shall end with the words Private Limited, also abbreviated as Pvt. Ltd.

2. Public Companies

The Companies Act of Bhutan, 2016 states that a public company is authorised by its articles to offer its shares or other securities to the public.

3. *State-Owned Enterprises (SOEs)*

SOEs are the companies owned and controlled by the state. The DHI owned companies such as Bhutan Power Corporation Limited, Drukair Corporation Limited, and Natural Resources Development Corporation Limited are few examples in Bhutan.

On the basis of the Extent of Control

1. *Government Companies*

The term government company may be defined as a company in which not less than 51% of the paid-up share capital is held by the government. For example, all the companies which Druk Holding and Investment (DHI) holds more than 51% - 100 % [*refer the pictures DHI portfolio shown above*] of the shares are government companies.

2. *Holding Companies*

Holding company is a company deemed to be a holding company of another by the virtue of the latter being its subsidiary company. The holding company does not engage in the operations of its subsidiaries. DHI is an example of a holding company and all other companies under DHI are subsidiary companies.

3. *Subsidiary Companies*

Subsidiary companies are the companies owned and controlled by the holding company. Bank of Bhutan Limited, State Trading Corporation of Bhutan Limited, Dungsam Cement Corporation Limited, and Wood Craft Centre Limited are some of the subsidiary companies of Druk Holding and Investments Limited.

On the basis of Jurisdiction or Nationality

i. *Foreign Companies*

The companies which are incorporated outside Bhutan but operating in Bhutan through their branches and agencies are called foreign companies. Jaiprakash Associates Limited and Gammon India Limited which are involved in Hydro Power Constructions are some examples of foreign companies operating in Bhutan.

ii. *Bhutanese Companies*

The companies that are incorporated under the Companies Act of Bhutan, 2016 are known as Bhutanese Company. Examples of Bhutanese companies are Bhutan Telecom Limited, and Dungsam Cement Corporation Limited [*refer the list in DHI portfolio above*].

iii. *Multinational Companies*

This type of companies operates in more than one country. They carry out economic activities in many countries. Few examples of multinational companies (MNCs) operating in Bhutan are Coca Cola, Le Meridien, Taj Tashi, and Amankora. These companies usually operate through Foreign Direct Investments (FDI).



Summary

- Company is a voluntary association of persons formed to carry on a business for profit and registered under the Companies Acts.
- The formation of the company involves four stages i.e promotion, incorporation of a company, raising of capital and commencement of business.
- The joint-stock company is classified into five categories.
- DHI was formed under the Royal Charter in 2007 and it is the holding company for its owned companies.



Self-check for Learning

- You are planning for a public company proposal to be complied with under the Companies Act of Bhutan, 2016. Carefully plan and write the steps you would take before you commence your business.
- List down companies owned by DHI which has 51%- 100% shares of its subsidiary companies.

2. ECONOMICS**2.1 Wants and Opportunity Cost**

Sub: Topic:

- Human Wants
- Economic Problems
- Production Possibility Frontier or Curve
- Opportunity Cost

Learning Objectives

- Define human wants.
- Explain the types of human wants.
- Examine the features of human wants.
- Explain the basic economic problems and their causes.
- Illustrate economic problems with the help of Production Possibility Curve.
- Explain the meaning of opportunity cost.

Introduction

Economics is concerned with various economic issues about the economic behaviour of individuals, society and the economy. The basis of all economic activities is the existence of human wants. The process of satisfying human wants is at the root of all economic activities. People work to earn income to satisfy human economic wants.

Meaning of Wants

‘Wants’ in economics is an effective desire for a particular thing, which can be satisfied by making an effort to acquire it. Human wants can be classified into various categories based on their consumption and importance.

Classification of Human Wants

1. *Necessities*: These human wants are vital for survival and existence. For example, food.
2. *Comforts*: These human wants are consumed to make living comfortable and easy but not necessary for survival. For example, furniture.
3. *Luxuries*: These human wants are consumed to show off one's status, prestige and power. For example, Diamond necklaces.

Features of Human Wants

1. *Wants are Unlimited*: Human wants are endless; there is no end to human wants. Wants start when the child is born and these wants remain with the human till they go to the graveyard.

2. *Wants are Complementary:* Some human wants are wanted together; consumption of one good gives the need of consuming another good. For example, Consumption of cars requires the consumption of petrol.
3. *Substitutability of Wants:* Some human wants can replace each other as they provide the same satisfaction. For example, washing of hair can be done by either using Sun Silk Shampoo or Dove shampoo. After all, they serve the same purposes.
4. *Wants are Competitive:* Human wants are unlimited but the income to satisfy those wants is limited. Therefore, competition arises among these wants. For example, with limited income, a consumer can either consume a plate of momo or a bottle of juice based on which one is required the most.
5. *Wants Multiply:* Human wants are not only unlimited, but they also keep on multiplying over time. With economic developments, there are varieties of goods and human wants to consume all those goods for satisfaction.
6. *Want Recur:* Human wants tend to come back over again since they are satisfied only temporarily. Wants reappear and they need to be satisfied again.
7. *A single Want can be Satisfied:* Since resources are limited, not all wants can be satisfied altogether. However, it is possible to satisfy a single want or few wants.
8. *Some Wants can be Postponed:* Depending on the level of importance, some wants can be postponed and some wants cannot be postponed. For example, if you are hungry, a plate of momo is more important than a bottle of juice.
9. *Wants Differ in their Urgency:* Wants differ in urgency or intensity. Some wants are more urgent that they need to be consumed immediately and some wants are less urgent that they can be consumed in the future. For example, hand washing soap and hand sanitizers are more urgent for now that they cannot be postponed.
10. *Wants Remain Ahead of the Availability of Goods and Services:* Human wants are always ahead of the resources available. Thus, resources are required to be used based on priority.



ACTIVITY 1

1. Do you think we need to prioritize a want? Justify.
2. Differentiate the three types of human wants with an example each.

Economic Problems and their Causes

Human wants are unlimited but the means to satisfy these wants are limited. The fact of life is that the total amount of goods and services that can be produced by using all the productive resources of an economy are insufficient to satisfy all the wants of the people. **Scarcity** is the fundamental problem of every society. Scarcity is a situation when people's wants exceed their resources.

Economic Problem

The economic problem is the problem regarding the allocation of limited resources for the production of alternative goods and services. In other words, the economic problem is the 'problem of choice'. Thus, the economic problem is the 'problem of relative scarcity and the 'problem of choice' arising there from. Therefore, every economy has to take the basic decision of making the best use of its available resources in producing goods and services

Why does the economic problem arise?

The basic economic problem is the problem of choice. The problem of choice arises because of three interrelated facts

1. *Unlimited Wants*: Human wants are endless; there is no end to it. They tend to multiply over time and keep on recurring. Therefore, individuals have to choose between different wants and so is the case with the whole economy.
2. *Limited Resources*: While human wants are endless and they are always ahead of the resources available, these resources are limited. They are scarce and they need to be put in use based on priority.
3. *Alternative Uses of Resources*: Resources can be put into alternative uses. With limited resources and their alternative uses, the economy can decide to produce more amount of some commodities and less amount of other commodities. For example, a piece of land can be used to produce wheat, vegetables, and many more. Thus, economic problems arise from the scarcity of resources relative to human wants.

Basic Economic Problems

'Basic problems' or central problems' are the problems that are common and fundamental to all the economies.

These problems are various manifestations of the basic economic problems. The following are the basic economic problems that all economy go through:

1. What to Produce and How Much to Produce

The problem of what to produce talks about what commodity the economy should produce and the problem of how much to produce is the problem of quantity to be produced. Since resources are limited, the economy should decide whether to produce necessity, comfort or luxury goods based on demands from the consumers and the availability of resources.

2. How to Produce

The problem of how to produce is the problem of deciding on what method/techniques of production to be used. Generally, there are two techniques of production, capital-intensive technique (uses more of capital and less of labour) and labour -intensive technique (uses more of labour and less of capital). The usage of these techniques depends on the level of technological knowledge and the availability of resources.

3. For Whom to Produce

This is the problem of distributing the total output of goods and services produced in an economy among its members. In simple terms, this problem is the problem of distributing total goods produced in the economy among individuals and families in the economic system. The distribution of income will determine the distribution of goods and services.

4. The Problem of Fuller Utilization of Resources

This is the problem of employment and unemployment of resources. Since resources are limited in amount, they need to be put in proper use or else it will cause dead loss reducing the economy's capacity to produce goods.

5. The Problem of Efficient Use of Resources

This problem is regarding the efficient use of the resources avoiding wastage of resources. The available resources should be put in their best possible use to produce the maximum output. For example, to have the maximum output carpenters should do the job of carpenters and masons do the job of masons.

6. The Problem of Economic Growth

This problem of the economy is the problem of increasing the economy's capacity to produce goods and services over the years. An increase in the economy's capacity to produce goods and services will increase the national income and the per capita income. As a result, every economy wants to increase its production capacity.

To sum up, every economy faces various basic economic problems as discussed above. The first three problems are concerned with the allocation of resources and the rest are concerned with the growth of resources.

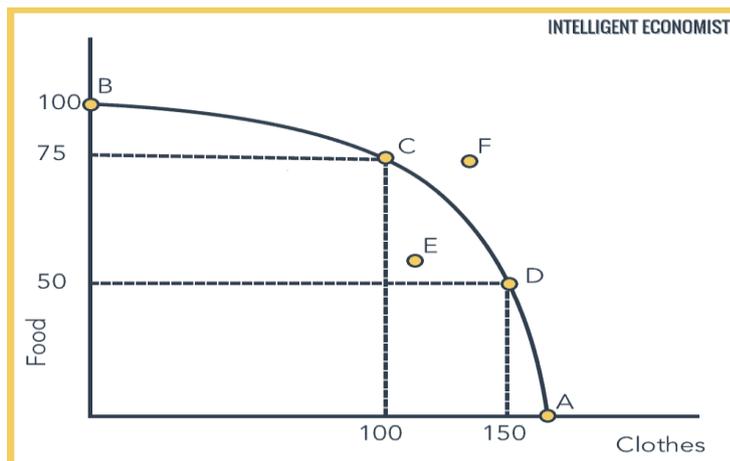


ACTIVITY 2

1. How is the problem of fuller utilization of resources different from the problem of efficient utilization of resources?
2. "Unemployment of resources can lead to dead loss." Explain.

Production Possibility Curve and Central Problems

The nature of an economic problem and the basic economic problems can be explained with the help of a simple diagram, known as the production possibility curve. A production possibility curve is a curve that shows various combinations of two goods that can be produced with available techniques and with the given amount of resources.



1. The Problem of Scarcity

This problem is indicated by point F in the diagram. Any points outside the production possibility curve show the combinations that cannot be attained with the given resources. Point F shows that there are not enough resources to produce the goods.

2. The Problem of Choice

Point C and point D in the above diagram shows the problem of choice. The producer can choose either point C or D based on the need for the amount of food and clothes respectively. Given the production possibility curve, the only way to raise the production of one good is to lower the production of the other good.

3. The Problem of What to Produce

Again, point C and point D in the above diagram shows the problem of what to produce. The economy needs to decide whether to allocate all the available resources in the production of only food or clothes or both, which in turn is determined by the tastes and preferences of the consumers in the economy.

4. The problem of Full and Efficient Utilizations of Resources

Point E in the above diagram shows the problem of full and efficient utilizations of resources. It shows either some of the resources are lying idle, or some of its resources are used inefficiently in production.

5. The problem of Economic Growth

With economic growth, there will be an increase in available resources and technological development. As a result, the economy's capacity to produce goods and services will increase resulting in the shift of production possibility curve attaining point F in the above diagram.

Opportunity Cost

Opportunity cost arises because of a scarcity of resources and the fact that resources have alternative uses. Whenever resources are allocated and choices made, something has to be given up. Every choice involves trade-offs, i.e. giving up one thing to get something else.

Therefore, the opportunity cost of every choice is the next best alternative that is given up in making that choice. In other words, it is the cost of producing anything which is expressed in terms of other alternatives forgone. Or the loss of other alternatives when one alternative is chosen. For example, the opportunity cost of playing football could be the knowledge that a person could have gained by reading a book. If a person decides to spend Nu.2000 on buying a pair of shoes, the opportunity cost would be not being able to save. An economy may decide to invest in building roads but at the cost of providing education. Bhutan may choose a clean environment at the cost of industrialization.



Self-check for Learning

1. With the help of a diagram illustrate economic growth taking place.
2. How is the concept of opportunity cost applicable in our daily life?

2.2 Definition and Determinants of Demand

Sub Topic:

- Meaning of Demand
- Kinds of Demand
- Factors Affecting Demand

Learning Objectives



- Interpret the meaning of demand.
- Differentiate types of demand.
- Explain the determinants of demand or factors affecting demand.

Introduction

The demand analysis and the demand theory are of vital importance to the economy, particularly to the business enterprises. They are the source of many useful insights for business decisions making. The success or failure of business firms depends primarily on its ability to generate resources by satisfying the demand of consumers. Demand also plays an important role for the consumers as demand measures consumer's desire and spending on a particular good or service at a specific price. In this lesson, you will get to know the meaning of demand, types of demand and the factors affecting demand.

Meaning of Demand

Demand refers to the total quantity of commodities that will be purchased at a particular price during a particular period.

OR

Demand is a desire backed by a willingness and the ability to pay for a particular commodity during a particular period.

For instance, Mr.A, while going outing with his parent, demanded 2 plates of Vegetable Momo from XY Hotel at the rate of Nu. 30 per plate. Thus, Vegetable Momo is the commodity, 2 plates of Momo is the quantity demanded, Nu.30 is the price per plate and a day is the time period.

There are certain things you should remember while discussing the demand.

1. Need to have the desire to consume
2. Willingness to pay for it
3. Ability to pay for the demand

Once you have fulfilled all the above points, then a consumer can make his/her demand effective.

There are different types of demand for goods in the market and are classified based on the number of consumers, nature of goods, the interdependence of demand, nature of the use of the product, and based on time.

1. *Price Demand*: The price that people are willing to pay for goods and services when a particular amount or quantity is available.
2. *Individual and Market Demand*: Individual demand is defined as the total quantity of a commodity that a consumer will purchase at a particular price during a particular period whereas market demand is the total quantity of a commodity that all consumers are willing to purchase at a particular price during a particular period.
3. *Income Demand*: It relates to the various quantities of a commodity or service that will be bought by the consumer at various levels of income in a given period.
4. *Cross Demand*: Refers to change in the quantity demanded of a good when the price of related good change.
5. *Joint Demand*: Joint demand refers to the relationship between two or more commodities or services when they are demanded together. For example, the demand for cars and petrol.
6. *Derive Demand*: It is the demand resulting from the demand for an intermediate or related good/service. For example, an increase in the demand for wood because of the increase in the need for furniture.
7. *Composite Demand*: The demand for goods and services who got more than one use so that an increase in the demand for one product leads to a fall in the supply for others.

While purchasing a commodity, individuals might have been influenced by several considerations such as the amount of money you want to spend, the price of the commodity, your liking for it, income, etc. So the demand for any particular commodity is influenced by a large variety of *determinants or factors*.

Determinants of Demand or Factors Affecting Demand

Several factors can affect the demand of commodity or services.

1. *Price of the Commodity*



ACTIVITY 1

Instruction: Use the data given in the table below. Use a graph and draw the relationship between price and demand. Follow the steps given below to draw the graph.

Steps:

1. Draw x-axis and y-axis.
2. Take price to the y-axis and quantity demanded to the x-axis.
3. Plot graph using the data given in the table below.

