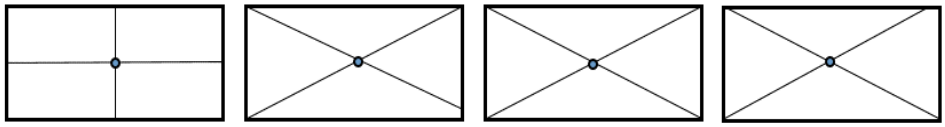
SECTION A [40 MARKS]
ANSWER **ALL** QUESTIONS

Question 1

a) **Directions: For each question, there are four alternatives A, B, C and D. Choose the correct alternative and circle it. Do not circle more than ONE alternative. If there are more than one choice circled, NO score will be awarded.** **[25]**

i. The position of centre of gravity of a uniformly shaped rectangle is located correctly in



A I
B II
C III
D IV

ii. Big Bang theory is a widely accepted theory regarding the origin and evolution of the universe. Based on the red shift data, most astronomers infer that the universe is currently

A expanding.
B contracting.
C moving randomly.
D fixed and stationary.

iii. Which of the following shows work done is against gravity?

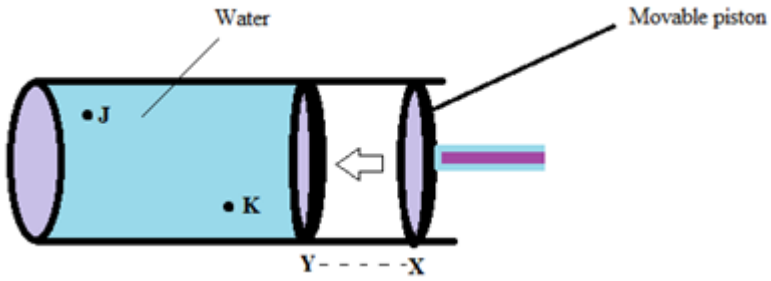
1 Boy kicking a ball.
2 Man pulling a table.
3 Girl lifting an object to a certain height.
4 Girl taking out water from a well of 20 m depth.

A 1 and 2
B 2 and 3
C 3 and 4
D 4 and 1

iv. When a couple acts on a body it produces

A rotational motion.
B frictional motion.
C vibrational motion.
D translational motion.

v. Water is trapped inside a closed cylinder with a movable piston. At a constant temperature, if the position of the piston shifts from X to Y then the pressure at



A J will be greater than at K.
B K will be greater than at J.
C both J and K will be same.
D both J and K will be different.

vi. The amount of heat absorbed or evolved by a body is given by $Q = mc\Delta T$. What does the variable 'c' stand for?

A calorimeter
B heat capacity
C latent heat capacity
D specific heat capacity

vii. "X" states that the magnitude of an induced emf is directly proportional to the rate of change of the magnetic field through the circuit. The law "X" is

A Lenz's law.
B Ampere's law.
C Faraday's law.
D Fleming's law.

viii. The electromagnetic spectrum is a continuum of all electromagnetic waves arranged according to frequency and wavelength. The correct order of waves in increasing order of frequency is

A visible light < radio waves < ultraviolet rays < microwaves.
B ultraviolet rays < visible light < radio waves < microwaves.
C radio waves < microwaves < visible light < ultraviolet rays.
D microwaves < radio waves < visible light < ultraviolet rays.

ix. What happens to the atomic number of an element after emitting an alpha particle and a beta particle?

A increases by 1
B decreases by 1
C decreases by 2
D remains the same

x. Bucket P contains hot water at 93.1°C and Q contains cold water at 24.8°C. When the same volume of water is mixed, the temperature of the mixture will be

A higher than P.
B higher than Q.
C equal to P.
D equal to Q.

xi. The figure below shows the body in different postures.

Which of the following describes the most stable posture?

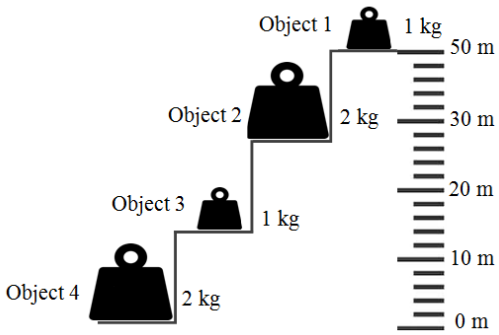
A small base area and lower centre of gravity
B small base area and higher centre of gravity
C large base area and lower centre of gravity
D large base area and higher centre of gravity

xii. Different types of spacecrafts are used for various space exploration purposes. The Perseverance rover of NASA landed successfully on the surface of Mars on 18 February 2021. One purpose of the rover was to

