

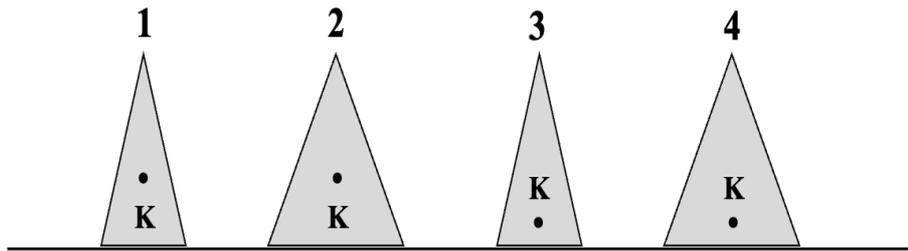
**SECTION A [40 MARKS]**  
**ANSWER ALL QUESTIONS**

**Question 1**

**[25]**

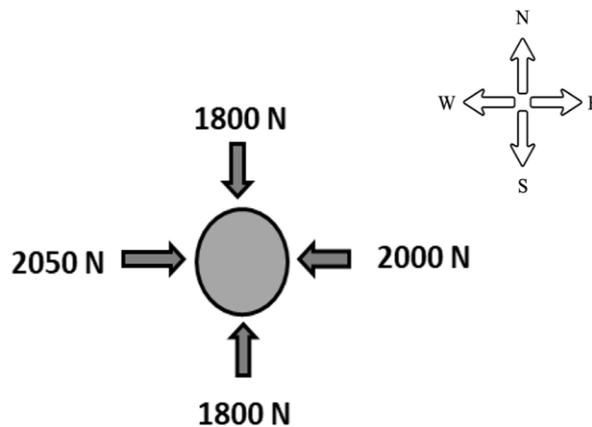
a) For each question, there are **FOUR** responses: **A, B, C, and D**. Choose the corresponding letter and **CIRCLE** it neatly. No score will be awarded if you circle more than **ONE** letter.

i. The figure below shows four solid cones. The centre of gravity of each cone is marked by a point labeled **K**. Which cone demonstrates the greatest stability?



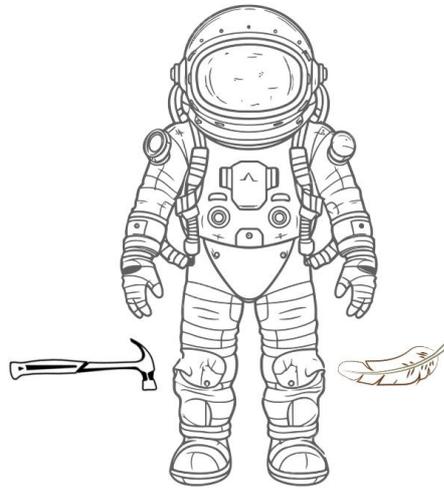
- A Cone 1
- B Cone 2
- C Cone 3
- D Cone 4

ii. A body is acted upon by four different forces from different directions as indicated in the figure below. Along which direction the body is likely to move?



- A East
- B West
- C North
- D South

- iii. The picture below depicts astronaut David Scott conducting a live demonstration during the final Apollo 15 mission. He dropped a geologic hammer and a feather simultaneously. In space, without air resistance, both fell at the same rate. "Free fall" is the condition in which

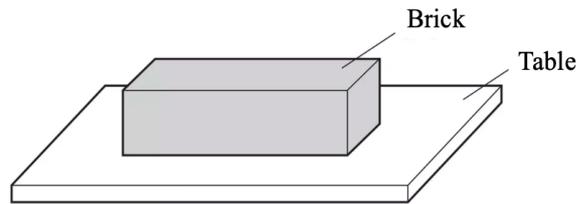


- A the motion of a body is due to gravity alone, when air resistance is applicable.  
B the motion of a body is due to gravity alone, when air resistance is negligible.  
C the motion of a body is due to velocity alone, when air resistance is negligible.  
D the motion of a body is due to gravity alone, when air resistance is maximized.
- iv. The table below shows the time taken by four athletes with different body weights to complete the 200 m race during annual school sports day. Who is the most powerful athlete among them?