Price (Nu)	Quantity Demanded (Kg)
10	2
8	6
6	8
4	10

2. *The Income of the Consumer*

Generally, income and demand have a positive relationship. A high-income consumer is willing to purchase more and low-income consumer is willing to purchase less. However, there are three kinds of goods we need to consider while discussing income and demand.

- a. *Normal Goods*- Normal goods are those goods whose demand increases with the increase in income. For instance: Furniture.
- b. *Inferior Goods*: Inferior goods are those goods whose demand falls with the increase in income. For instance: Maize.
- c. *Inexpensive Goods of Necessities*: Inexpensive goods of necessities are those goods whose demand initially increases with the increase in income and then remains constant with further increase in income. For instance: Salt.

3. *Consumers' Tastes, Habits, Fashion and Preferences*

With the change in consumer's taste, fashion, habit and preference, they tend to purchase more irrespective of price.

4. *Prices of Related Goods*

There are two types of goods under the price of related goods.

- a. *Substitute Goods*: are those goods, which can replace each other as they carry the same level of utility. Change in the price of a substitute good changed the demand for other substitute goods. For example, an increase in the price of tea will increase the demand for coffee.
- b. *Complementary Goods*: are those goods, which are used together. An increase in the price of a complementary good decreases the demand for the other complementary good. For example, an increase in the price of cars decreases the demand for cars.

5. *Consumers' Expectations*

When a consumer expects a change in the price of a commodity in the future, the demand for that commodity in the present changes. For example, if a consumer expects a rise in the price of Sun silk shampoo in the future, the demand for Sun silk increases in the present even if the price is high.

6. *Consumer-Credit Facilities*

Demand for commodities increases when consumers are given the provision of credit facilities.

7. *Size and Composition of Population*

As per the size and composition of the population, the demand changes accordingly. For example, if the population consists of more children than the demand for children's good increases.

8. *Government Policy*

If the government decides to increase the sales tax, the sellers will then increase the price of goods. This will lead to a decrease in the demand for those goods at a higher price.



Self-check for Learning

Instruction: Answer the following questions in your notebook. Assess your answer referring to the lesson.

1. What can cause a decrease in demand for a commodity?
 - a. Increase in monthly salary.
 - b. Increase in prices of a commodity.
 - c. Increase in technological advancement.
 - d. Increase in size of the population.

2. Which factor below plays an important role in increasing demand for an umbrella?
 - a. Increase in income of the consumer.
 - b. A decrease in the price of an umbrella.
 - c. Approaching of the rainy season.
 - d. Better credit facilities.

3. What will happen to demand for hand-washing soap, if everybody feels that hand washing is the best way to stop spreading any kind of disease? Explain.

4. Mr X is working as a CEO in one of the promising firms in the country and having a desire to drive a very luxurious car but not willing to use his savings to spend on buying a car. Will his desire be able to turn into effective demand? Support with reason.

5. Suppose the government increases the rate of sale tax on all the luxury goods, what will happen on quantity demanded of luxury goods in the market? Give reasons.

2.3 Law of Demand and the Changes in Quantity Demanded

Sub Topic:

1. Law of Demand
2. Reasons for Negatively Sloping Demand Curve
3. Movement along Demand Curve and Shift in Demand Curve

Learning Objective



- State the law of demand.
- Explain why demand curve slopes negatively.
- Demonstrate movement along the demand curve and shift in the demand curve.

Introduction

The law of demand will help us to understand how consumers respond to the changes in the price of a commodity. As a result, it is important to understand how consumers would react if the demand is affected by other determinants like income, population and taste preferences, etc.

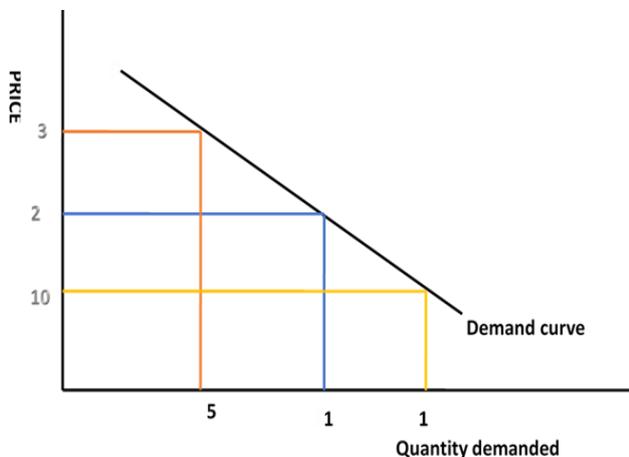
Law of Demand

The law of demand states that quantity demanded by the consumer changes with the change in price while other factors affecting demand remaining the same. It shows the behaviour of output with the change in the price of the commodity, other factors affecting demand remaining the same.

Statement of the Law

The law of demand states that other things remaining the same or equal the quantity demanded commodity increases with the fall in price and vice-versa. Thus, the law demand indicates an inverse relationship between price and quantity demanded of a commodity as shown in the diagram below.

Demand Curve



Why does a demand curve slope downward? Or, why does the demand curve slope negatively?

The demand curve is negatively sloping or in simple words, it is a downward sloping curve. It slopes in such a manner showing that when the price of a commodity increases, the demand for that commodity will decrease as no consumer will be willing to purchase any goods at a higher price. On the other hand, a consumer is willing to purchase more quantity of a commodity when the price of that commodity is less.

It can be explained with the following factors:

1. Law of Diminishing Marginal Utility

One of the reasons for the negative sloping of the demand curve is the law of diminishing marginal utility. According to the law of diminishing marginal utility, the marginal utility of the commodity falls with the increase in its consumption. A consumer will maximize satisfaction when the price of the commodity is equal to the marginal utility. Hence, consumers consume more even if marginal utility is falling until the marginal utility is equal to the price to maximize satisfaction with a decrease in price.

2. Income Effect

A change in demand due to change in real income resulting from a change in the price of the commodity is known as income effect. When the price of the commodity falls, it results in a rise in real income or purchasing power of the consumers' given money income. As a result, consumers buy more of the commodity under question and vice-versa.

3. Substitution Effect

The substitution effect is the effect that is caused by a change in the relative price of substitution goods on the quantity demanded of a commodity under question. When the price of the good under question (X) falls, it becomes relatively cheaper than its substitute(Y). Therefore, consumers tend to buy more when the price of the good falls.

4. Several Uses of a Commodity

There are certain goods, which can be put to several uses. When the prices of such goods are high, it will be used for more important purposes only and, therefore, a small quantity will be demanded. On the contrary, when the price of good falls, it will be put to less important purposes also, leading to an increase in demand.

5. Increase in the Number of Consumers

When the price of the commodity falls, the demand for the commodity increases due to income effect and substitution effect for existing consumers. Further, a poor and moderate-income group who are not able to purchase initially would also purchase the commodity under question. Consequently, demand increases leading to negative sloping of the demand curve.

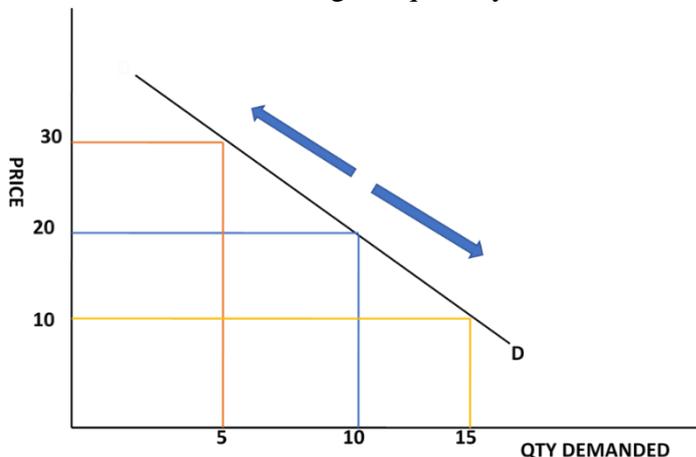
Movement along the Demand Curve and Shift in the Demand Curve

Change in the price of a commodity, other things remaining unchanged causes a movement along the demand curve and change in other factors, price remaining unchanged causes a

shift in the demand curve. These movements and shifts in the demand curve change the quantity demanded of a commodity.

Movement Along the Demand Curve (changes in quantity demanded)

When the quantity demanded of a commodity changes (rises or falls) because of changes in its price while other factors affecting demand remain constant. Movement along the demand curve is also called a change in quantity demanded.

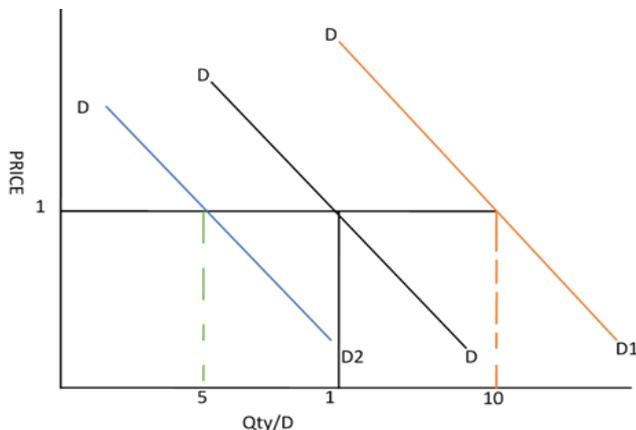


Change in quantity demand may be of two types.

1. *Expansion of Demand*: is defined as an increase in the quantity demanded due to a fall in the price. For example, from the diagram above, we can see that quantity demanded increases from 10 to 15 due to the fall in price from 20 to 10. It is indicated by downward movement along the demand curve.
2. *Contraction of Demand*: is defined as a decrease in the quantity demanded due to a rise in the price. For example, from the diagram above, we can see that quantity demanded decreases from 10 to 5 due to the rise in price from 20 to 30. It is indicated by upward movement along the demand curve

Shift in the Demand Curve (*change in demand*)

When the quantity purchased of a commodity changes (increase or decrease) due to change in other factors, price remaining unchanged, this leads to a shift in demand curve either to the right or left.



Changes in demand may be of two types:

1. *Increase in Demand:* When there is an increase in the quantity demanded, due to change in other factors but price remaining unchanged. For example, the quantity demanded in the above diagram increases from 1 to 10, the price remaining unchanged at 1. It is indicated by the rightward shift of the demand curve from D to D1
2. *Decrease in Demand:* When there is a decrease in the quantity demanded, due to change in other factors but price remaining unchanged. For example, the quantity demanded in the above diagram decreases from 1 to 5, the price remains unchanged. It is indicated by the rightward shift of the demand curve from D to D2



ACTIVITY 1

Instruction: You need to draw separate diagrams for expansion of demand, contraction of demand, increase in demand and decrease in demand. Using the diagrams, try to answer the following questions.

1. Differentiate expansion of demand and increase in demand.
2. Differentiate the contraction of demand and decrease in demand.



Summary

1. Law of demand states that quantity demanded by the consumer changes with the change in price while other factors affecting demand remaining the same.
2. Movement along the demand curve (Changes in quantity demanded) is when quantity demanded of a commodity changes (rises or falls) because of change in its price while other factors affecting demand remain constant.
3. Expansion of demand is an increase in the quantity demanded due to a fall in the price whereas contraction of demand is a decrease in the quantity demanded due to a rise in the price.
4. Shift in the demand curve is when quantity purchased of a commodity changes (increase or decrease) due to change in other factors, price remaining unchanged.
5. Increase in demand is when there is an increase in the quantity demanded, due to change in other factors but price remaining unchanged whereas a decrease in demand is when there is a decrease in the quantity demanded, due to change in other factors but price remaining unchanged.

2.4 Exceptions to the Law of Demand

Learning Objectives



- List the cases in which the demand curve does not take a negative slope.
- Explain the positive demand curve through a drawing.
- Examine the cases in which the demand curve is upward sloping.

Introduction

From the law of demand and the derivation of the demand curve, we have seen that the demand curve normally slopes downwards.

Do you think the demand curve will always slope downward?

The demand curve will not always slope downward. The demand curve takes a positive slope in some exceptional cases. Today, we will look at some exceptional cases of demand. These are the exceptions to the law of demand. I will take you through the cases and situations in which the consumers purchase more quantity at a higher price.

Exceptions to the Law of Demand

General law of demand states that the quantity demanded of a good or service by a consumer rises with the fall in price and quantity demanded of a good or service by a consumer falls with the rise in price. However, consumers may purchase more quantity at a higher price and less quantity at less price. These are exceptions to the law of demand.

Exceptions to the Law of Demand states that quantity demanded of a good or service rises with the rise in price and quantity demanded of a good or service fall with the fall in price, other things remaining same.



ACTIVITY 1

Instruction: Use the table given below, draw a graph and see how an exceptional demand curve looks like. Follow the steps I have given for you and try drawing the graph using the data given below.

Steps:

1. Draw x-axis and y-axis.
2. Take Price to y-axis and quantity demanded to the x-axis.
3. Plot the graph using the data given in the column.

Price (Nu)	Qty Demanded (Kg)
10	8
8	6
6	4
4	2

Question: How does your graph look like? Is it a downward sloping curve or an upward sloping curve? Hint: An exceptional demand curve should have an upward sloping.

There are several reasons for an upward sloping demand curve. We will now go through the exceptional cases of demand.

1. Giffen Goods

Giffen goods (named after the 19th century economist Sir Robert Giffen who pointed out this phenomenon for the first time) are those inferior goods on which the consumer spends a large part of his income and the demand for which falls with a fall in their price. Let us say maize is an inferior good, which is consumed by the low-income earners. As the price of maize falls, real income (purchasing power) of the consumer rises. With an increase in real income, a consumer can afford to purchase superior foods like rice. Thus, with a fall in the price of maize, the demand for maize falls.

2. Articles of Snob Appeal

Articles of snob appeal are the commodities, which serve as a status symbol, increase social prestige or are a source of display of wealth and richness. Consumers purchase these commodities at a higher price as it shows their status, power and prestige. For example, when the price of diamonds rises, their prestige and values also rise. Therefore, at a higher price, the quantity demanded of diamonds by rich consumers may increase. Thorstein Veblen was the first to coin the term and termed these goods as goods of conspicuous consumption.

3. Expectations Regarding Future Price

A consumer may buy more in the present even at a higher price as the consumer expects a further rise in the price of a commodity in the future. Similarly, a consumer may buy less in the present even at a lower price as the consumer expects a further fall in the price of a commodity in the future. For example, if a consumer expects a rise in the price of oil in the coming months due to the lockdown of the country, the consumer may buy more litre of oil at the present even at an expensive rate.

4. Emergencies

Law of demand may not operate during emergencies like war, famines and epidemics. During such situations, consumers behave abnormally. For instance, consumers expect a shortage of goods due to emergencies (lockdown of the country due to COVID-19), thus, they purchase more even at higher prices in the present.

5. Quality- Price Relationship

Often, people assume that high priced products are of higher quality. Thus, consumers demand more of higher-priced products as they take price as an indicator of quality.

6. Change in Fashion

Fashion does determine the quantity purchased in an abnormal manner. Fashionable commodities are usually of higher prices and consumers will purchase more even at a higher price. Moreover, when a commodity goes out of fashion, consumers may not buy even at lower prices. For example, consumer do not mind paying more for clothes that are in fashion.



Self-check for Learning

Instruction: Answer the following questions in your book.

1. Will consumers buy more of essential commodities if the price rises?
2. Do you know what demonstration effect is? It refers to the tendency of a person to emulate the consumption patterns of others such as friends, relatives, actors, etc. Will it be one of the exceptions to the law of demand?