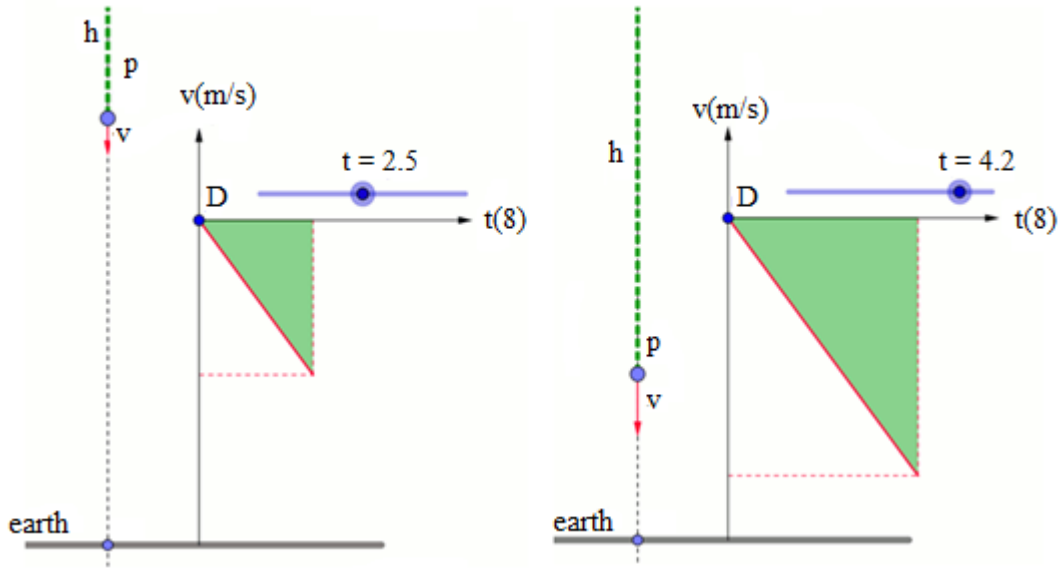
A study the signs of human activity on Mars.
B hunt for signs of past microbial life on Mars.
C look for signs of past water activity on Mars.
D search for soil and rocks sample on Mars.

xiii. Which object will have the maximum gravitational potential energy?

A Object 1
B Object 2
C Object 3
D Object 4



xiv. The graphs shown in the figure represent the change in velocity of a body under a free fall.



With the increase in time, the velocity of a falling body will

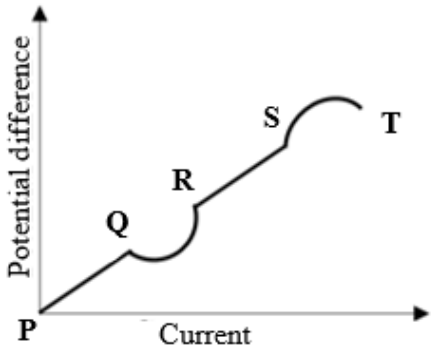
A increase.
B decrease.
C become zero.
D remain the same.

xv. A stone suspended on a string is placed under the surface of water. If the stone is lowered deeper into the liquid, which is true?

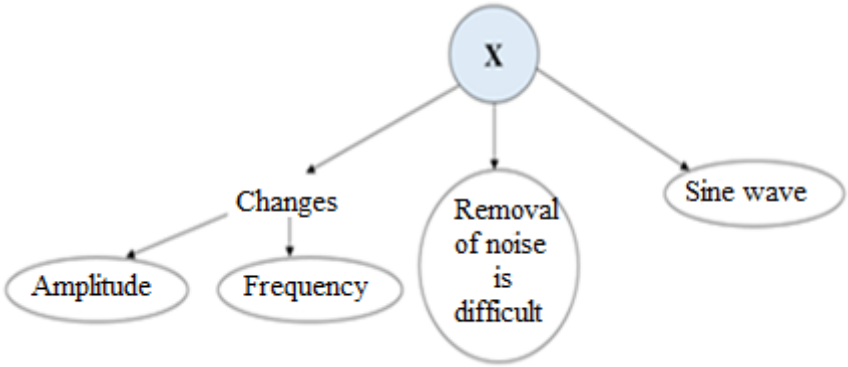
A	Pressure increase	Depth increases
B	Pressure increase	Density of liquid decreases
C	Pressure decreases	Mass of the stone increases
D	Pressure remains same	Surface area of stone decreases

xvi. The given graph shows the relationship between the potential difference across a resistor and the current flowing through it. At which intervals does the resistor obey Ohm's law?

A PQ and QR
B PQ and RS
C QR and ST
D QR and RS



xvii. The figure below shows information about a signal X.



Signal **X** represents

A digital signal.
B periodic signal.
C analogue signal.
D signal modulators.

xviii. If a radioactive nucleus X with mass number M and atomic number A emits a beta particle to form a daughter nucleus Y, then the $\boldsymbol{\beta}$-decay can be represented as follows:

A $\quad {}^{M}_{A}X \xrightarrow{\beta-particle} {}^{M}_{A+1}Y + e^{0}_{-1}$

B $\quad {}^{M}_{A}X \xrightarrow{\beta-particle} {}^{M}_{A+1}Y + e^{0}_{1}$

C $\quad {}^{M}_{A}X \xrightarrow{\beta-particle} {}^{M}_{A+1}X + e^{0}_{1}$

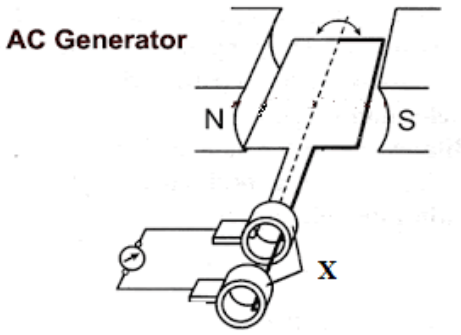
D $\quad {}^{M}_{A}X \xrightarrow{\beta-particle} {}^{M}_{A-1}Y + e^{0}_{-1}$

xix. Then figure below shows one of the applications of electromagnetic waves.

This is related to

A X-rays.
B microwaves.
C ultraviolet rays.
D infrared radiation.