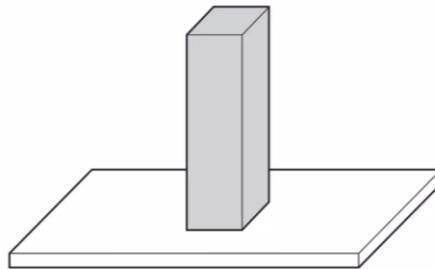
Name of athlete	Weight	Time taken
Nima	500 N	18 s
Dawa	600 N	20 s
Karma	700 N	30 s
Mindu	800 N	40 s

- A Nima  
B Dawa  
C Karma  
D Mindu

- v. In an experiment to demonstrate the relationship between pressure and force, a brick is kept with its flat, rectangular side on the table as shown in the figure below.



Then, the brick is turned so that it rests on the table on its smallest face as shown in the figure below.



How has this affected the force and the pressure exerted by the brick on the table?

	<b>Force</b>	<b>Pressure</b>
(a)	increased	unchanged
(b)	increased	increased
(c)	unchanged	increased
(d)	unchanged	unchanged

- A (a)  
 B (b)  
 C (c)  
 D (d)

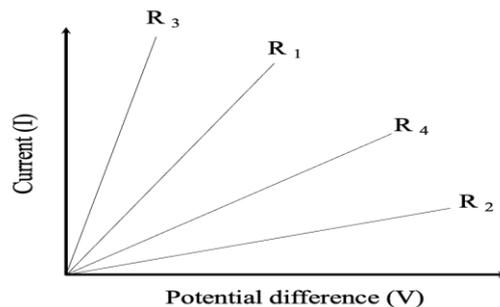
- vi. When a body is submerged in the fluid, it experiences a pressure due to fluid, which is called hydrostatic pressure. Which of the following equations can be used to measure hydrostatic pressure?

- A  $P = \frac{F}{A}$   
 B  $P = \rho g V$   
 C  $P = \rho g h$   
 D  $P = W - \rho g V$

vii. A copper bar weighing 25 kg was heated for 12 minutes. The temperature increased from 25°C to 55°C. If the specific heat capacity of copper is 385 J/kg°C, how much heat was gained by the copper bar?

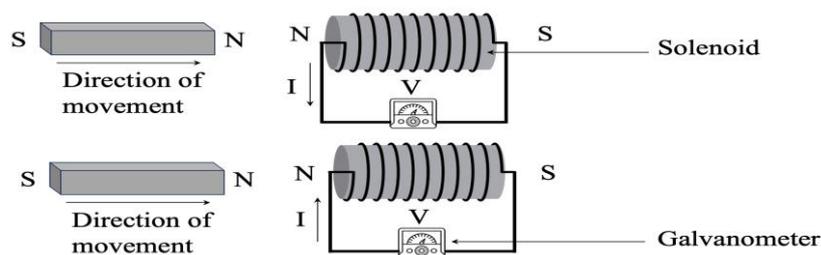
- A 115,500 J
- B 240,625 J
- C 288,750 J
- D 529,375 J

viii. In a physics class, a student conducts an experiment and plots the V-I graph for four samples of nichrome wire, each with different resistances  $R_1$ ,  $R_2$ ,  $R_3$  and  $R_4$  as shown in the figure below. What is the relation between  $R_1$ ,  $R_2$ ,  $R_3$  and  $R_4$ ?



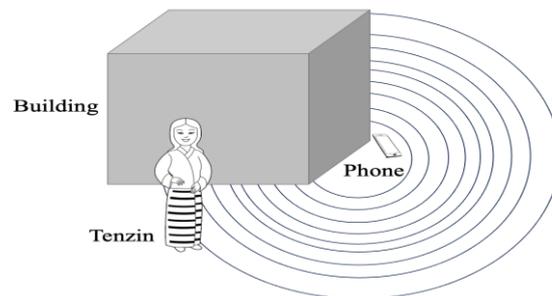
- A  $R_3 > R_1 > R_4 > R_2$
- B  $R_2 > R_4 > R_1 > R_3$
- C  $R_4 > R_3 > R_2 > R_1$
- D  $R_1 > R_2 > R_3 > R_4$

ix. A boy did an experiment using a bar magnet and a solenoid connected to a galvanometer as indicated in the figure below. When he constantly moved the bar magnet towards and away from the solenoid, it was found that there was deflection of the pointer in the galvanometer. Which of the following concepts is demonstrated by the experiment?