2.5 Elasticity of Supply

Sub Topic:

1. Meaning of Elasticity of Supply
2. Classification of Price Elasticity of Supply based on Numerical Values

Learning Objectives



- Define price elasticity of supply.
- Identify and classify the price elasticity of supply.
- Determine the price elasticity of supply using formula.
- Derive the supply curve to show price elasticity of supply based on numerical values.

Introduction

The law of supply tells us in which direction supply will change because of a change in price, but it does not give us the magnitude of change in supply. Price elasticity of supply will give us the knowledge on the degree of responsiveness of quantity supplied of a commodity when there is a change in the price of that commodity.

Price Elasticity of Supply

Price elasticity of supply is the degree of responsiveness or the sensitivity of quantity supplied of a commodity in response to change in its price. It is calculated as the ratio of the percentage change in quantity supplied to the percentage change in its price.

Symbolic:

$$E_s = \frac{\text{Percentage in quantity supplied}}{\text{Percentage change in price}}$$

$$= \frac{P}{Q_s} \cdot \frac{\Delta Q_s}{\Delta P}$$

where P = initial price
 Q_s = initial quantity supplied
 ΔQ_s = change in quantity supplied
 ΔP = change in price

Example:

If an increase in the price of a ballpoint pen from Nu.40 to Nu.50 results to an increase in quantity supplied of pens from 1,000 to 1,500, what is the elasticity of supply?

$$Q = 1000 \quad \Delta Q = 1500 - 1000 = 500$$

$$P = 40 \quad \Delta P = 50 - 40 = 10$$

$$e_s = \frac{\Delta Q}{\Delta P} \times \frac{P}{Q}$$

$$= \frac{500}{10} \times \frac{40}{1000}$$

$$= 2 \text{ [elastic]}$$

To describe the various degrees of price elasticity of supply, economists have grouped them into five categories that we will go through in the coming session.

Price Elasticity of Supply based on Numerical Values

1. Perfectly Inelastic Supply

When the quantity supplied of a commodity does not at all respond to change in its price, it is called perfectly inelastic supply. The value of elasticity will be zero.

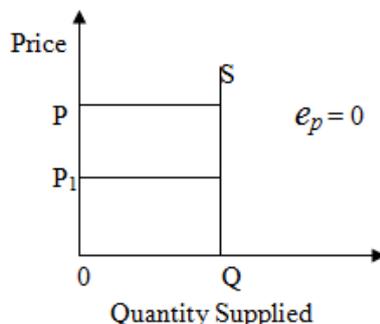


Figure 1

Explanation of Figure 1

The x-axis represents quantity supplied and the y-axis represents the price. S is the supply curve. Initially, at price OP quantity supplied is OQ. Quantity supplied remains unchanged (OQ) though there is a decrease in the price from OP to OP1. The vertical supply curve shows that the price elasticity of supply is zero as it does not respond at all to the change in price.

2. Perfectly Elastic Supply

When sellers are prepared to sell an infinitely large quantity of a commodity at a particular price and nothing at all at a slightly lower price, the elasticity of supply is said to be perfectly elastic. Its value will be infinity.

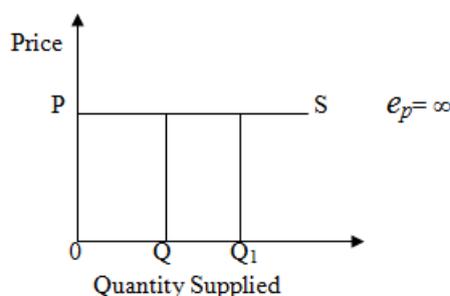


Figure 2

Explanation of Figure 2

The x-axis represents quantity supplied and the y-axis represents the price. S is the supply curve. Initially, at price OP quantity supplied is OQ. Price remaining unchanged (OP), quantity supplied increases from OQ to OQ1. The horizontal supply curve shows that the price elasticity of supply is infinity as supply keeps changing with the price remaining the same throughout.

3. Unitary Elastic Supply

When the proportionate change in quantity supplied of a commodity is equivalent to proportionate change in its price, the elasticity of supply is said to be unitary. A straight line supply curve passing through the origin has an elasticity of unity over its whole length.

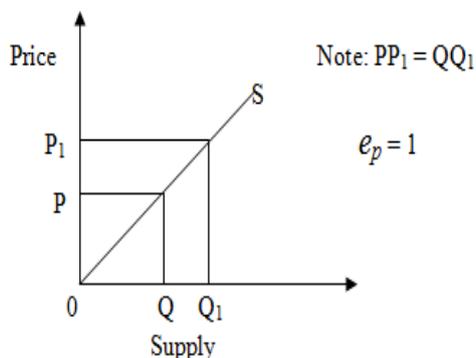


Figure 3

Explanation of Figure 3

The x-axis represents quantity supplied and the y-axis represents the price. S is the supply curve. Initially, at price P quantity supplied is OQ. When the price increased from OP to OP1, the quantity supplied also increased from OQ to OQ1. Here, the percentage change in price is equal to the percentage change in quantity supplied. The upward sloping supply curve from the origin shows that price elasticity of supply is equal to one or unitary

4. Elastic Supply

Supply is said to be price elastic when the percentage change in quantity supplied of a commodity is greater than the percentage change in its price. The elasticity value will be greater than one. In fact, any straight-line supply curve passing through Y-axis (intercepts Y-axis) has elastic supply through.

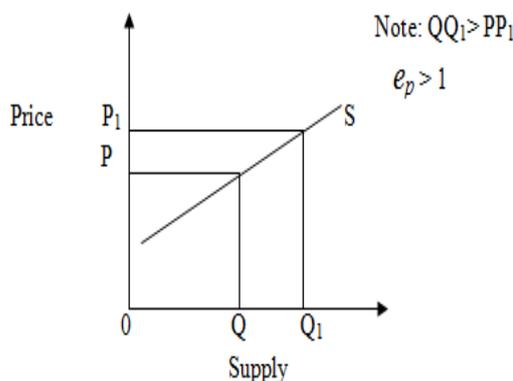


Figure 4

Explanation of Figure 4

The x-axis represents quantity supplied and the y-axis represents the price. S is the supply curve. Initially, at price P quantity supplied is OQ. When price increased from OP to OP1, quantity supplied also increased from OQ to OQ1 but this time, the percentage change in

quantity supplied is more than percentage change in price. The upward sloping supply from the y-axis shows that price elasticity of supply is greater than 1.

5. Inelastic Supply

In the case of inelastic supply, the percentage change in quantity supplied is less than the percentage change in price. Thus, the elasticity value will be less than one. In general, any supply curve passing through X-axis (intercepts X-axis) has inelastic supply throughout.

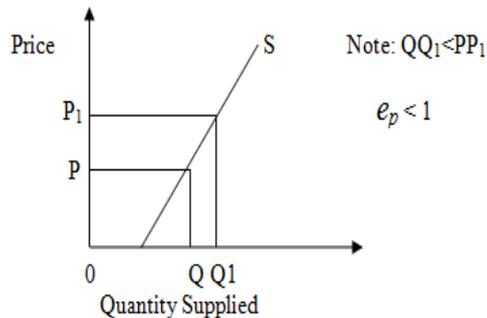


Figure 5

Explanation of Figure 5

The x-axis represents quantity supplied and the y-axis represents the price. S is the supply curve. Initially, at price P quantity supplied is OQ. When price increased from OP to OP₁, quantity supplied also increased from OQ to OQ₁ but this time, the percentage change in quantity supplied is less than the percentage change in price. The upward sloping supply curve from the x-axis shows that the price elasticity of supply is less than 1.



Self-check for Learning

Instruction: Diagrammatically differentiate the following.

1. Perfectly inelastic supply and perfectly elastic supply.
2. Elastic supply and inelastic supply.
3. Demonstrate price elasticity of supply equals to unitary.

3. ACCOUNTANCY

3.1 Types of Business, Accounts and Debit and Credit Rules

Learning Objectives



- Classify different categories of business activities.
- Compare and contrast different business activities.
- Apply the rules of debit and credit.
- Compare and contrast traditional and modern approaches.

Introduction

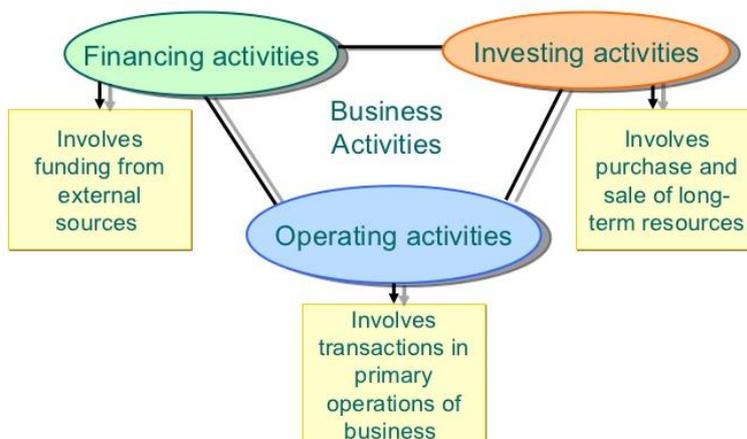
You are familiar with the word ‘business’. Take the example of a shopkeeper or business person near your place and observe his activities. The shopkeeper buys different goods from wholesalers or producers and sells them to customers (buyers). Sometimes, the shopkeeper sells goods on credit to known customers. The shopkeeper also makes payments through cheques. Sometimes, the shopkeeper withdraws goods or cash for his personal use. These and many more are the shopkeeper’s business activities. Now, you ask the shopkeeper how he/she remembers the names of customers, details of goods, etc. The shopkeeper would answer that whatever goods are sold on credit are noted down the same in a notebook or diary. Similarly, the shopkeeper notes down all the credit purchases.

This lesson focuses on the classification of business activities, the meaning of account, and the rules of accounting, which will help you in recording the business transactions and preparing different financial statements.

Types of Business Activities

The business activities are of:

1. Operating Activities.
2. Investing Activities.
3. Financing Activitie



1-5

1. Operating Activities

Operating activities consist of principal activities that a company performs to earn income. In other words, these are the primary business operations that a company performs to earn revenue. This is what the company is in business to do. For a business, this is the most important source of cash as it is directly related to the capacity and the competitiveness of the entity to earn revenues. Operating activities are the first main category of net cash activities listed on the statement of cash flows.

Examples

ABC Ltd. purchases electronics and appliances from manufacturers and sells them to customers. So any activity that is involved in ABC Ltd. purchasing inventory or selling inventory to customers is considered an operating activity.

ABC Ltd. also has activities that are not directly related to selling products to customers like selling fixed assets, getting loans from banks, or paying dividends to shareholders. None of these activities are considered operating activities because they can't be related to the entity's principal business activity: selling products to customers. These activities would either be considered investing or financing activities.

Some other examples of operating activities are:

- Purchase of merchandise, raw materials, and supplies.
- Sale of goods and merchandise.
- Providing services to customers.
- Payment of operating expenses.



2. Investing Activities

Investing activities consist of buying and selling long-term assets (Non-Current Assets) and other investments. You can think of these activities like the money a company uses to invest in itself or the money it makes from its investments. Investing activities are the second main category of net cash activities listed on the statement of cash flows.

Example

When a company purchases a new vehicle with cash, the cash outflows are listed in the investing section. Likewise, if a company sells one of its vehicles, the cash proceeds are

listed in this section as well.

Some examples of investing activities are:

- Purchase of land, buildings and equipment.
- Purchase of stock and bonds issued by other entities.
- Sale of land, buildings and equipment.
- Sales of stock and bonds issued by other entities.



3. Financing Activities

Financing activities are transactions or business events that affect long-term liabilities and equity. In other words, financing activities are transactions with creditors or investors used to fund either company operations or expansions. These transactions are the third set of cash activities displayed on the statement of cash flows.

Example

Cash inflows from creditors usually consist of new loans issued to the company, while cash outflows from creditors include loan and interest payments. The issuances of bonds and bond payments are also consisted as financing activities.

Some other examples of investing activities are:

- Issuance of stock and bonds.
- Borrowings from creditors.
- Repayment of the borrowings from creditors.
- Repayment of bonds payable.
- Repurchase of the entity's own stock.



ACTIVITY 1

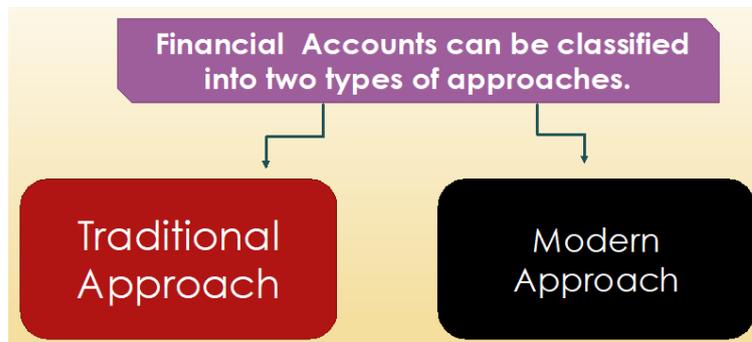
- Do some research and find out why business activities are classified into three categories mentioned above.
- Where can the concept of classification of business activity be applied?

Type of Accounts

You have already studied the meaning of 'Dual Aspect'. It implies that each accounting transaction has two aspects. For example, goods sold to Mr. Ugyen on credit for Nu. 80,000. In this transaction, the two aspects are –Mr. Ugyen and Sales Account. Records of these two aspects, i.e. Mr. Ugyen on the one hand and a Sales Account on the other should be kept.

Many more transactions related to the above aspects may take place during the course of business operations. It will be better if all the transactions of Mr. Ugyen are recorded in one place under the heading Mr. Ugyen. Similarly, all the transactions pertaining to sales should be placed under the heading 'Sales'. Like "Ugyen" and "Sales", there are many other aspects of 'various business transactions e.g. cash, furniture, purchases, buildings, rent, etc. At any point in time, *any heading pertaining to a particular item or person* may be seen and the financial position of that item or person may be assessed.

This classified and consolidated record of a particular type of transaction under a heading is known as ‘Account’. Thus an account is a systematic record of transactions pertaining to a particular item or person, which can be measured in terms of many during a particular period. The abbreviation for the word ‘account’ is A/c.