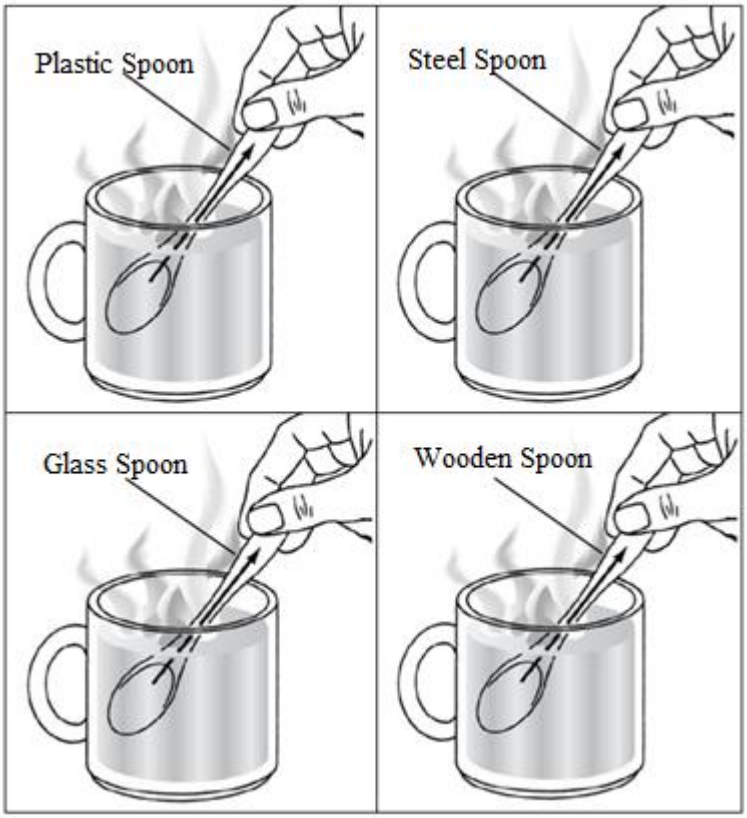
xx.



The function of the part labelled X in the a.c generator is to

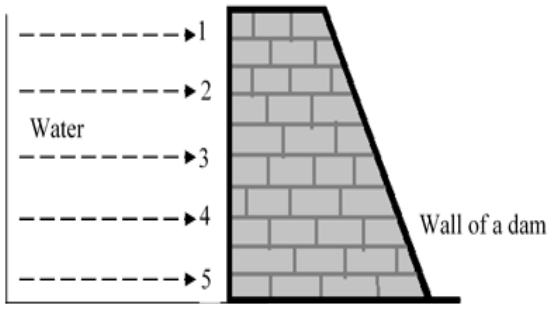
A produce magnetic field.
B induce current in the coil.
C help in rotation of the magnet.
D help in rotation of the armature coil.

xxi. Four spoons of different materials were used to stir an equal amount of hot tea with the same temperature in a cup. The spoon that gets heated the fastest will be the



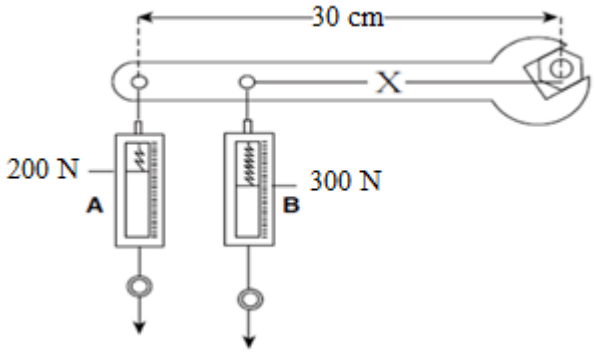
A steel spoon.
B glass spoon.
C plastic spoon.
D wooden spoon.

xxii. The pressure of water inside a dam was measured at five different points. Which of the following sequence shows increasing pressure exerted at different points?



A $1 > 2 > 3 > 4 > 5$
B $1 < 2 < 3 < 4 < 5$
C $1 = 2 = 3 = 4 = 5$
D $1 < 2 < 3 < 4 > 5$

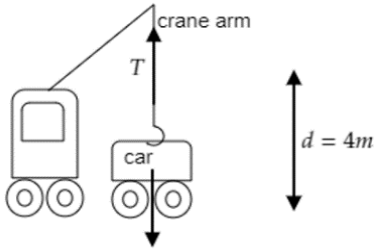
xxiii. In the diagram given below, a force meter **A** was used on a spanner to loosen a nut and it reads 200 N. Force meter **B** was then used to loosen the nut and it reads 300 N. What is the distance **X** in the figure?



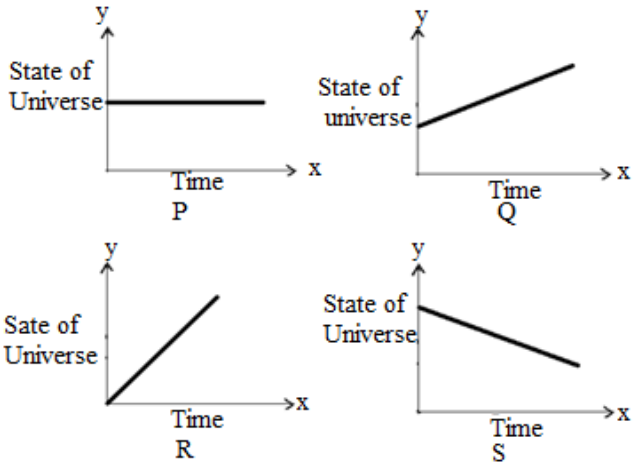
A 10 cm
B 15 cm
C 20 cm
D 25 cm

xxiv. A crane pulls up a car of mass 500 kg to a height shown in the figure below in 50 seconds. What is the power developed by the crane? Take g =10 m/s^2

A 200 W
B 300 W
C 400 W
D 500 W



xxv. The graphs P, Q, R and S represent the changing size of the universe with time.