- A The electric current is induced due to the induced voltage
- B The electric current flows from the magnet to the solenoid
- C The electric current is induced due to the motion of the magnet
- D The electric current is induced due to the change in magnetic flux

- x. Which electromagnetic wave plays an important role in maintaining the Earth's average temperature and climate stability through the greenhouse effect?
- A Visible Rays
  - B Gamma Rays
  - C Infrared Rays
  - D Ultraviolet Rays
- xi. Tenzin lost her phone and used another phone to call while searching. She heard her phone's ringtone coming from the other side of the building, even though she couldn't see it, as shown in the figure below. Why was she able to hear her phone ringing despite it being on the other side of the building?

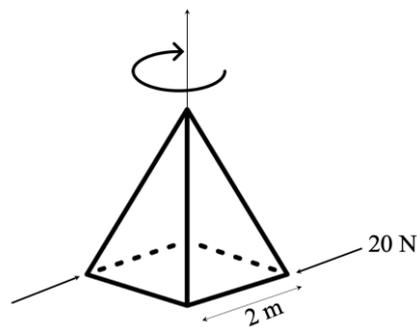


- A The building's walls are transparent to sound waves
  - B The phone's volume is loud enough to penetrate the walls
  - C The ringtone frequency is high enough to travel long distances
  - D Sound waves can diffract around obstacles and through openings
- xii. Radioactive radiations have the ability to penetrate through the substances. Which of the following radiations has the highest penetrating power?
- A X ray
  - B Beta rays
  - C Alpha rays
  - D Gamma radiation
- xiii. Evaluate the following statements to determine which best highlights the primary impact of human space exploration:
- A Human space exploration fostered the international space race.
  - B Human space exploration improved management of astronauts' health on long missions.
  - C Human space exploration advanced our understanding of the Earth's environment and climate.
  - D Human space exploration has led to technological advancements with wide-ranging applications on the Earth.

- xiv. Tshewang and Dorji participated in a rope-walking contest. Tshewang walked with his arms closed but soon fell off while, Dorji spread his arms wide open and successfully completed the walk as shown in the figure below. How did spreading the arms help Dorji maintain his balance on the narrow rope?

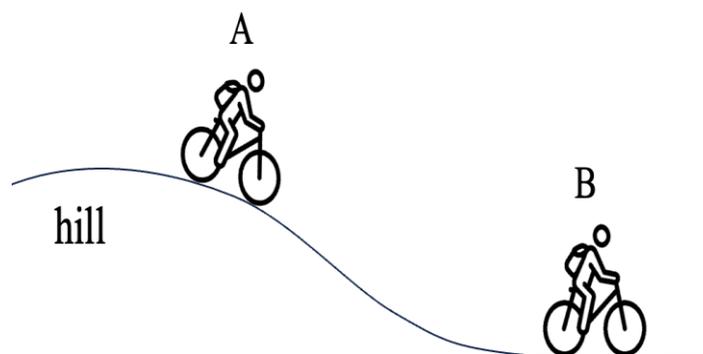


- A Spreading arms helped keep the line of gravity within the body  
B Spreading arms helped keep the line of gravity outside his body  
C Spreading arms helped keep the line of gravity at the upper part of the body  
D Spreading arms helped keep the line of gravity at the lower part of the body
- xv. A square-based pyramid is suspended as shown in the figure below. Refer the figure to calculate the torque exerted at its base.