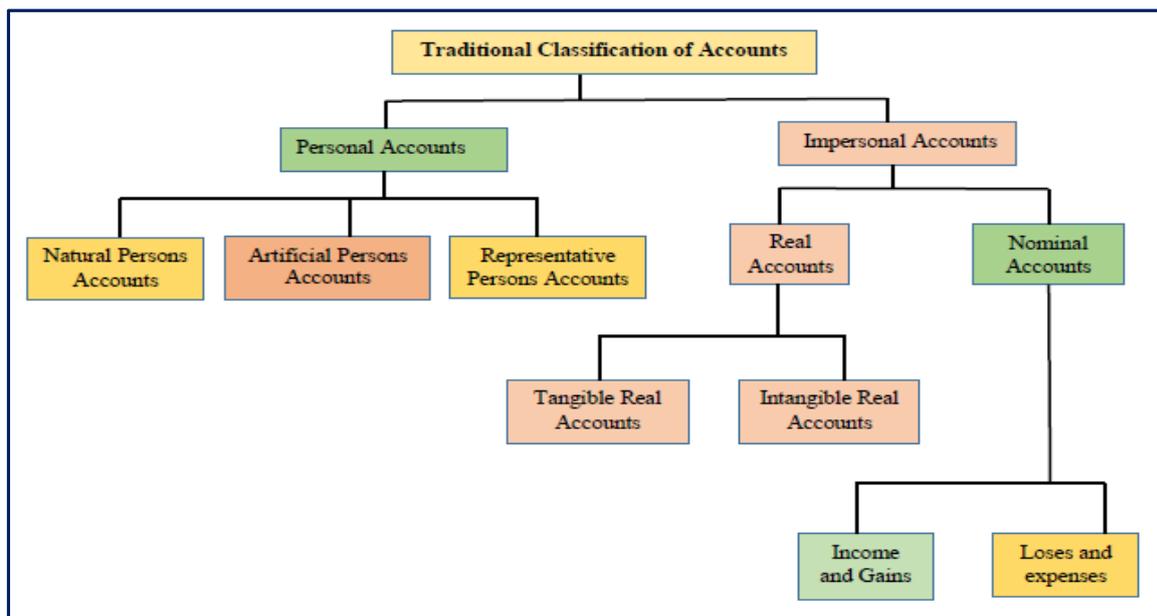


Traditional Classification of Accounts

This is an old system of classifying accounts. Under this system, accounts are classified into two groups as shown in the illustration given below:

i. Personal Accounts

These accounts are related to individuals, firms, companies, etc. A few examples of personal



accounts include debtors, creditors, banks, outstanding/prepaid accounts, accounts of credit customers, accounts of goods suppliers, capital, drawings, etc.

Natural Personal Accounts: The term ‘Natural Persons’ means a person who is the creation of God. E.g. Tara’s A/C, Pema’s A/C, etc.

Artificial Personal Accounts: Personal accounts are those created artificially by law, such as corporate bodies and institutions, are called Artificial Personal Accounts. E.g. Damchen Pvt. Ltd, BIL, RICBL, BOB, clubs, schools, etc.

Representative Personal accounts: Accounts that represent a certain person or a group directly or indirectly. Example, let us say that wages are paid in advance to an employee – a wage prepaid account will be opened in the books of accounts. This wages prepaid account is a representative personal account indirectly linked to the person.

ii. Real Accounts

All assets of a firm, which are tangible or intangible, fall under the category “Real Accounts”.

Tangible real accounts are related to things that can be touched and felt physically. Few examples of tangible real accounts are building, machinery, stock, land, etc.

Intangible real accounts are related to things that can't be touched and felt physically. Few examples of such real accounts are goodwill, patents, trademarks, Copyrights, etc.

iii. Nominal (Revenue, Expense) Accounts

Accounts that are related to expenses, losses, incomes or gains are called Nominal accounts. The dictionary meaning of the word “nominal” is “existing in name only” and the meaning remains absolutely true in accounting sense too, because nominal accounts do not really exist in physical form, but behind every nominal account money is involved. E.g. Purchase A/C, Salary A/C, Sales A/C, Commission received A/C, Prepaid Payments, etc.

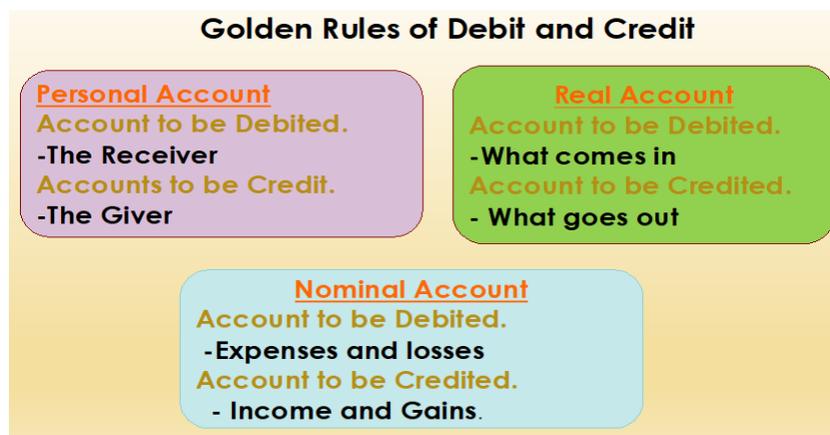
Note: when prefix or suffix is added to a Nominal Account, it becomes a Personal Account.

The table given below explains the above rules.

Nominal Account	Personal Account
1. Interest A/c	Outstanding Interest A/c, Interest received in Advance A/c, Prepaid Interest A/c
2. Rent A/c	Outstanding Rent A/c, Prepaid Rent A/c
3. Salary A/c	Outstanding Salaries A/c, Prepaid Salaries A/c
4. Commission A/c	Outstanding Commission A/c, Prepaid Commission A/c

Based on the above three accounts, a set of rules often called ‘Golden Rules of Account’ is used to record transactions under the double entry bookkeeping system.

The Rules of Debit and Credit (Traditional) at a Glance



Let us understand in-depth about how to make analysis of transactions with the help of Illustration 1 and 2 given below and see how to know about accounts involved, nature of the account, how it is affected and which account will be debited and which account will be credited accordingly using Traditional Approach.

Illustration 1

Analyse the following transactions. State the nature of accounts and state which account will be debited and which account will be credited according to the Traditional approach.

Transaction 1: Ugyen started a business with cash Nu.800, 000 on 1 January 2020.

Transaction 2: Borrowed from Ram Nu.100, 000.

Transaction 3: Purchased furniture for Nu.80, 000 in cash from RK furniture house.

Transaction 4: Purchase furniture from R.C Furniture for Nu. 50,000.

Transaction 5: Purchased goods for cash Nu.15, 000.

Transaction 6: Purchased goods from Sonam Nu.30, 000.

Transaction 7: sold goods for cash to Deepak Nu.25,000

Transaction 8: Sold goods to Khandu on credit for Nu.50,000

Transaction 9: Cash received from Khandu Nu. 40,000.

Transaction 10: Cash paid to Sonam Nu.20, 000.

Transaction 11: Deposited cash into bank Nu.50, 000 for opening an account.

Transaction 12: withdrew cash from the business for personal use Nu.5, 000.

Transaction 13: withdrew cash from the bank for office use Nu.10, 000.

Transaction 14: Paid salary to staff Nu. 20,000.

Transaction 15: Paid rent by cheque Nu.7, 000.

Solution:

Analysis of Transition with the help of Traditional Approach

Sl. No	Transactions	Accounts Involved	Nature of account	How Affected	Debit Nu.	Credit Nu.
1.	Ugyen started a business with cash.	Cash Capital	Real Personal	Cash is coming in. Ugyen is the giver of cash	800,000	800,000
2.	Borrowed from Ram	Cash Loan from Ram	Real Personal	Cash is coming in. Ram is the giver of cash.	100,000	100,000
3.	Purchased furniture for Nu.80, 000 for cash.	Furniture Cash	Real Real	Furniture is coming in. Cash is going out	80,000	80,000
4.	Purchased furniture from R.C for Nu.50, 000.	Furniture R.C furniture	Real Personal	Furniture is coming in. R.C furniture is the giver.	50,000	50,000
5.	Purchased goods for cash Nu. 15,000	Purchases (Note 1) Cash (Note 2)	Nominal Real	Goods come in. Purchase is an expense. Cash is going out.	15,000	15,000

6.	Purchased goods from Sonam Nu.30,000	Purchases Sonam	Nominal Personal	Goods come in. Purchase is an expense. Sonam is a giver.	30,000	30,000
7.	Sold goods for cash to Deepak Nu.25,000	Cash Sales	Real Nominal	Cash is coming in. Sale is an income.	25,000	25,000
8.	Sold goods to Khandu on credit for Nu. 50,000	Khandu Sales	Personal Nominal	Khandu is the receiver. Sale is an income.	50,000	50,000
9.	Cash received from Khandu Nu. 40,000	Cash khandu	Real Personal	Cash is coming in. Khandu is the giver.	40,000	40,000
10.	Cash Paid to Sonam Nu. 20,000	Sonam Cash	Personal Real	Khandu is the receiver. Cash is going out.	20,000	20,000
11.	Deposited cash into bank nu.50,000	Bank Cash	Personal Real	Bank is the receiver. Cash is going out.	50,000	50,000
12.	Withdrew cash for personal use Nu.5,000	Drawings Cash	Personal Real	Ugyen is the receiver. Cash is going out.	5,000	5,000
13.	Withdrew cash from bank for office use Nu. 10,000	Cash Bank	Real Personal	Cash is coming in. Bank is giver.	10,000	10,000
14.	Paid salary to staff Nu.20,000	Salary Cash	Nominal Real	Salary is an expense. Cash is going out.	20,000	20,000
15.	Paid rent by cheque Nu.7,000	Rent Bank	Nominal Personal	Rent is an expense. Bank is giver.	7,000	7,000

Illustration 2

Analyse the transaction after studying the business scenario given below.

Business scenario

Analyze the transaction based on the traditional approach of accounting. State which accounts are to be debited and credited.

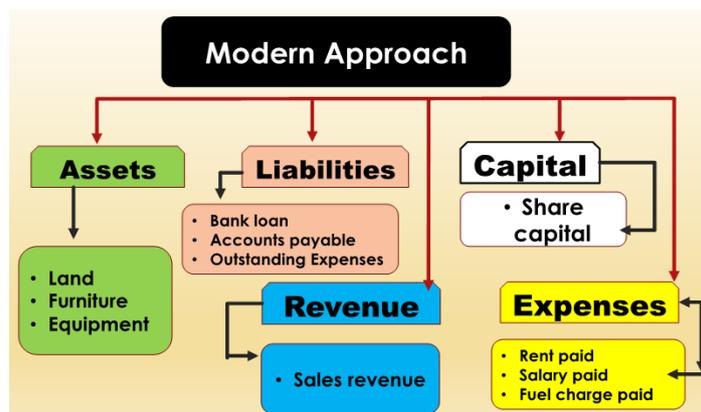
Mr. Tashi invested Nu. 100,000 and started a whole sale business for organic vegetables produced from Dagana. His shop is located in Thimphu anticipating the huge percentage of population not practicing vegetable farming to be his targeted customer. He purchased furniture worth Nu.10,000 to be used in the shop in Thimphu. Then, he purchased vegetables worth Nu. 50,000 from a group of farmers of Drujeygang, Dagana making cash payment. He also went to Tashiding village and purchased 700kgs of green chilli at Nu. 7,000 from Dorji on credit. He sold all the vegetables at Nu. 100,000. He paid Nu. 7,500 as salary to salesperson and his rent were outstanding for a month Nu. 13,000.

- *Purchases refer to the purchase of goods for resale and not the purchase of assets.*
- *In cash purchases, the seller's name is not relevant. Hence, it is not considered. Similarly in cash sales, the purchaser's name is not relevant. Hence, it is not considered.*

Solution: Analysis of Transactions

Sl. No	Account	Nature of Accounts	How Account are Affected	Debit or Credit
1	Cash A/c Capital A/c	Real Personal	Cash is coming in. Karma is the giver.	Debit Credit
2	Furniture A/c Cash A/c	Real A/c Real A/c	Furniture is coming in. Cash is going out.	Debit Credit
3	Purchase A/c Cash A/c	Nominal A/c Real A/c	Good comes in. Purchase is expenses. Cash is going out.	Debit Credit
4	Purchase A/c Dorji A/c	Nominal A/c Personal A/c	Good comes in. Purchase is an expenses. Dorji is the giver.	Debit Credit
5	Cash A/c Sales A/c	Real A/c Nominal A/c	Cash is coming in. Sales is an income.	Debit Credit
6	Salary A/c Cash A/c	Nominal A/c Real A/c	Salary is an expense. Cash is going out.	Debit Credit
7	Rent A/c outstanding rent	Nominal Personal	Rent is expense. Outstanding rent A/c represents the landlord to whom rent is payable.	Debit Credit

1. Classification of Accounts under the Modern Approach



1. Assets Accounts

Assets are the properties, possessions or economic resources of a business. They help in business operations and help in earning revenues. They can be measured in terms of money. They help in carrying out the normal operations of the business. For example, land, building, furniture, machinery, vehicles, etc.

2. Liabilities Accounts

Liabilities are the amounts that an entity owes to the outsiders. These are the obligations or the debts payable by the business. For example, Accounts Payable, etc.

3. Capital Accounts

The money brought into the business by the owner is called Capital or Owner’s Equity. Capital is an obligation of the business that has to be paid back to the owner. Because business is a separate entity from its owner.

4. Revenue Accounts

Revenue is the amount earned by the business by selling goods or rendering of services. For example, Sales, rent received, interest received, dividend earned, etc.

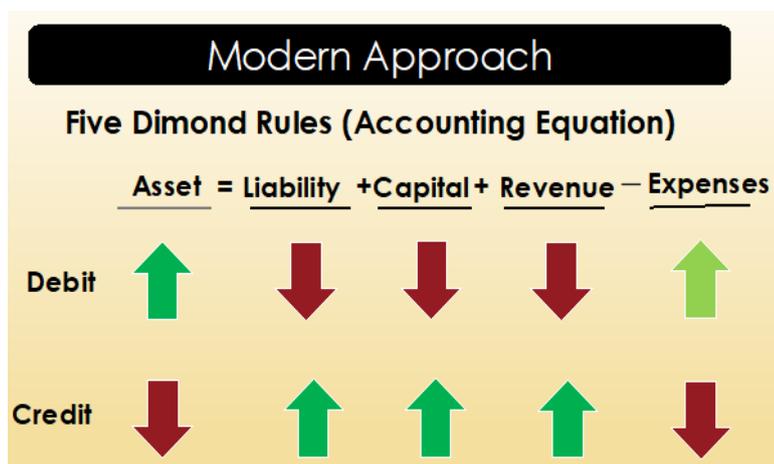
5. Expenses Accounts

All costs incurred or money spent by a business in order to earn revenues is called expenses. It is noteworthy here that when the benefits of the money spent are exhausted within a period of one year, it is called an Expense.

For example, rent paid, salary paid, electricity charges, interest paid, etc.

Rules of Debit and Credit under Modern Approach

Sl.No.	Types of account	Rules
1	Assets	Increase in assets- Debit Decrease in assets- Credit
2	Liabilities	Increase in liabilities- Credit Decrease in liabilities- Debit
3	Capital	Increase in capital- Credit Decrease in capital- Debit
4	Revenue	Increase in revenue- Credit Decrease in revenue- Debit
5	Expenses	Increase in expenses- Debit Decrease in expenses- Credit



Let us understand about how to make an analysis of transactions with the help of Illustration 3 and 4 given below and see how to know about accounts involved, nature of the account, how it is affected and which account will be debited and which account will be credited accordingly using Modern Approach.

Illustration 3

Analyse the following transactions. State the nature of accounts and state which account will be debited and which account will be credited according to the Modern approach.

Transaction 1: Ugyen started a business with cash Nu.800, 000 on 1 January 2020.

Transaction 2: Borrowed from Ram Nu.100, 000.

Transaction 3: Purchased furniture for Nu.80, 000 in cash from RK furniture house.

Transaction 4: Purchase furniture from R.C Furniture for Nu. 50,000.

Transaction 5: Purchased goods for cash Nu.15, 000.

Transaction 6: Purchased goods from Sonam Nu.30, 000.

Transaction 7: sold goods for cash to Deepak Nu.25,000

Transaction 8: Sold goods to Khandu on credit for Nu.50,000

Transaction 9: Cash received from Khandu Nu. 40,000.

Transaction 10: Cash paid to Sonam Nu.20, 000.

Transaction 11: Deposited cash into bank Nu.50, 000 for opening an account.

Transaction 12: withdrew cash from the business for personal use Nu.5, 000.

Transaction 13: withdrew cash from the bank for office use Nu.10, 000.