The graph that best supports the Big Bang theory is

A P.
B Q.
C R.
D S.

b) **Fill in the blanks by writing suitable word/s.** **[5]**

i.	The type of equilibrium possessed by the shape **P** will be _____ if the base support area of **P** is broader than the shape **Q.**	
ii.	The amount of pressure exerted by a solid body depends upon its _____ and area of contact.	
iii.	The resistance of a room heater that draws a current of 2.3A when connected to 230 V mains will be _____ Ω.	
iv.	A high-frequency electromagnetic wave modulated in amplitude and frequency to transmit a signal is known as _____wave.	
v.	The atomic number of an element will not change when it emits _____radiation.	

c) **State whether the following statements are TRUE or FALSE.** **[5]**

i.	The fastest man in the world, Usain Bolt completed 100 m in 9.58 seconds. This means he had more power compared to other sprinters.		
ii.	Shorter length of a conductor will increase the efficiency of electrical appliances.		
iii.	The base of a vehicle is kept low, wide and heavy to increase its stability.		
iv.	While opening a door, the force you apply is greater if you open it from the part closer to the hinges.		
v.	The output power in a transformer is always obtained in the primary coil.		

d) **Match each item under Column A with the item in Column B. Rewrite the correct pairs by writing the alphabet against the number in the space provide.** **[5]**

Column A	Column B
i. Organisms surviving in extreme environments	a. Fleming's right hand thumb
ii. The direction of induced voltage in a.c generator	b. $Q = mc\Delta T$
iii. Under ideal conditions, heat gained by a cold body = heat lost by a hot body	c. gravity
iv. Satellites moving around the earth	d. extremophiles
v. A ball is a free falling object	e. Principle of calorimetry
	f. zero work done
	g. mesophiles
	h. Fleming's left hand thumb rule

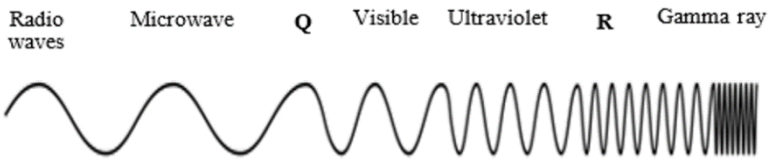
i.		
ii.		
iii.		
iv.		
v.		

SECTION B [60 MARKS]

ATTEMPT **ANY SIX** QUESTIONS

Question 2

a)



i. Name the radiations Q and R. **[1]**

Q	
R	

ii. Why do you think R is more harmful than Q? **[1]**

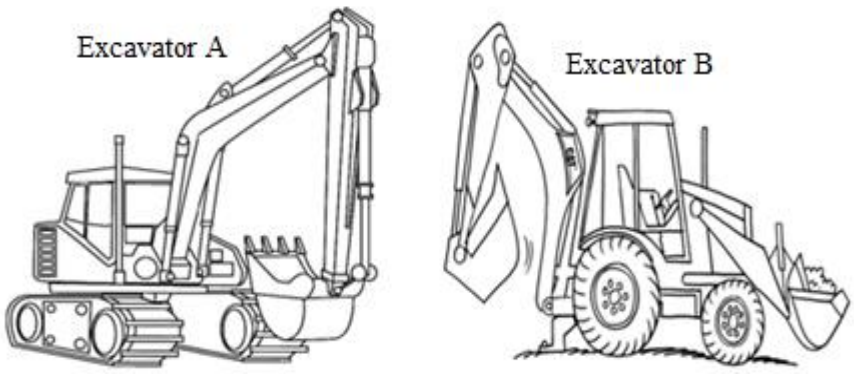
b) *Space exploration is sending people or machines into space to visit other planets and objects in space. Humankind has dreamed of visiting the space for hundreds of years, but it was not until 1969 that the first person walked on the Moon.*

Being in a world of exploring technology, what type of space exploration would you prefer? Support with any **TWO** reasons. **[2]**

c) During the 2020 Tokyo Olympic, Adam Peaty from Great Britain won the Gold Medal in 100 m breaststroke swimming event. The 86 kg man took 57.37 seconds to complete the race. Calculate the work done by him. [Take g = 10 m/s^2] **[2]**

d) A transformer with X turns in primary coil and Y turns in secondary coil is used to change the magnitude of voltage to 240 V. Calculate the input voltage and name the type of transformer if Y= 2 X. **[2]**

e) Two different types of excavators with the same mass are shown in the figure.