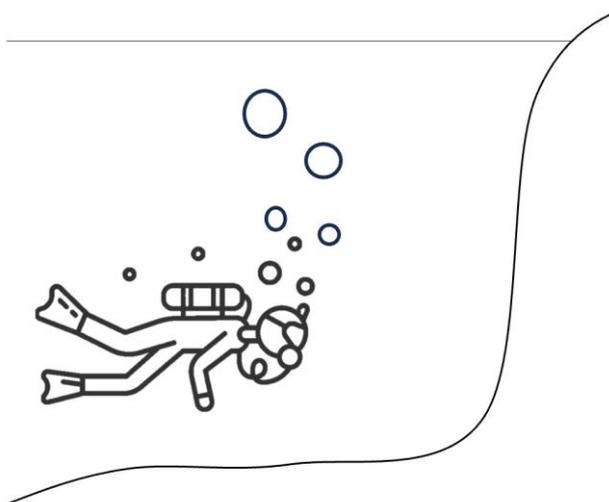
- A 4 Nm  
B 40 Nm  
C 0.02 Nm  
D 0.04 Nm
- xvi. Falling objects experience driving force as well as the drag force. At a certain stage of fall, objects fall at a constant velocity, called terminal velocity. When do falling objects attain terminal velocity?
- A When the driving force is less than the drag force  
B When the driving force is equal to the drag force  
C When the driving force is greater than the drag force  
D When the driving force is slightly greater than the drag force

- xvii. A cyclist starts from rest at point A on a hill and coasts downhill without pedaling as shown in the figure below. The cyclist then applies the brakes and comes to a stop at point B.



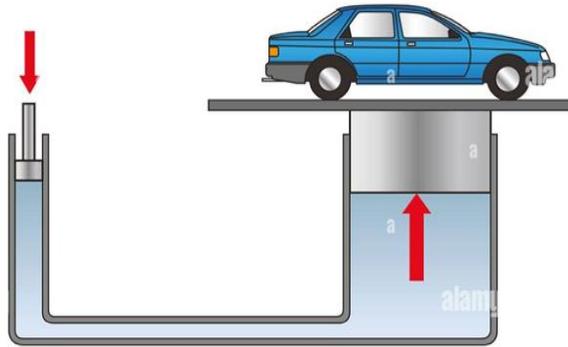
Which energy changes have taken place between A and B?

- A kinetic  $\rightarrow$  heat  $\rightarrow$  gravitational potential
  - B kinetic  $\rightarrow$  gravitational potential  $\rightarrow$  heat
  - C gravitational potential  $\rightarrow$  kinetic  $\rightarrow$  heat
  - D gravitational potential  $\rightarrow$  heat  $\rightarrow$  kinetic
- xviii. An underwater diver uses a breathing apparatus. A bubble of gas exhaled by the diver rises to the water's surface. As the bubbles rise, they increase in size, as shown in the figure below. Why do the size of the bubbles increase as they rise to the surface?

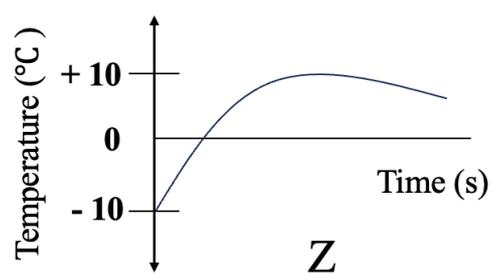
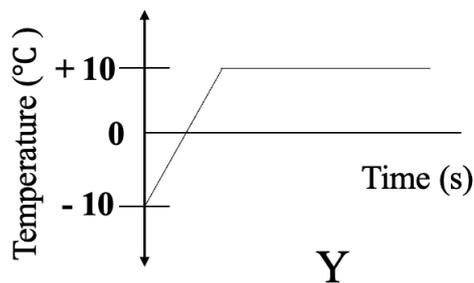
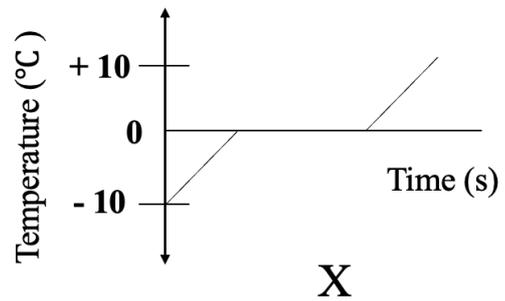
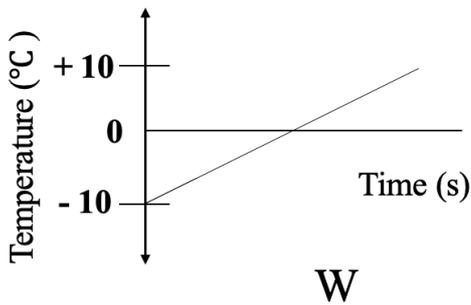