Transaction 14: Paid salary to staff Nu. 20,000.

Transaction 15: Paid rent by cheque Nu.7, 000.

Solution:

Analysis of Transactions with the help of Modern Approach

Sl.No	Transactions	Accounts Involved	Nature of Account	How Affected	Debit Nu.	Credit Nu.
1.	Ugyen started a business with cash.	Cash Capital	Asset Capital	Increased Increased	800,000	800,000
2.	Borrowed from Ram	Cash Loan from Ram	Assets Liability	Increased Increased	100,000	100,000
3.	Purchased furniture for Nu.80, 000 for cash.	Furniture Cash	Asset Asset	Increased Decreased	80,000	80,000
4.	Purchased furniture from R.C for Nu.50, 000.	Furniture R.C furniture	Asset Liability	Increased Increased	50,000	50,000
5.	Purchased goods for cash Nu. 15,000	Purchases Cash	Expense Asset	Increased Decreased	15,000	15,000
6.	Purchased goods from Sonam Nu.30,000	Purchases Sonam	Expense Liability	Increased Increased	30,000	30,000
7.	Sold goods for cash to Deepak Nu.25,000	Cash Sales	Asset Revenue	Increased Increased	25,000	25,000
8.	Sold goods to Khandu on credit for Nu. 50,000	Khandu Sales	Assets Revenue	Increased Increased	50,000	50,000
9.	Cash received from Khandu Nu. 40,000	Cash Khandu	Assets Assets	Increased Decreased	40,000	40,000
10.	Cash Paid to Sonam Nu. 20,000	Sonam Cash	Liability Asset	Decreased Decreased	20,000	20,000
11.	Deposited cash into bank nu.50,000	Bank Cash	Asset Asset	Increased Decreased	50,000	50,000
12.	Withdrew cash for personal use Nu.5,000	Drawings Cash	Withdrawal Asset	Increased Decreased	5,000	5,000

13.	Withdrew cash from bank for office use Nu. 10,000	Cash Bank	Asset Asset	Increased Decreased	10,000	10,000
14.	Paid salary to staff Nu.20,000	Salary Cash	Expense Asset	Increased Decreased	20,000	20,000
15.	Paid rent by cheque Nu.7,000	Rent Bank	Expenses Asset	Increased Decreased	7,000	7,000

Illustration 4

After studying the business scenario given below, analyse the transactions.

Business scenario

Analyze the transaction based on the traditional approach of accounting. State which accounts are to be debited and credited.

Mr. Tashi invested Nu. 100,000 and started a whole sale business for organic vegetables produced from Dagana. His shop is located in Thimphu anticipating the huge percentage of population not practicing vegetable farming to be his targeted customer. He purchased furniture worth Nu.10,000 to be used in the shop in Thimphu. Then, he purchased vegetables worth Nu. 50,000 from a group of farmers of Drujeygang, Dagana making cash payment. He also went to Tashiding village and purchased 700kgs of green chilli at Nu. 7,000 from Dorji on credit. He sold all the vegetables at Nu. 100,000. He paid Nu. 7,500 as salary to salesperson and his rent were outstanding for a month Nu. 13,000.

Solution:

Analysis of Transactions with the help of Modern Approach

Sl. No.	Accounts involved	Nature of Accounts involved	How accounts are affected	Debit or Credit
1	Cash A/c Capital Alc	Assets A/c Capital A/c	Asset is increased Capital is increased	Debit Credit
2	Furniture A/c Cash A/c	Assets A/c Assets Alc	Asset is increased Asset is decreased	Debit Credit
3	Purchase Alc Cash A/c	Expenses A/c Asset Alc	Expense is increased Asset is decreased	Debit Credit
4	Purchase A/c Dorji A/c	Expense A/c Liability Alc	Expense is increased Liability is increased	Debit Credit
5	Cash A/c Sales A/c	Asset A/c Revenue A/c	Asset is increased Revenue is increased	Credit Credit
6	Salary Alc Cash A/c	Expense A/c Asset A/c	Expense is increased Asset is decreased	Debit Credit
7	Rent Alc Rent Outstanding A/c	Expense Alc Liability A/c	Expense is increased Liability is increased	Debit Credit

**ACTIVITY 2**

Instruction: Classify the following accounts into Real, Personal and Nominal Accounts.

- | | |
|------------------|--------------------------|
| a. Interest | g. Cash |
| b. Drawings | h. DSB publishers |
| c. Capital | i. BDBL |
| d. Bank loan | j. Bank Overdraft |
| e. Depreciation | k. Commission receivable |
| f. Motor vehicle | l. Discount received |

**ACTIVITY 1**

Instruction: From the list of items given, classify them into different head of accounts under both the approaches.

- Land, Rent due, Commission received, Salary paid, Capital, Cash in hand, Cash at bank, Furniture, Purchases and Sales.

**Summary****Types of Business Activities**

The business activities are of: Operating Activities; Investing Activities; and Financing Activities.

- Meaning of Account – An account is a systematic record of transactions that can be measured in terms of money and related to business during a particular period.

Types of Accounts

- *Traditional Classification:* Personal Account, Real Account and Nominal Account.
- *Modern Classification:* Assets, Liabilities, Capital, Revenue, and Expenses
- *Rule of Accounting:* Rule for debit and credit when the accounts are classified as Personal, Real and Nominal.
- *Personal Account:* Debit the receiver; Credit the giver.
- *Real Account:* Debit what comes in; Credit what goes out.
- *Nominal Account:* Debit all expenses and losses; Credit all incomes and gains
- The rules for debit and credit when the accounts are classified as Asset, Liability, Capital, Revenue, and Expense:
 - Increase in Assets-Debit and decrease in Assets -Credit.
 - Increase in Liability-Credit and decrease in Liability-Debit.
 - Increase in Capital-Credit and decrease-Capital-Debit.
 - Increase in Expense-Debit and decrease in Expense-Credit.
 - Increase in Revenue-Credit and decrease in Revenue-Debit.

**Self-check for Learning**

1. Why is it important to know how to classify accounts?
2. Is it necessary to know how to classify the accounts with the help of both the approaches? Give one reason to support your statements.
3. Analyse the transactions given below and state the nature of accounts and state which account will be debited and which account will be credited according to the both the approaches:

Transaction 1: Sonam started a business with cash Nu.400, 000 on 1 January 2019.

Transaction 2: Borrowed from Karma Nu.200, 000.

Transaction 3: Purchased furniture for Nu.50, 000 in cash from a furniture house.

Transaction 4: Purchase furniture from Lemo Furniture for Nu. 60,000.

Transaction 5: Purchased goods for cash Nu.50, 000.

Transaction 6: Purchased goods from Tara Nu.20, 000.

Transaction 7: sold goods for cash to Pema Nu.50,000

Transaction 8: Sold goods to Wangmo on credit for Nu.20,000

ARTS STREAM

1. MEDIA STUDIES

1.1. Information and Information Literacy

Learning Objectives



- Explain the term information.
- Explain the term information literacy.
- Comprehend the importance of information literacy.
- Identify essential information literacy skills.

Introduction

“Children and young people not only need to be able to read for information; they also need to be able to work out what trust they should place on the information and to identify when and how people are aiming to persuade or influence them,” *Curriculum for Excellence (2009)*.

Concept of Information

“We live in the information age, and *information* is increasing at a rapid pace. We have the internet, television, radio, and other information resources available to us 24 hours a day, 7 days a week, 30 days a month, 365 days a year. However, just because so much information is so easily and quickly available does not mean that all of it is worthwhile or even true.”

Have you realized that we are always surrounded by information from the moment we wake up until we go to sleep? In this information-saturated society, we are bombarded with all sorts of information at an exponential rate that is being transmitted through various communication channels. Thus, it is called an *information age*.

What is Information?

Information can be defined as facts provided or learned about something or someone or an event. Let me explain this further.

In simple terms, information is a communicable fact, data, and opinion about someone or something which the audiences or receivers can understand.

**ACTIVITY 1**

Instruction: Check how much you have understood the concepts of information by answering the following two questions.

- Explain the concepts of information.
- Explain the concept of the information age.

In your explanation, think whether you can get these three points; facts, data, and opinion while defining information. Also when you think of the information age reflect on some of the information sources like radio, TV, books, newspaper, the internet, etc.

Information Literacy

“For all societies, information literacy is becoming an increasingly important component of not only literacy policies and strategies, but also of global policies to promote human development,” *UNESCO (2003)*.

The concept of information literacy is different from media literacy. Here, the focus is more towards information, the nature of information, and skills to identify good information.

- Information Literacy is the ability to identify what information is needed, understand how the information is organized, identify the best sources of information for a given need, locate those sources, evaluate the sources critically, and ethically share that information.
- “...the hyper ability to know when there is a need for information, to be able to identify, locate, evaluate, and effectively use that information for the issue or problem”. *US Forum on Information Literacy*.
- “As a set of abilities requiring individuals to recognize when information is needed and locate, evaluate, and use effectively the needed information”.
- “Information literacy is the adoption of appropriate information behaviour to identify, through whatever channel or medium, information needs, leading to wise and ethical use of information in society.” *Johnston and Webber*.

Are you an information literate person? Yes, you are if you have the following general and technical abilities.

In general, an information literate person should have the following six abilities.

- Identify what information is needed.
- Understand how information is organized.
- Identify best sources of information.
- Locate sources.
- Evaluate the sources critically.
- Share information.

Technically, an information literate person would be able to:

- Spot fake news and questionable news sources.
- Use search engines effectively to find good quality information.
- Evaluate resources for trustworthiness, quality, and reliability.
- Familiarity with databases, scholarly and peer-reviewed journals, and published literature.

Also, remember that there are other literacies including computer literacy, cultural literacy, digital literacy, and technology literacy.



ACTIVITY 2

Instruction: Answer the following questions to review the lesson on Information Literacy.

- What do you understand by the term information literacy?
- What are some of the skills required to become an information literate person?

Information literacy is knowing when and why you need information, where to find it, and how to evaluate, use and communicate it in an ethical manner.)

The Importance of Information Literacy

Do we need to be information literate? Who all would need to be information literate?

In fact, everybody would need to be information literate in the 21st Century.

Read and analyse the following points to understand the importance of information literacy.

- We live in an information-saturated society, where we are bombarded with information in a variety of formats.
- All information is not created equal: some are authoritative, current, reliable, but some are biased, outdated, misleading and false.
- Communication technologies to access, manipulate and create information are expanding rapidly.
- Information literacy helps us combat Data Smog (an overwhelming excess of information-*Google*).
- Promotes problem-solving approaches and thinking skills.
- Asking questions and seeking answers.
- Overall gain individual confidence and become a responsible citizen.
- It helps in finding information.
- It helps in forming opinions and suggestions.
- It helps in evaluating sources and making decisions.
- It helps to become successful learners and effective contributors.

Let us now explore the general concept of information literacy skills.

1. *Identify What Information is Needed*

a) Categories of Information
<ul style="list-style-type: none"> • Popular • Scholarly • Trade

b) Types of Information
<ul style="list-style-type: none"> • Primary • Secondary • Tertiary

c) Formats of Information
<ul style="list-style-type: none"> • Printed • Digital • Audio/Video • Multimedia • Microform • Human

2. Identifying Topic

- a. Understand the nature of your information as it will help you determine the kind of information required for the intended purpose and the utility.
- b. Formulate questions based on the kind of information you require for the intended purpose.

3. Searching for Information

Search Query	Key Concepts
<i>Find the population of Bhutan</i>	Search for facts or data, rather than knowledge or analysis and answers to be found in a single source like NHPS.
<i>What is the history of the internet?</i>	Report or review. Collate and synthesize existing information. Summary of the past. Answers to be found in a selection of books, articles and websites.
<i>Impacts of media on youth</i>	There's no ready answer. Gathering and analysing information or data to extract new meaning or solutions

4. Locating Sources

- a. Citation is a brief description of a specific information source, usually appearing in a bibliography or a database. It appears in different formats, like the American Psychological Association (APA) and Modern Language Association (MLA).
- b. Reading citations represent any written, spoken, or broadcast sources, websites, and chapters from books, interviews and documentaries.

5. Evaluating Sources

Criteria	Important Clues
a) Authority	<ul style="list-style-type: none"> • Author's credentials • Author's affiliation with educational institution or organization
b) Currency	<ul style="list-style-type: none"> • Date of information published or revised. • Any newer topics published on the topic.
c) Purpose	<ul style="list-style-type: none"> • Purpose of publishing this information. • Obvious bias or prejudice. • Omit any important facts that might disprove a claim.
d) Relevance	<ul style="list-style-type: none"> • Do information answer your research questions? • Add something new to your knowledge of the topic.
e) Accuracy	<ul style="list-style-type: none"> • Errors in spelling, punctuation or grammar. • Reviewed by editors or subject experts. • Any citations are references.

6. Sharing Information

- Take accurate notes of where you found specific ideas.
- Complete citations for the information you used.
- Use quotation marks when directly stating another person's words.
- Always credit original authors for their information and ideas.



ACTIVITY 3

Instruction: Reflect and write down the list of Information Literacy (IL) skills

Your list includes: -----

After listing the skills, refer to the following points.

- A need for information, the resources available, how to find information, the need to evaluate results, how to work with or exploit results, ethics and responsibility of use, how to communicate or share findings, how to manage findings)
- It is a combination of research skills, critical thinking skills, computer technology skills, and communication skills.
- Information literacy is essential for academic success, effective functioning in the workplace, and participation in society as a knowledgeable citizen.



Self-check for Learning

1. Why would you as a student need to have Information Literacy Skills?
2. What are the media literacy skills that can help us?
3. How is Information Literacy important to you?

1. 2. Technological Convergence and Media Conglomerates

Learning Objectives



- Define technological convergence and media conglomerates.
- State factors that bring about technological convergence.
- Relate technological convergence to media conglomerates.

Introduction

Since the 1990s, the information and communication technology (ICT) has been perceived as the critical technology for economic development, and the ICT industry itself has been growing exceptionally fast. Moreover, technology convergence in ICT has received particular attention. ICT innovations diffuse into existing products and thus come to form a new integral part of the goods. The creation of synergies, blurring of industry boundaries, integration, and overlapping of markets are all used to describe convergence.

Concept of Technological Convergence

Until recently different types of technology were used for different media. Each of these had their specific function; a radio to listen to an audio broadcast, a telephone for voice communication, a television for video broadcast, a Walkman to listen to music, a camera to take pictures and a computer to type or send an email. Now a single device like mobile has multiple functions; one device can function in diverse ways. We can listen to music, take pictures, watch videos, play games and do a lot more,

Due to technological convergence, all of them have come together/ merge. The technologies that were originally unrelated have become more closely integrated and even unified as they develop and advance. This is the basic idea of technological convergence.

What is a Technological Convergence?

Technological convergence is the process by which existing technologies merge into new forms that bring together different types of media and applications. It is the convergence of technology. Through technological convergence, devices can interact with a wider array of media types. In the past, each entertainment medium had to be played on a specific device. The video was displayed on a television through some type of video player, music came through a tape deck or Compact Disc (CD) player, and video games were played through a console of some sort. Now we can do it all on a single device.



Fig: Technological convergence. <https://shape.att.com/blog/technology-convergence>

Technological convergence has resulted in devices that not only interact with the media they are primarily designed to handle but also with a number of other formats.

Books were initially in printed format. But now we can have it in different formats such as digital- kindle app [kindle e-books] or audio-books in Audio format.



ACTIVITY 1

Try out the following questions.

- Define technological convergence.
- Give some examples of technological convergence.