Using the concept of pressure, explain which excavator is best suitable to operate on a muddy ground? **[2]**

Question 3

a) Read the statements given in the table to identify different types of equilibrium. **[2]**

Sl. No.	**Description**	**Types of Equilibrium**	
1	The line of gravity of its weight falls outside the base of support on slight displacement.		
2	The body has an ability to regain its original position when displaced by an external force.		
3	Construction of a Chorten		
4	A cone on its apex		

b) Hot stone bath is a popular ancient Bhutanese medicinal practice. It is believed that the heat from the water, the minerals released from the rock and the local herbs all combine to produce medicinal benefits for joint pains, stomach disorders, arthritis and hypertension. To extract the medicinal benefits, 15 kg stone of 1000 J/kg °C at 100 °C is dropped into the water at 10 °C. If the final temperature is 30 °C, what mass of the water is used if its specific heat capacity is 4200 J/kg °C? **[2]**

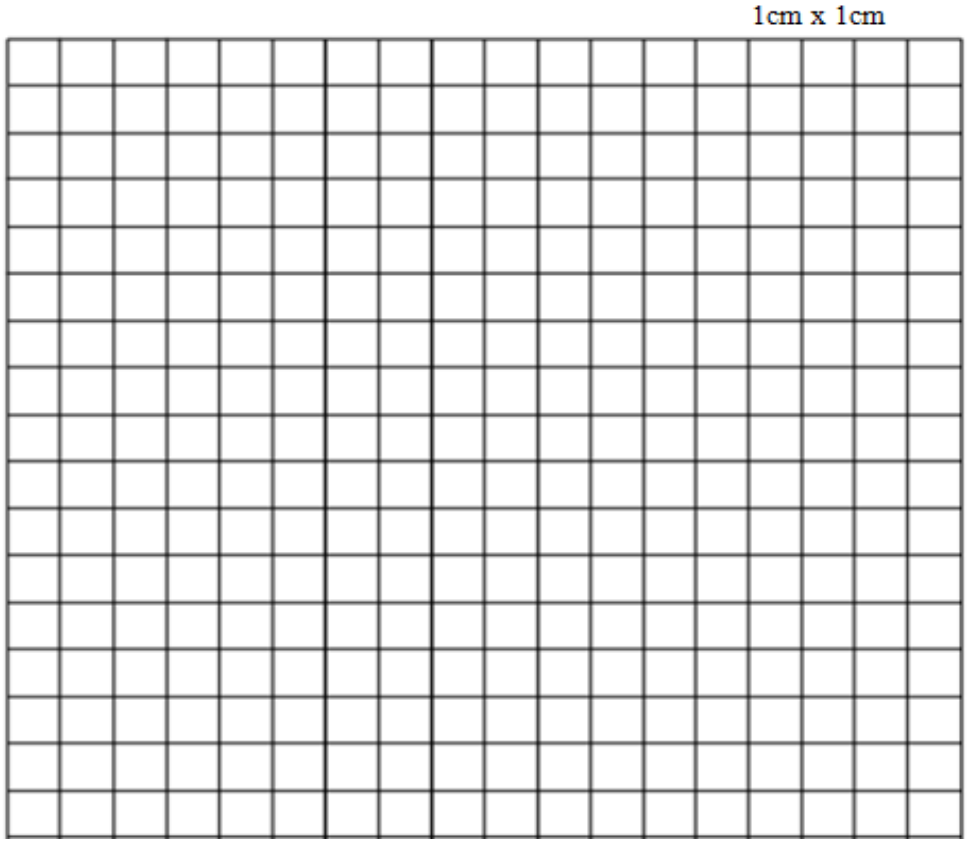
c) Bhutanese studying and working in Australia could enjoy the live coverage of "The Voice of Bhutan" aired on BBS. Which wave is responsible for the transfer of the information? Explain. **[2]**

d) The force of attraction between any two bodies can be explained by Newton's universal law of gravitation. State the law. **[1]**

e) The experimental data recorded by a student while verifying Ohm's law using an unknown conductor P is shown in the I-V table. Use the given data to plot a graph showing the relationship between current and voltage. **[3]**

I-V Table

Potential difference(V)	**Current (A)**
2	0.2
4	0.5
6	0.7
8	0.8
10	0.8

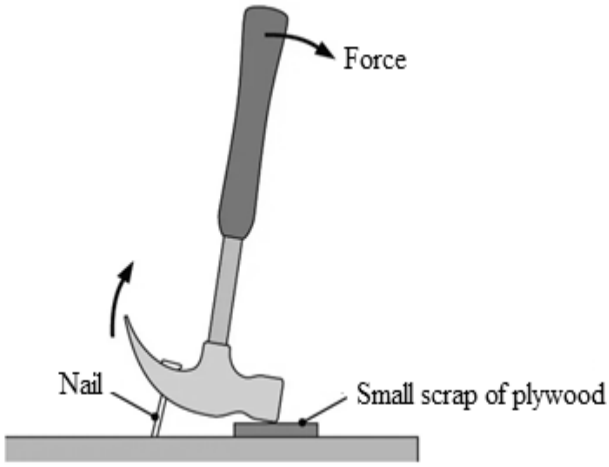


Is the unknown conductor P, ohmic or non ohmic?

Question 4

a) The Ministry of Information and Communication, Royal Government of Bhutan inaugurated eight vehicle-charging stations at Changlimithang, Thimphu on 24th June 2021. The initiative is to encourage the people to buy electric vehicles. Write an advantage of electric vehicles. **[1]**

b) A carpenter is removing the nail from a wooden plank using a hammer as shown the figure below. **[2]**



Suggest **TWO** ways to increase the moment of force so that he can extract the nail easily.