Technological Convergence and its Factors

1. *Advancement in Telecommunication*

- In the past, different forms of communication media used their specific technologies. Voice conversations used a telephone, video communication briefly used high-end video phones, and e-mail required a computer. Due to the advancement of telecommunications a single electronic device can be used for many purposes. In this way telecommunications advancement has led to convergence.
- Technological convergence has resulted in computers and handheld devices like mobile smartphones and tablets that can provide all of this functionality with a single electronic piece of equipment.

2. *Changes in Hardware*

- Such technological convergence also leads to devices that are designed specifically to replace many different items. Mobile phones, for example, have moved far beyond their beginnings as simple voice communication devices and now offer the functionality of personal music players, digital cameras, and text messenger systems.
- New devices, such as tablet computers, have been developed simply as a format for convergence, with a single item functioning in the place of numerous earlier electronics.

3. *The Internet*

- It is perhaps the most widespread example of technological convergence.
- Virtually all entertainment technologies, from radio and television to books and games, can be viewed and played online.
- Computers with Internet access offer greater functionality than primary devices like media players or e-Readers for digital books.
- All of these different types of media have become digitized and made more readily available than ever before.

So, to sum up, a technology convergence is the result of basically the advancement in telecommunications, and changes in hardware and the internet.

While technological convergence gives consumers the convenience of having many devices all in one, saving on both size and cost. The downsides are:

- Initial tradeoff in quality.
- When companies introduce new multi-technology formats, the various technologies it is comprised are usually at a slightly lower standard than on independent devices.
- Usually within a year or two, however, this disparate quality is reduced and dedicated devices may become obsolete.
- Some technologies remain specialized, however; digital cameras, for example, often remain preferable to phone cameras in terms of image quality and features, especially for professional photographers.



ACTIVITY 2

Instruction: Take some time to reflect and answer the question given below.

- What could be some merits and demerits of technological convergence?

Introduction to Media Conglomerates

What is a conglomerate?

- A conglomerate is a combination of two or more corporations engaged in entirely different businesses together into one corporate structure, usually involving a parent company and several (or many) subsidiaries.
- Often, a conglomerate is a multi-industry company.
- Conglomerates are often large and often multinational.

Media Conglomerate

A conglomerate is, by definition, a large company that consists of divisions of seemingly unrelated businesses.

- A media conglomerate describes companies that own large numbers of companies in various mass media such as television, radio, publishing, movie, and the internet.
- Each of these companies is an enormous mass media conglomerate: it controls music companies, record companies, hardware, software, television, radio.
- As of 2008, The Walt Disney Company is the world's largest media conglomerate, with News Corporation, Viacom and Time Warner ranking second, third, and fourth respectively.

One of the greatest impacts of technological convergence, telecommunication, and computers, is the emergence of **media conglomerates**. Now with the advent of new media, the different forms of media are converging into a single form. This phenomenon is called media conglomerates.

Now, let us understand the meaning of the media conglomerate.

- A media conglomerate, also known as a media group, or media institution is a company that owns numerous companies in various mass media; i.e. television, radio, publishing, motion picture, and the Internet. Some media conglomerates use their access in multiple areas to share various kinds of content such as news, video and music, between users. For example, “Sony Corporation is a media conglomerate. They own numerous companies in mass media including broadcast, film production, TV show, and motion pictures.



ACTIVITY 3

Check your learning by answering the following questions.

1. Define media conglomerate.
2. Provide some examples of media conglomerates.

Summary

- Access to media has changed the way the audience consumed media messages in several ways. For example a couple of years back we were not able to send instant messages to our friends or family; the only thing close to that was making phone calls, which was quite expensive. So the majority of people used to write letters.
- Due to the advancements of technology we can now communicate with people all around the world instantly.
- Using one single device we can access news and information from different parts of the world, anytime, anywhere.
- The advantage of access to digital media that you could be traveling to another country but not knowing what the weather is going to be there, however you can now go on your device and find out very easily.
- Overall, digital media has massive impacts on how the audience consumes media, and ways we live in a media saturated society.



Self-check for Learning

1. Check how well you have learned from the lessons on the following topics.
 - Technology Convergence
 - Technology Convergence and its factors
 - Introduction to Media Conglomerates
2. Also, write answers to the following questions.
 - Have our lives become easier with technological convergence or has it complicated our life? How?
 - Do you think that media conglomerate will dominate the Bhutanese media sector one day? Explain your answer.

2. GEOGRAPHY**2.1 Transport***Learning Objectives*

- Define transportation in your own words.
- List all means of transport in the world.
- Trace out the importance of transportation.
- Write a brief history of transportation in Bhutan.
- Explain the reasons as how the road is the main means of transport in Bhutan.

Introduction

All the schools in Bhutan had to be closed because of the COVID-19 pandemic, and you all had to return home. Do you think you could have reached home without transportations?

Transportation

Now, what do you understand by transportation?

- It is the movement of people or goods from one place to another by using different means or modes of transport.
- It is a system in which the people and goods move from one place to another. OR to take or carry people or goods from one place to another using a vehicle, aircraft, ship, etc.

In the following activities, we will explore more on different means of transportation and its impacts.

**ACTIVITY 1**

Instruction: Write answers to the questions given below.

- Explain the meaning of transportation in your own words.
- What are the main means of transportation in the world? Think for a few seconds and list them.

The means of transport is a term used to describe different types of transportation systems used to take goods or persons from one place to another. The following are the three categories of transport used in Bhutan:

1. Land Transport
2. Water Transport
3. Air Transport.

The five common means or modes of transport are:

1. Roadways.
2. Railways.
3. Waterways.
4. Airways.
5. Pipelines.

Why do you think there is a need for transportation? Think for a few seconds and note down.

Importance of Transportation

Transportation is important as life's necessities and pleasures cannot possibly fit within the reach of our static bodies from birth to death. We either have to move ourselves to things or have things moved to us.



ACTIVITY 2

“Transportation acts as basic economic arteries of the country and helps in economic growth and globalization”. Give five justifications to support this statement.

Do you know the history of transportation in Bhutan? Think for a few seconds.

History of Means of Transportation in Bhutan

1. In the past, humans were the main means of transport. Later, they started using animals like horses, mules, yaks, and oxen followed by vehicles, water and then air.
2. These days, roadways and airways are the most common means of transportation. In remote areas, the common means of transportation are people and animals.

History of Road Transport in Bhutan

1. Construction of the first national highway – Phuntsholing – Thimphu - Dechencholing (179 km) started in 1959 and was completed in 1962.
2. At the end of the first five-year plan (1961-1966), about 1770 km of roads were constructed including the 208 km which connected Phuntsholing with Paro and Thimphu. Thimphu saw the first motor vehicle in 1962 and Paro in 1964.
3. Other highways constructed were – Samdrup Jongkhar to Tashigang (180km), Gelephu – Trongsa (224 km) and the lateral road connecting Haa, Thimphu, Wandgdue Phodrang, Trongsa, Bumthang, Mongar, and Tashigang.
4. After the introduction of the mechanized transport system in Bhutan, Bhutan Government Transport Service (BGTS) was entrusted with goods and passengers transportation.
5. However, the government gradually started privatizing public transport service in 1985 and fully achieved in 1990.
6. To promote and develop the surface transport, Road Safety and Transport Act became operational since October 1997.
7. Today, the Department of Roads is responsible for the design and planning of roads in Bhutan.

Druk Air (the National Airline) was commenced since February 1983 providing air services that were commercialized in 1985.

How does road help the Bhutanese people?

1. Facilitates the mobility of people.
2. Helps producers in the marketing of their produce.
3. Creates economic opportunities like businesses.
4. It accelerates both international trade as well as domestic trade.
5. Connects remote villages with urban centres.

Popular Means of Transport used in Bhutan

1. Roadways
2. Airways
3. Ropeways

Roadways

In this lesson, we are going to focus on roadways. Roads first appeared in Bhutan in 1962 with the completion of National highway that connected Phuntsholing and Thimphu. Thereafter, a number of roads were laid throughout the kingdom to play a crucial role in stimulating domestic and international trade.

The Need for Road Transport in Bhutan

1. Bhutan is a mountainous country with steep gradients and numerous river valleys that makes the construction of other modes of transport such as railways impossible.
2. Bhutan being a developing country is financially having difficulty in connecting all the dzongkhags by airlines.
3. Bhutan being a landlocked country with rugged terrain does not favour waterways.

Hence, road transport can be the only mode of transport that is cheap and efficient.

**ACTIVITY 3**

In addition to roadways, which mode of transportation do you think is most suitable for Bhutan? Justify your answer with five points.

**Self-check for Learning**

Check your learnings by answering the following questions.

1. Define transportation in your own words.
2. Mention all means of transportation.
3. Name the major means of transportation used in Bhutan.
4. Write the importance of transportation.
5. Write a brief history of how road transportation started in Bhutan.

2.2 Concept of Agriculture

Learning Objectives



- Explain the concept of agriculture.
- Comprehend the evolution of agriculture.
- Identify different types of agriculture.
- Explain the importance of agriculture.
- Identify the problems faced by the Bhutanese farmers.
- Suggest measures to overcome problems related to agriculture.

Introduction

Most of our parents carry out agricultural activities. Do you know what agriculture is? You can think for a few five minutes.

The term ‘agriculture’ is derived from two Latin words ‘ager’ or ‘agri’ meaning soil and ‘cultura’ meaning cultivation. So the cultivation of land is known as agriculture. Agriculture refers to the art and science of cultivating crops and raising animals.

In the following activities, we will explore more about the concept of agriculture, its evolution, types, importance, problems and measures to address the problems.

Concepts of Agriculture

- Agriculture is an applied science that encompasses all aspects of crop production including horticulture, livestock rearing, fisheries, forestry, etc.
- Agriculture as an art embraces knowledge of the ways to perform the operations of the farm in a skillful manner.
- Agriculture as a science it utilizes all technologies developed on scientific principles such as crop breeding, production techniques, crop protection, economics, etc. to maximize the yield and profit.



ACTIVITY 1

Instruction: Write the answers to the questions.

- Explain the concepts of agriculture in your own words.
- Do you know how agriculture came into existence?

Evolution of Agriculture

1. *Hunting*: it was the primary source of food in the old days. It is an important occupation and has been existing since the stone ages.
2. *Pastoral*: Humans obtained their food through domestication of animals, e.g cow, buffalo, horse, yaks, etc.

3. *Crop Culture*: By living near the river bed, he had enough water for his animals and domesticated crops and started cultivation. Thus humans started to settle in a place.
4. *Trade*: When people started producing more and the excess was exchanged, this is the basis for trade.

Branches of Agriculture

1. *Agronomy*
Deals with the production of various crops which include food crops, fodder crops, fibre crops, sugar, oilseeds, etc.
2. *Horticulture*
Deals with the production of fruits, vegetables, flowers, ornamentals plants, spices, condiments and beverages.
3. *Forestry*
Deals with the production and large scale cultivation of perennial trees for supplying wood, timber, rubber, etc.
4. *Animal Husbandry*
Deals with agricultural practices of breeding and raising livestock to provide food for humans and to provide power (draught) and manure for crops.

Children! How many types of agriculture do you think are there? I know you can name a few. Think for a few seconds and list them down.

Types of Agriculture

The types of agriculture classified based on the use of tools and methods are:

1. Primitive Agriculture.
2. Modern Agriculture.

1. Primitive Agriculture

It is when farmers carry out agricultural activities using traditional tools and ancestral methods like oxen to plough, ash as an insecticide, manure to maintain the fertility of the soil, humans instead of machines, etc.

2. Modern Agriculture

Is when farmers carry out agricultural activities using modern tools and methods like power tiller to plough, thresher, weedier, chemicals fertilizer instead of manure, insecticides, pesticides, weedicides instead of ash and latest techniques of agriculture.

Types of Agriculture Based on the Purpose

1. Subsistence Agriculture
2. Semi- Commercial Agriculture
3. Commercial Agriculture

1. Subsistence Agriculture

It is when farmers carry out agricultural activities to meet the needs of the family members using traditional tools and ancestral methods on a small scale. In this type of farming, farmers use farmyard manures, indigenous seeds and simple tools. Productivity is usually low.

2. Semi-Commercial Agriculture

It is when farmers carry out agricultural activities not only to meet the needs of the family members but also to sell the extra products after their consumption.

3. Commercial Agriculture

It is when farmers carry out agricultural activities mainly for sale using modern tools and techniques on a large scale. This type of farming uses large land, labourers and machines. Some of the commercial crops grown in Bhutan are; oranges, apple, cardamom and potatoes.

Difference between Subsistence and Commercial Farming

Subsistence Agriculture	Commercial Agriculture
1. Production is mainly for family consumption.	1. Production is mainly for sale
2. Small-scale production	2. Large –scale production
3. Labour intensive farming	3. Capital intensive farming
4. Old methods of farming	4. Modern methods of farming
5. Grow multiple crops	5. Mainly one crop is grown
6. Use of local manures like cow dung, dry leaves, vegetables, ash, etc.	6. Use of chemicals like fertilizer, insecticides, pesticides, weedicides, etc.
7. Main crops are food crops	7. Main crops are cash crops

Types of Agriculture based on the Amount of Rainfall Received by a Place.

1. Wet Agriculture
2. Dry Agriculture

Wet Agriculture	Dry Agriculture
1. Is practised in places with an average annual rainfall of ≥ 75 cm	1. Is practised in places with an average rainfall of ≤ 75 cm
2. Irrigation is necessary	2. Irrigation not very necessary
3. Crops grown are rice, jute, tea, etc.	3. Crops grown are wheat, barley, buckwheat, millets, maize, etc.

The land is categorized into seven types, namely, dry land, wetland, orchard, cardamom, *khimsa* (housing plot) in the urban area, *khimsa* in a rural area, and *tsesa* (kitchen garden). The total land owned by regular Bhutanese households is 352,647.03 acres. Of these, about 70% is dry land (245,199.09 acres), 17% is wetland (58,569.25 acres), and the remaining 13% are other types of land (orchard, cardamom, *khimsa*; rural. *Khimsa*: Urban, *Tsesa*).

Of the total, 79.8% are cultivated by landowners themselves, and 3.5% are leased out. This indicates that the remaining 16.7% is left uncultivated or fallow (14.6% dry land, 1.8% wetland and the remaining 0.3% are other types of land).

Among the categories, the majority of the households own dry land (54.6%), followed by wetland (26.7%), Khimsa in rural (24.6%) areas, tsesa (9.6%), orchard (8.3%), cardamom (8.1%), and khimsa (4.0%) in urban areas. The proportion of landholding households is higher in rural areas as compared to urban areas.

Types of Agriculture Based on the Size of the Land.

1. Extensive Agriculture
2. Intensive Agriculture

1. Extensive Agriculture

It is when agricultural activities are carried out on a large scale. It is practised where the population density is low and the land is plentiful and inexpensive.

2. Intensive Agriculture

It is when agricultural activities are carried out on a small scale. It is practised where the population density is high and the land is scarce and expensive.

Differences between Extensive and Intensive Agriculture

Extensive Agriculture	Intensive Agriculture
1. Practised on a large scale.	1. Practised on a small scale.
2. Per unit output is low.	2. Per unit output is high.
3. Practised where population density is low and the land is plenty.	3. Practised where population density is high and the land is scarce.
4. Input is not extensively used.	4. Use of massive inputs of capital and labour.

Other types of Agriculture

1. Plantation Agriculture

This is also known as tree crop farming. People grow a single crop on a relatively large area of land. Crops cultivated include hazelnut, apple, orange and areca nut. It is usually done on commercial bases with a substantial amount of capital investment.