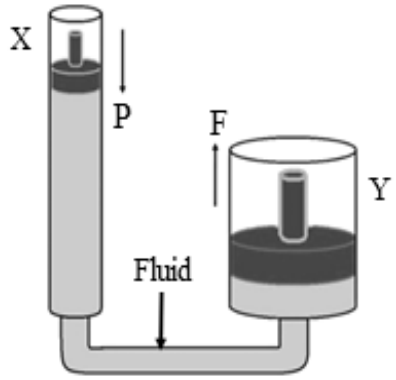
c) A teacher shows the class an experiment on radioactivity using three different sources of radiation i.e. an alpha emitter, beta emitter and a gamma emitter respectively. A sensor was used to detect and count the nuclear radiation. Different thickness of papers were placed between the source and the sensor to record the data. The result from the experiment is shown in the table. **[2]**

Sl. No	**Thickness of paper(mm)**	**Source X (Count per second)**	**Source Y (Count per second)**	**Source Z (Count per second)**
1	0.2	30	68	65
2	0.6	32	36	60
3	1.0	33	5	52
4	1.6	32	0	45
5	2.0	30	0	33

Identify the types of radiation X, Y and Z. Give reasons for your answers.

d) To induce voltage, Faraday's Laws indicate the need to have continuous change in the number of magnetic field lines passing through the armature coil. Therefore, in hydropower plants, the turbines attached to the armature coil of the dynamo is continuously turned using a mechanical energy from the water. Mention **TWO** ways to increase the generation of electricity. **[2]**

e) Two cylinders X and Y are connected by a U-tube as shown in the figure below. The cross- sectional area of cylinder Y is greater than that of X.

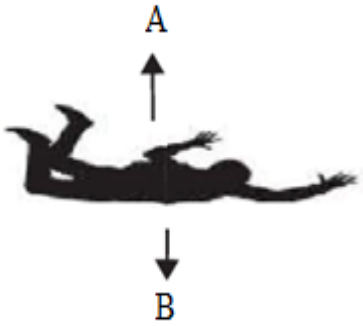


i. Which cylinder will exert more pressure? Why? **[2]**

ii. What is the function of the fluid used in the system? **[1]**

Question 5

a) The falling object experiences two types of force. The forces are labelled as A and B as shown in the figure below.



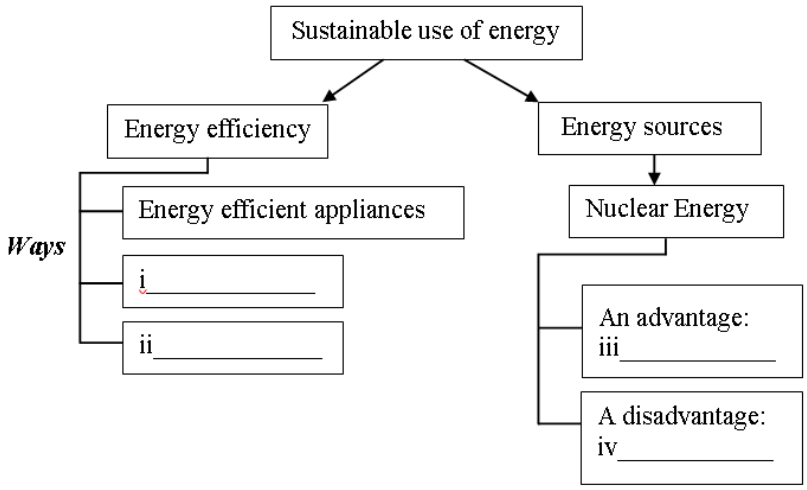
i. Name the forces A and B. **[1]**

ii. If the mass of the falling person is 60 kg, calculate force B. [Take g = 10 m/s^2] **[1]**

b) Thirst is a mechanism of our body that gives us the urge to drink more fluids when body produces more heat than the actual heat required by it. Suppose you feel thirsty during a hot summer day, which fluid would you prefer? Support with **TWO** reasons. **[2]**

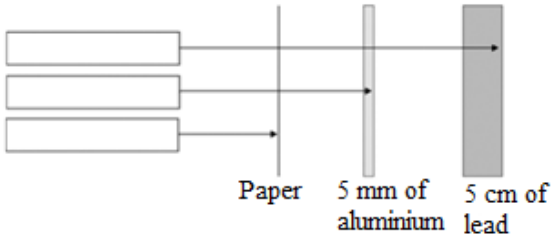
c) As an obstruction to the flow of electric current, resistance of a wire depends on several factors. Mention **TWO** ways to have a maximum current flowing through a wire. **[2]**

d) Complete the following flowchart. **[2]**



i.	
ii.	
iii.	
iv.	

e) A teacher demonstrated the penetrating power of alpha, beta and gamma radiations through different materials as illustrated below. Write the name of the correct radiation in each box. **[2]**



Write **ONE** safety precaution while performing such an experiment.

Question 6

a) Three objects of different shapes are cut from the same sheet of metal as shown below. **[2]**

disc L-shape square

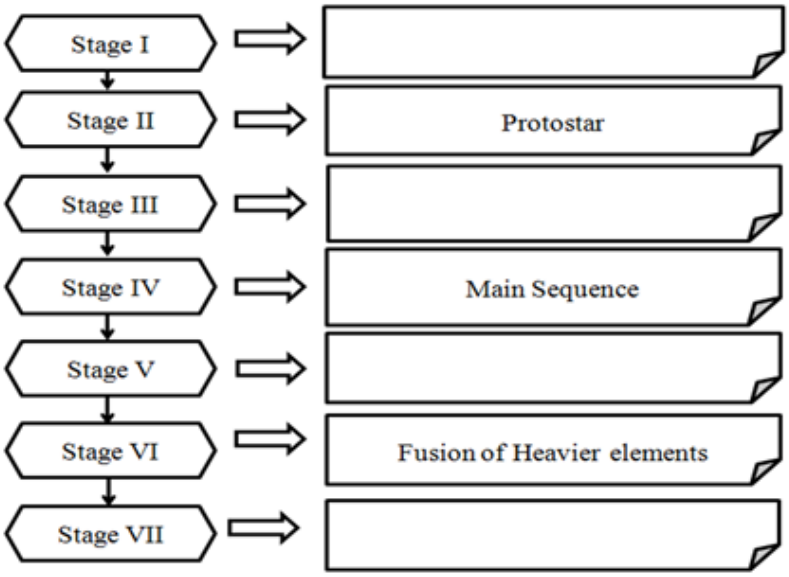
Do you think the centre of gravity in all the shapes lie on the body? Justify with an example.