2. Orchard Agriculture

It is planting of fruits and nuts trees for commercial purposes. Most of the orchard farming is done with a single variety of fruits or nuts.

3. Shifting Cultivation/ Tseri/ Slash and Burn

It is the cultivation of crops on a plot of land cleared by felling of trees and burning them. After the soil loses its fertility, the land is abandoned and shifts to a new plot.

The process is repeated and people may come back to cultivate former land after it has been left for years to regain its fertility. Ploughing and the use of tools are rarely found. Even irrigation and manures are not used hence the cost of production is low. Farmlands are usually smaller in size.

4. Pastoral Agriculture

It is the raising of livestock rather than growing crops. It includes dairy farming, raising cattle for beef and sheep for wool. It is also known in some regions as ranching, livestock farming or grazing.

5. Mixed Farming

It is when farmers cultivate crops and raise animals simultaneously on the same land.

6. Arable

In this type of farming, people grow crops only, unlike in mixed or pastoral farming. Crops produced include annual crops such as vegetables, plantain, cassava, grains and legumes. This type of farming is practised either on a small or commercial scale.

7. Nomadic

It is the rearing of animals on natural pastures. People move with their animals in search of natural pastures for their livestock.

8. Semi Nomadic

It is where only a part of a family moves with their herd while other members practice sedentary farming.

9. Sedentary

Farmers remain in the same place throughout the year. In Bhutan the subsistence mixed farming system is dominant. More than one production system are operating in this farming system. In a warm temperate zone production system operates on wetland and dry land. Rearing livestock and the utilization of forest resources also prevail.



ACTIVITY 2

Instruction: Check your understanding by answering the following questions.

1. Differentiate primitive agriculture and modern agriculture by mentioning four differences.
2. From the above list, can you identify the types of agriculture that are practised by us?
3. Which type of agriculture or farming system is becoming popular in your locality? Why do you think it is happening?
4. Why do you think our farmers have adopted a mixed farming system?

5. “Commercial farming has raised the living standard of the Bhutanese farmers.”
Explain your justifications supporting the phenomenon.

Importance of Agriculture/ Role of Agriculture in the Bhutanese Economy

1. Provides employment opportunities to 79% of the population.
2. Contributes to national income - contributed 15.17% to GDP in 2017 through land taxes, irrigation charges, export duties on agricultural production.
3. Source of raw materials for the agro-based industries.
4. Develops and promotes national and international trade.
5. Provision of food grains.
6. Ensures food security for the country.

Problems of Bhutanese Agriculture

i. Low Level of Literacy

- A high percentage of our farming community is either illiterate or have a low level of literacy.
- The level of reception of technologies is very low.

ii. Pests causing Damage and Losses

- 42% of the farmers have reported wild animal damage of their crops
- 37% (wild boar), 22% (deer), 24% (monkey), 2% (elephant), 5% (bear), 10% (other animals like porcupines and barking deer).

iii. Poor Access to Markets for the Surplus Produce

- Market and market network for both internal and external market is still at its infancy.
- Access to markets is one of the focus areas for the Ministry of Agriculture for enhancing the growth of agriculture.

iv. Small-size Land Holdings

- Led to land fragmentation for generations making commercial agriculture very difficult.
- 50% of the farming community faces the problem of effective farming.

v. Poor Adoption of Technological Packages

- Technological packages are hardly taken up in totality.
- Example: technical package for chilli production might recommend row-row and plant-plant distance, etc.
- Can be attributed to the limited capacity, awareness and the subsistence nature of farming.

vi. Farm Labour Shortage

- There is a shortage of labourer in villages due to rural-urban migration.

vii. Availability and Access to Agricultural Inputs

- Distribution system for agricultural inputs like seeds, fertilizers, other agro-chemicals, equipment, and implements is a huge challenge.

viii. **Lack of Irrigation**

- Rivers are flowing down the gorges, while the agricultural land is on the slopes and valleys.
- 31% of the farm households are constrained by lack of irrigation.

ix. **Steep Terrain**

- Makes farm mechanization almost impossible.
- Only 7.8% of the total land is used for agriculture.

x. **Storage Problems**

- To enhance the market value and reduce the post-harvest loss of all crops.

Measures to Overcome the Problems of Bhutanese Farmers

1. Educate farmers on the importance of agriculture and the use of modern farm technologies to improve their yield.
2. The government can assist farmers in combating wildlife conflict by providing electric fences and other preventive measures.
3. The government can construct roads to connect villages with the towns which will help them in marketing their products.
4. Since the land size is small for the application of machines, the government can encourage cooperative farming.
5. Poor adoption of technological packages is caused by ignorance of farmers so the government can advocate on the advantages of using modern technologies.
6. The biggest challenge faced by our farmers is the shortage of labourer which is caused by rural-urban migration. The government can develop rural areas and create opportunities even in the villages to retain.
7. The government can subsidize and distribute the farm machineries fairly irrespective of the remoteness.
8. The government can assist farmers in building irrigation channels and other means of irrigation.
9. The government can encourage farmers to practice terraced or contour farming.
10. The government can also provide farmers in building proper storage like silos.



ACTIVITY 3

Covid -19 pandemic has also impacted our farmer. Explain three positive impacts and three negative impacts on our farmers in terms of farming.



Self-check for Learning

Check how well you have learned from the lessons by answering the following questions.

1. Explain the concept of agriculture.
2. Elaborate on the evolution of agriculture.
3. Explain briefly different types of agriculture.
4. List down the type of agriculture practised in our country.
5. If you become a farmer in the future which type of agriculture would you choose?
Give at least three justifications.
6. 'Agriculture is considered as lifeblood or arteries of Bhutanese society.' Explain giving at least five justifications.
7. Identify the problems faced by farmers where you live at present.
8. Suppose you are a farmer. How are you going to address the problems faced at present?

2.3 Industrial Resources

Learning Objectives



- Explain the meaning of industry.
- Explain the types of industries.
- Differentiate different types of industries.
- Explain factors affecting location of industries.
- Elaborate the impacts of industries.

Many times we hear the word industry, right? Can you define it? Think for 5 seconds.

Introduction

An **industry** is a group of manufacturers or businesses that produce a particular kind of goods or services. The word **Industry** comes from the Latin word 'industria', that means "diligence, hard work," and the word is still used with that meaning.

In the following activities, we will explore more on the classification of industries, factors that determine the location of an industry and the impacts of industries.

Concepts of Industry

An industry is a group of manufacturers or businesses that produce a particular kind of goods or services and generate employment opportunities. There is a misconception that industry is a collective large-scale manufacturing of goods in well-organised plants with automation and specialization. However, the industry also includes other commercial activities that provide goods and services such as agriculture, transportation, hospitality and tourism.



ACTIVITY 1

Instruction: Write the answers to the question.

- Explain the concepts of industry in your own words.

Can you think of different types of industries? Think for a few seconds and list them.

Classification of Industries

Industries are classified into four sectors based on the nature of the activities.

1. Primary sector
2. Secondary sector
3. Tertiary sector and
4. Quaternary sector.

1. Primary Sector Industries

It includes productions and extractions of raw materials. Activities such as agriculture, mining, forestry and fishing are the primary sector. This sector is more prominent in developing countries.

2. Secondary Sector Industries

These industries transform raw materials into end products. This leads to the addition of value and results in more profits. It generates employment and helps in improving living standards and per capita income. Some examples of the secondary sector are heavy manufacturing, light manufacturing, and food processing and energy production.

3. Tertiary or Service Sector Industries

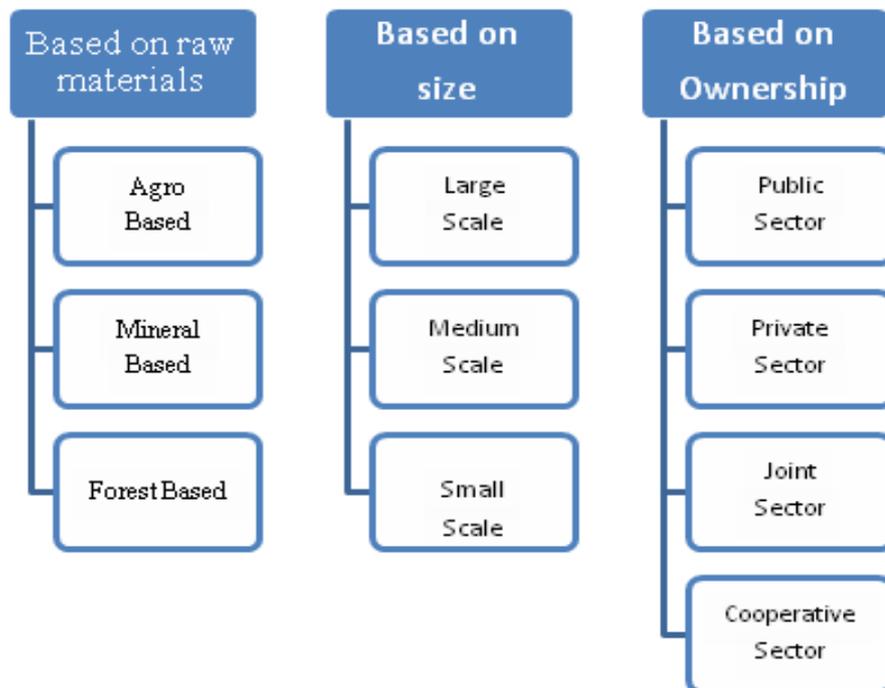
Industries that provide goods and services to consumers. This includes various businesses such as financial, educational, medical institutions, tourism and hospitality. This sector helps in the development of primary and secondary sectors.

4. Quaternary Sector Industries

It is an advanced form of the tertiary sector. It provides services related to knowledge, information and researches. Most of the quaternary industries in the United States involve computer and information technologies. Some industries in the quaternary sector are a consultancy, financial planning, designing, information technologies, research and development (RandD) and the generation of information. The workforce involved in this sector are highly educated and recognized.

TAKE IT	Primary industry - involve taking raw materials from the ground or growing things.	
MAKE IT	Secondary industry - involves the making of things (manufacturing)	
SELL IT	Tertiary industry - involves selling things or providing a service.	
PROVIDE IT	Quaternary industry - involves providing information and expertise e.g. a researcher	

Students! What is the other basis on which we classify the industries? Think for a few seconds and make a list.

Classification of Industries based on Raw Materials Used, Size and Ownership.**Types of Industries based on Raw Materials Used**

Based on the raw materials used industries can be classified into:

1. Agro-based.
2. Mineral-based.
3. Forest-based industries.

1. Agro-based Industries

- Are those that use plants and animal products as raw materials? Food processing, vegetable oil, textile, dairy products and leather industries are examples of these industries.

2. Mineral-based Industries

- Are those that use minerals as raw materials.
- It is the basic industry on which other industries depend. Iron and steel, Copper Smelting, Aluminium and Cement industry are examples of mineral-based industries.

3. Forest-based Industries

- Are those that use forest products as raw materials.
- Paper, match, silk industry and handicraft are examples.

Types of Industries Based on Size

The size of employment, capital investment and volume of production determine the type of industry. However, the size of employment, amount of capital investment, and the range of

volume of production differ from country to country. For instance, industries with a capital investment of less than 30 million Ngultrum are considered as small scale industries in Japan, while in Bhutan it is considered as medium scale industries.

Scale	Employment size	Investment (Million Nu.)	National Total (in 2013)	Types in the country
Cottage	1-4	Less than 1 million	7,293	Bumthang Cheese, Bee Keeping, Poultry farming, Home-made potato chips, pickles, Daga Tshingdre Tsongpa
Small	5-19	1-10 million	5,255	Chharu Tshongdrel, Poultry farming, Bakery
Medium	20-99	10-100 million	N/A	Bhutan Fruit Products Ltd., Bhutan Agroindustries Ltd., Rice mills, Dairy processing plants
Large	100+	Greater than 100 million	N/A	

Source: Department of Cottage and Small Industry, MoEA, 2013.

Types of Industries based on Ownership

1. Public Sector Industry

It encompasses the companies, enterprises or businesses wherein the Government is the owner of the business by way of a majority shareholding in the business. These businesses are controlled, managed and operated by Government. Companies owned, controlled, managed and being operated by Government/Government Bodies comes under the public sector.

2. Private Sector Industries

It includes those companies, enterprises or businesses which are owned by private individuals or private companies. The companies in the private sector are controlled, managed and operated by private individuals or private entities.

3. Joint Sector Industries

It includes those companies, enterprises or businesses which are owned jointly by the Government and private individuals who have contributed to the capital. Here both public and private sectors join hands to establish new enterprises.

4. Cooperative Sector Industries

It is an association of workers and craftsmen involved in cottage or village industries, who come together to undertake collective production, processing and marketing of goods manufactured by the members and provide them with the necessary service and assistance. Such industries are organized, controlled and managed by workers for meeting their common purpose.



ACTIVITY 2

“Growing unemployment in Bhutan can be attributed to several intra-personal and societal reasons. The demand and preference to join the public sector by job seekers is one of the main reasons for the rising unemployment problem, especially among the youth and highly educated people. The scenario is further aggravated by the country’s underdeveloped private sector.”

- 1 In reference to the extract:
 - a. Explore and list the characteristics of public and private sectors.
 - b. Discuss the reasons for choosing employment in the public sector. Explain at least five reasons.
2. Industries can be classified into different types based on the raw materials used. Which type of industry should Bhutan promote? Give five justifications to your answer.

Children! If you have a plan to establish an industry what are the factors that you would consider? Think for a few seconds and make a list.

Factors Affecting the Location of Industries

The factors influencing the location of an industry can be divided into two broad categories.

1. Geographical Factors
2. Non Geographical Factors

1. Geographical Factors

i Availability of Raw Material

The location of an industry is sometimes determined simply by the location of raw materials. Industries that use heavy and bulky raw materials are usually located near the supply of raw materials.

For example, cement industries are localized in Gomtu, Samtse as limestone (main raw material) is found nearby it. {Cement industry uses 20 MT of raw materials to produce 1MT cement. }

Even those industries that depend on perishable goods are set up nearby the raw material. (As it cannot be transported over long distance).

ii *Availability of Power Source*

A regular supply of power is a pre-requisite for the localization of industries. Hence, most industries tend to concentrate at the point that has the best economic advantage in obtaining power.

iii *Availability of Labour Force*

The modern industries still require a large number of workforces despite increasing mechanization. The existence of a labour force attracts industries. Most of the industries are located in the southern part of the country as the labourers are easily available from neighbouring states of India. Industries also tend to establish in or near urban areas because of the availability of labour forces.

iv *Availability of Transport*

Transport facilities are necessary for the assembly of raw materials and the marketing of the finished products. The development of roads initially in the southern part is one of the reasons for having a high concentration of industries in southern parts of the kingdom.

v *Accessibility to Market*

Nearness to market is essential for the quick disposal of manufactured goods. It helps in reducing the transport cost and enables the consumer to get things at cheaper rates. The ready markets are the most essential for perishable and heavy commodities.

vi *Availability of Water*

Industries that need water in huge quantities tend to establish near the water source for their proper functioning.

vii *Availability of Favourable Site*

Site requirements for industrial development are of considerable significance. Sites generally should be flat, large and well served by adequate transport facilities. As of now industries are set up in rural areas as the cost of land in urban centres has shot up.

viii *Suitable Climate*

Industries are also established in areas having a moderate climate. There can be no industrial development in an extremely hot, humid, dry or cold climate.

2. Non-geographical Factors

i *Capital*

Capital is the money or wealth needed to produce goods and services. Modern industries are capital intensive and require huge investments. Capitalists are available in urban centres, hence industries get established in the urban centres.

ii Government Policies

A Government's plan for reducing regional disparities, elimination of land, water and air pollution and for avoiding their heavy clustering in urban centres has become no less an important factor. There is an increasing trend to set up all types of industries in an area where they derive common advantage of water and power supply for their products. The latest example is the establishment of industrial estates.

iii Banking Facilities

The establishment of industries involves daily exchanges of crores of ngultrums which is possible through banking facilities only. So the areas with better banking facilities are better suited to the establishment of industries.

iv Insurance

There is a constant fear of damage to machine and labourer in industries for which insurance facilities are necessary. Hence, areas with insurance facilities are suitable for industries.

v Political Stability

Strikes and lock-outs lead to the loss and closure of industries. Hence, there is an imperative need for political stability.

**ACTIVITY 3**

Instruction; Read the article provided below and discuss the importance of the transport system in the location of industries. Explore the factors that led to the establishment of Pasakha industrial estate in Phuentsholing.

Road to Pasakha Industries in Bad Condition

October 7, 2017, Kuensel

With numerous potholes along the one-kilometre (km) stretch of the Pasakha road between Baunijhora and Bhalujhora streams, officials of the association of Bhutanese industries' (ABI) say it is time the road is maintained. The road becomes dusty and polluted in winter and rainwater fills the potholes in summer, posing risk for the vehicles plying on it. Programme officer with the ABI, Pema Namgyel Ghaley, said that the state of the road is getting worse every day. He said that the numerous potholes along the way and the worsening road condition has caused difficulty for the transporters to export and import raw materials and goods in and out of Pasakha industrial estate. He said that the road condition has become an additional cost for the maintenance of vehicles. Pema Namgyel Ghaley also said private passengers and industrial employees plying on the road are complaining of the road condition.

Think of positive and negative impacts of industrialisation.

Impact of Industrial Development

The establishment and development of industries have both positive and negative impacts on a country.

Positive Impact

1. Industrial development creates diverse employment opportunities.
2. It raises the living standard of the people as it increases employment opportunities and the choice of goods.
3. Industrial development helps in better use of raw materials.
4. Encourages entrepreneurship among people.
5. Increase in production increases the export and decreases the import thus making the balance of payment favourable.
6. It also promotes self-sufficiency.
7. The location of an industry leads to the development of other infrastructure facilities like health, education, communication and transport.
8. Industrial development ultimately results in the development of the country

Negative Impact

1. An increasing number of industries require a greater amount of resources and leads to the depletion of natural resources.
2. Wastes, smoke and harmful gases released from industries pollute land, water, and air.
3. Smoke and harmful gases released in the atmosphere causes acid rain.
4. Creates regional economic imbalance.
5. Cause rural depopulation and overcrowding in the industrial areas.

**Self-check for Learning**

Check your learnings from the above lesson by answering the following questions.

1. Explain the concept of industry.
2. Elaborate four sectors of industry.
3. Make a list of types of industries based on the raw materials used.
4. Differentiate primary sector from secondary.
5. Differentiate secondary from the tertiary sector.
6. Differentiate tertiary from the quaternary sector.
7. Make a list of industries based on the size.
8. Make a list of industries based on ownership.
9. Explain at least five geographical factors and five nongeographical factors that determine the location of an industry.
10. Briefly explain five positive impacts and five negative impacts of industrialization.
11. “Major cause of global warming and climate change is industrialization”. Justify the given statement.

2.4 Communication

Sub Topics:

- Meaning of Communication
- Means of Communication
- Impacts of Communication

Learning Objectives



- Define communication in your own words.
- Mention two broad means of communication.
- Differentiate between print media and electronic media.
- Explain five positive impacts and five negative impacts of mass communication.

Introduction

Communication is the transfer of information, messages, ideas, thoughts, feelings and emotions from one person to another person through a medium.

Communication is an essential part of our life. The word communication is derived from a Latin word 'Communis' which means to share or to participate.

Types of Communication in Bhutan.

In Bhutan, there are two types of communication.

1. Print media
2. Electronic media.

1. Print Media

- It is the medium that disseminates the information to the mass in printed form. Different forms of print media are newspapers, magazines, books, brochures, periodicals, journals, etc.

2. Electronic Media

- Are media that use electronics or electrochemical energy for the audience to access the content (Williams, 1999)
- Television, radio, telephone, computer, cinema, etc. are some examples of electronic media.

1. Define communication in your own words.
2. State four differences between print media and electronic media.

**ACTIVITY 1**

Instruction: Draw a media timeline of Bhutan in an chronological order after reading the notes given in the box below.

History of Communication in Bhutan

The Postal Services was first launched on 10th October 1962 with the opening of a post office in Phuntsholing. In November 1973, Bhutan Broadcasting Service was established as a radio service by a group of volunteers (then NYAB). The satellite Earth station stationed at Thimphu was installed in 1990 along with a sophisticated international telephone service system. This has helped in connecting quickly via direct dial call facilities and to clear the quality of sound on the phone.

BBS Television was launched on June 2, 1999, to commemorate the Silver Jubilee reign of 4th Druk Gyalpo. Cable television was introduced soon after that. BBS officially launched its 2nd channel (BBS 2) on 21 Jan. 2012. Kuzoo FM (1st September 2006), Radio Valley (12th April 2007), Centennial Radio (21st September 2008), Sherubtse FM (8th May 2009), Radio High (5th August 2010), Radio Wave (12th October 2010) are other radios.

The 1st newspaper, Kuensel was launched in 1965 as an internal government bulletin. On 30th April 2006, Bhutan Times the 1st private newspaper was launched followed by Bhutan Observer (2nd June 2006), Bhutan Today (30th October 2008), Business Bhutan (26th September 2009), The Journalist (21st December 2009), Druk Nyeltshel (2nd August 2010), Druk Yoezer (19th February 2011), Druk Gyelyong Sharshog (2011) and The Bhutanese (21st February 2012).

Mass Media and its Impacts

Mass media is the medium that passes the information to the big mass of audiences. Radio, Television, Newspaper, Books, Cinema, Tshechu and Domche are some examples.

Mass media plays a central role in the existence, development and maintenance of society. No society can function or achieve a goal without mass communication. Mass media are capable of impacting mankind in various ways. We are exposed daily to a bombardment of media messages. Most of the information we receive about our community, dzongkhag, the nation and the world comes to us through newspapers, magazines, television and radio.

Mass media brings changes largely in the psychological domains. The information and views communicated through these media affect many aspects of human life like thoughts, attitudes, beliefs, behaviour, knowledge and value systems whether it is written, televised or spoken as mass media reaches a large audience. Mass media have exposed people to technical subjects which are of their day to day use. It has affected our society both positively and negatively in the field of the family, marriage, religion, economy, education and polity. It has programmed our thoughts, what and how we dress and how we relate to one another, etc.

Certain images shown on television influence kids to misbehave, disobeying parents under the impression. Disobedience leads to complications like teenage pregnancy, drug abuse, etc.

People who are addicted to social media may experience negative side effects such as eye strain, social withdrawal or lack of sleep.

On the other hand mass, media can persuade young kids positively if they tune to a programme that motivates positive forces and can also obtain varieties of information related to their subjects using the internet. It educates people on different issues, provides up to date

1. Explain four positive impacts and four negatives impacts of mass media.
2. 'Mass media benefits society more than its destruction.' Do you agree? Justify your answer with 6 points.

news and has reduced disasters be it human-induced or natural.



Summary

- Communication is the transfer of information, messages, ideas, thoughts, feelings and emotions from one person to another person.
- Two types of communication are print media and electronic media.
- Print media transfers information in printed form. Newspaper, magazine, book, brochure, periodical, journal, etc are the examples.
- Electronic media transfers information through devices that use electrochemical energy. Television, radio, telephone, computer, cinema, etc. are some examples of electronic media.
- Mass media passes the information to the big mass of audience. Radio, Television, Newspaper, Books, Cinema, Tshechu and Domche are some examples.
- Mass media has affected our society both negatively and positively in the field of the family, marriage, religion, economy, education and polity. Television influences kids to misbehave and disobey parents which lead to teenage pregnancy, drug and alcohol abuse, etc. People addicted to social media experience eye strain, social withdrawal or lack of sleep. However, mass media provides a sea of information to the people. It educates people on different issues, provides up to date news, helps in reducing disasters, etc.



Self-check for Learning

Instruction: Answer the following questions to check your learning.

- Define communication in your own words.
- Mention two broad means of communication.
- Differentiate between print media and electronic media.
- Explain five positive impacts and five negative impacts of mass communication.

ANSWERS

English

Science Fiction

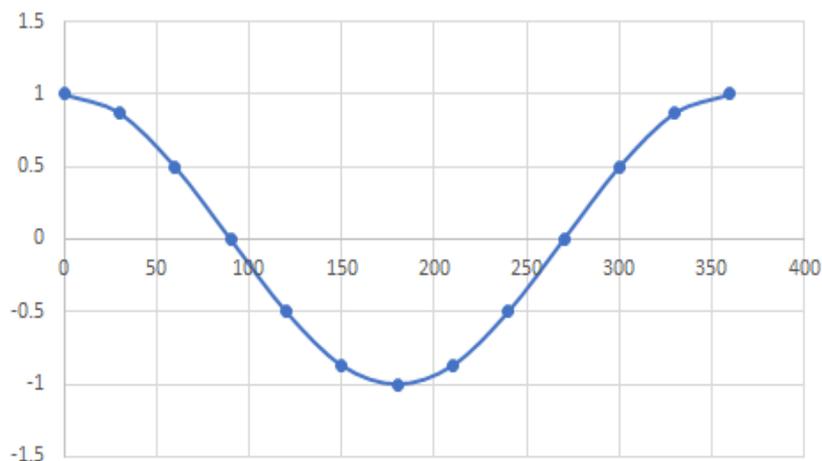
- Both the stories use the latest modern technology (robot in ‘Too Bad’ and brain transplant in ‘Mirror Image’). Both the stories expose the impact of science and technology (Tertia’s anxiety about the use of Mike, losing Mike at the end resulting in dissatisfaction in ‘Too Bad’ and Alice’s discomfort with her new body, Jenny’s reservation about her twin sister in the story ‘Mirror Image’).
- Cancer, an incurable disease is cured by a mini-robot in the story ‘Too Bad’.
If not for science and technology, Alice would not have gotten a new body or life.
- Tension in the family is experienced in both the stories.

Mathematics

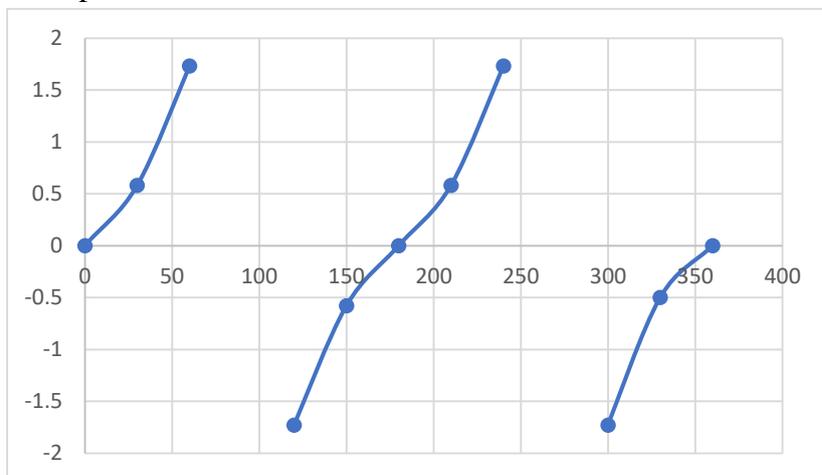
Ratios, Identities, and Relationships

Answers (Activity 2):

1. Graph of $\cos \theta$



2. Graph of $\tan \theta$



Answers (Activity 3):

1. $15\sqrt{3}$ metres
2. 10 metres

Answers (self-check learning):

1.

$$i. \text{ sine } \theta = \frac{\text{perpendicular}}{\text{hypotenuse}} = \frac{a}{c}$$

$$ii. \text{ cosine } \theta = \frac{\text{base}}{\text{hypotenuse}} = \frac{b}{c}$$

$$iii. \text{ tangent } \theta = \frac{\text{perpendicular}}{\text{base}} = \frac{a}{b}$$

$$iv. \text{ cosecant } \theta = \frac{\text{hypotenuse}}{\text{perpendicular}} = \frac{c}{a}$$

$$v. \text{ secant } \theta = \frac{\text{hypotenuse}}{\text{base}} = \frac{c}{b}$$

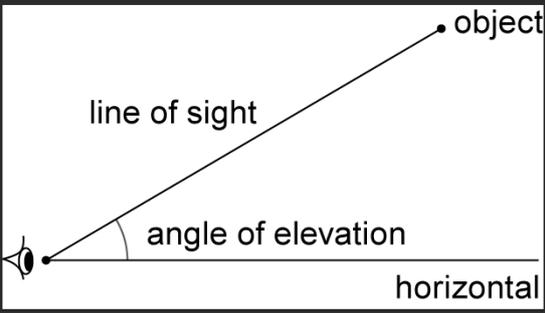
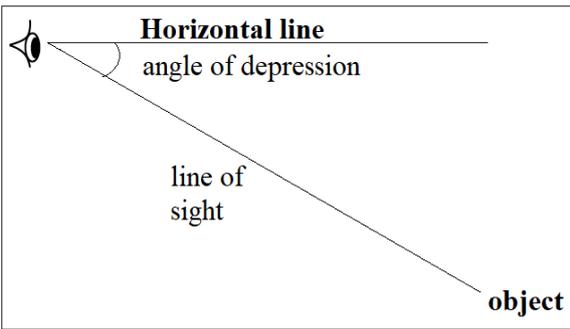
$$vi. \text{ cotangent } \theta = \frac{\text{base}}{\text{perpendicular}} = \frac{b}{a}$$

2. Negative

3. $\sin \theta$ and $\text{cosec } \theta$ are positive in II quadrant

4. $\sin \theta$, $\text{cosec } \theta$, $\cos \theta$ and $\sec \theta$ are negative in IV quadrant

5.

Angle of Elevation	Angle of Depression
<p>The angle of elevation is the angle between the horizontal line and the line of sight to the object that is above the horizontal line.</p> 	<p>The angle of depression is the angle between the horizontal line and the line of sight to the object that is below the horizontal line.</p> 

Physics

Bernoulli's Principle

1. Wings of an aeroplane is an airfoil which is aerodynamically engineered surface. They are designed and oriented in such a way that as the plane starts to roll down the runway, the airstream flowing over the wings have higher velocity as compared to the airstream beneath the wings. Due to this, the pressure below the wings is higher than the pressure over the wings, as a result, it produces an upward lift.

2. Solution: Given

$A_1 = \text{Cross sectional area of the water pipe}$

$A_2 = \text{Cross sectional area of the hose}$

$v_1 = \text{velocity of the water}$

You know,

$$A_1 v_1 = 10 A_2 v_2$$

$$v_2 = \frac{A_1 v_1}{10 A_2}$$

$$v_2 = \frac{(0.02)^2 \times 2}{10 \times (0.0025)^2}$$

$$v_2 = \frac{\pi r_1^2 v_1}{10 \pi r_2^2}$$

$$v_2 = 12.8 \text{ m/s}$$

Addition of Coplanar Vectors

1. 2.8 km towards north-east

Resolution of Vectors

1. B
2. 43.3 m/s and 25 m/s
3. 8 units and 13.85 units.
4. 0° and 90° .