b) In a simple calorimeter, 250 g of milk at 20ºC was added to 250 g of water at 50ºC. The final temperature of the solution was found to be 30ºC. Was the reaction exothermic or endothermic? Explain. **[2]**

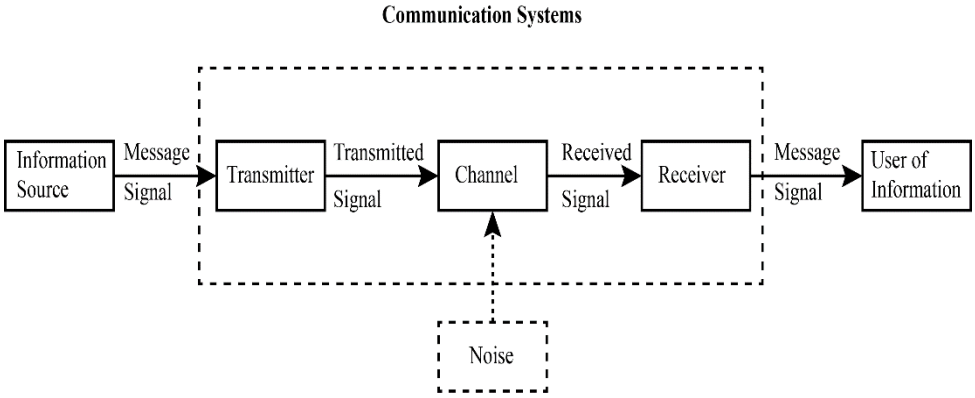
c) Why do students prefer a bag with broad shoulder straps to carry books to school? **[1]**

d) Like any living beings, stars also undergo a life cycle that begins with birth and expands through lifespan eventually leading to death. There are seven stages in a star's life cycle. Using the given information, complete the stages in the figure using the words given below. **[2]**

Red Giant	Supernovae	Giant Gas Cloud	T-Tauri Phase



e) Lhob Community Radio 91.1 FM at Lhotukuchu village under Dorokha is helping the community preserve their unique language, culture and tradition. The basic components of such a communication system is shown in the figure.



i. What is the function of a transmitter in a communication system? **[1]**

ii. List **TWO** properties of the waves used in the above communication system. **[1]**

iii. Suggest a way to minimize the noise from such communication signals. **[1]**

Question 7

a) The weight of a body and air resistance are the two main forces acting on a free falling body. What will happen if the two forces are equal? **[1]**

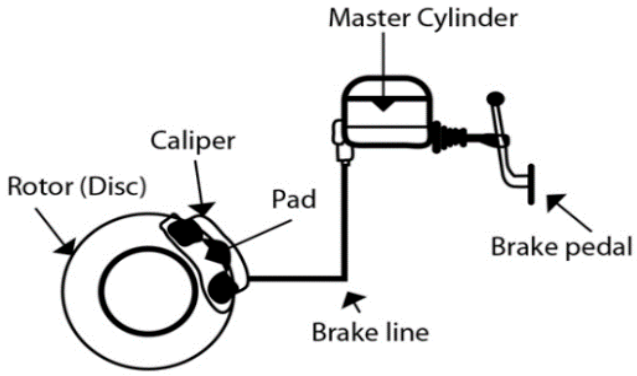
b) Lhamo uses three different bodies to study the moment of force. The table contains a set of data for bodies S, R and T.

Bodies	**Force (N)**	**Distance from the pivot (m)**
S	250	5
R	100	10
T	200	6

i. Name the body with the greatest moment of force. **[1]**

ii. How will you increase the moment of the body S to 3000 Nm? **[1]**

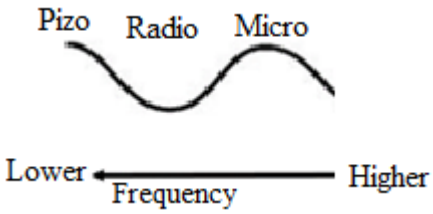
c) Hydraulic brakes could bring a high-speed car to halt when the driver applies a small amount of force on the brake pedal.



i. State the principle behind the working of a hydraulic brake. **[1]**

ii. Hydraulic machines can do lots of work with the application of a small force. Why do you think so? **[1]**

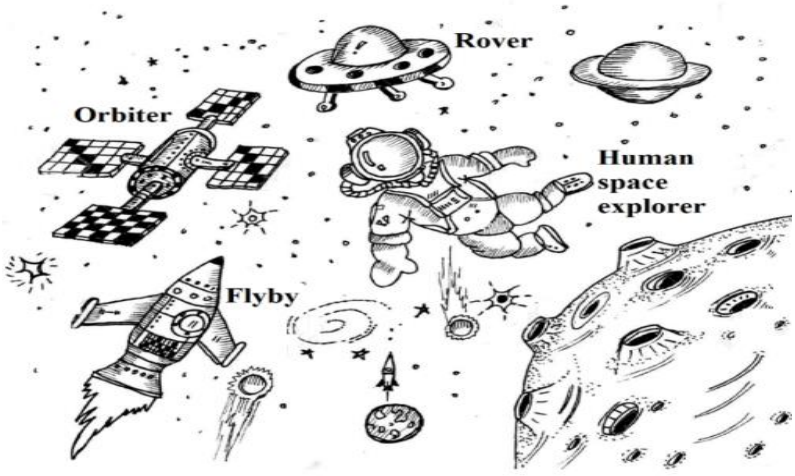
d) An English scientist James Clerk Maxwell developed a scientific theory to explain electromagnetic waves. He noticed that electrical fields and magnetic fields could couple to form electromagnetic waves. If Pizo is a new electromagnetic wave as shown in the figure below, complete the following questions.



i. Write **TWO** common properties between Pizo and radio waves. **[1]**

ii. Compare the wavelength of Pizo to microwaves. **[1]**

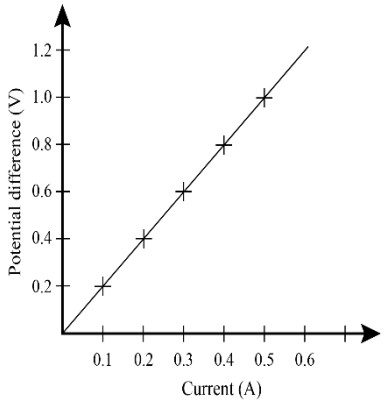
e)



Based on the mission definition, different types of space explorers such as flyby, orbiter, rover and human space missions are used. Select three methods of space exploration and write an advantage and a disadvantage for each method.

Question 8

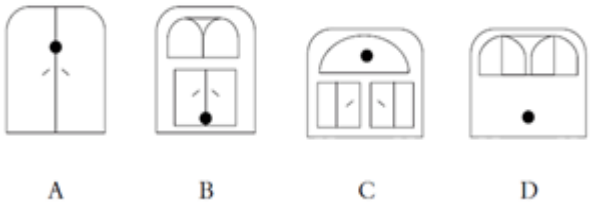
a) Study the I-V graph of a nichrome wire as shown in the figure. Name the law and constant variable illustrated by the graph. **[1]**



Name of the law:	
Constant Variable:	

b) A radioactive element ${}^{A}_{Z}S$ emits a α -particle and then a β -particle resulting in the formation of a new nucleus represented by ${}^{M}_{L}P$. If the value of A is 232 and Z is 90, write the atomic and mass number of element P. **[2]**

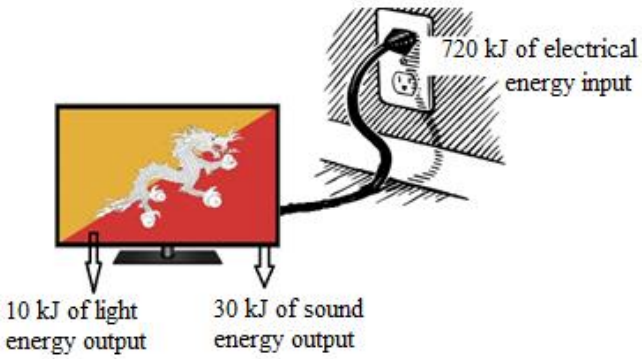
c) The figure below shows four different designs of trucks A, B, C and D with their centre of gravity marked with a dot(•).



Which design of truck is the most stable? Give reason for your answer. **[2]**

d) When the body is falling under the sole influence of gravity, it is said to be in the state of free fall. Write **TWO** characteristics that are true to free falling objects on the Earth. **[2]**

e) Ap Dorji switched on the TV to watch the live coverage of the National Day Celebration.



i. Calculate the total energy consumed by the light and sound of the TV? **[1]**

ii. What happens to the rest of the energy supplied? **[0.5]**

iii. Calculate an efficiency of the TV. **[1.5]**

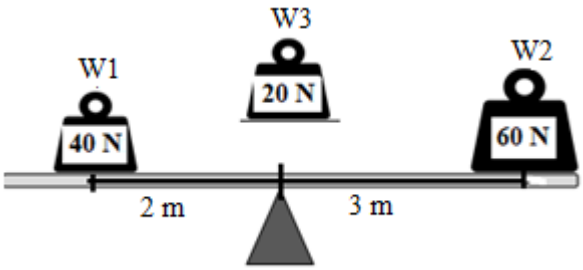
Question 9

a) Define calorimetry. Write any **TWO** assumptions to be considered while measuring heat flow using a calorimeter. **[2]**

b) While hydropower is the backbone of Bhutanese economy, the method of power generation has impacts on the environment. Mention **FOUR** negative environmental impacts of hydroelectricity on the environment. **[2]**

c) With the dream to enhance the land transportation system in Bhutan, the Ministry of Information and Communication has formed a special task force to study the feasibility of having electro-magnetic trains between Thimphu and Paro. Imagine that you are one of the members of that special team tasked to develop a simple prototype of an electric train to explain the working of an electro-magnetic train. Using copper wire, battery (AAA), neodymium magnets (super strong magnets that are plated with metal) and wire cutters, create a conceptual prototype of the train. You must include each step clearly. **[2]**

d) Two different weights W1 and W2 are placed on the seesaw. If the seesaw turns clockwise due to the weight W2, at what distance should the new weight W3 be placed to balance the seesaw? **[2]**



e) Automobile manufacturers install numerous lights in the vehicle for a better driving experience. Some lights are for normal alerts while others require immediate reaction. Explain why red light is used in most of the urgent signals. **[2]**