- A Water pressure on the bubbles increases with decrease in depth
- B Water pressure on the bubbles decreases with decrease in depth
- C Atmospheric pressure on the bubbles increases with decrease in depth
- D Atmospheric pressure on the bubbles decreases with decrease in depth

- xix. A hydraulic machine works based on Pascal's law of liquid pressure, as shown in the figure below. Which of the following statements best describes the working principle of a hydraulic machine?

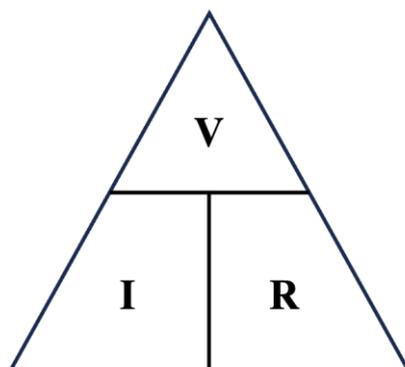


- A A hydraulic machine amplifies the amount of pressure applied  
 B A hydraulic machine applies the same amount of force to the load  
 C A hydraulic machine amplifies pressure and force applied to the load  
 D A hydraulic machine applies the same amount of pressure to the load
- xx. Ice at  $-10^{\circ}\text{C}$  is heated at a constant rate until it becomes water at  $+10^{\circ}\text{C}$ . Which among the following graphs below illustrates the temperature change over time?



- A W  
 B X  
 C Y  
 D Z

- xxi. The figure below shows notations to express a scientific law. Which law does the notations correspond to?



- A Ohm's Law  
B Pascal's Law  
C Faraday's Law  
D Newton's Law
- xxii. The fundamental difference between an AC generator and a DC generator is that
- A DC generator generates higher voltage.  
B AC generator generates higher voltage.  
C AC generator has an electromagnet while DC has a permanent magnet.  
D AC generator has slip rings while a DC generator has a split ring commutator.
- xxiii. The table below lists common uses of electromagnetic waves. Which row correctly identifies these waves?

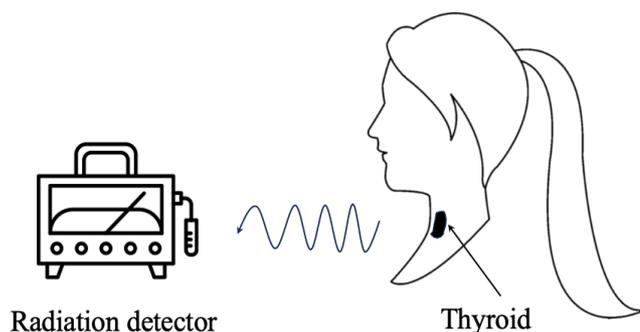
	<b>Satellite</b>	<b>Television remote</b>	<b>Sterilization of equipment in hospital</b>
1	Ultraviolet rays	Radio waves	Gamma rays
2	Microwaves	Infrared radiation	Ultraviolet rays
3	Radio waves	Microwaves	Infrared radiation
4	Microwaves	Infrared radiation	X ray

- A 1  
B 2  
C 3  
D 4

xxiv. We use a remote control to switch to our favorite TV channel. Sometimes, we can't change the channel when someone blocks the path between us and the TV. Which property of infrared radiation does this illustrate?

- A Infrared radiation undergoes reflection
- B Infrared radiation undergoes diffraction
- C Infrared radiation travels along the bend path
- D Infrared radiation travels along the straight line

xxv. The radioactive isotope iodine-123 is used by doctors to examine the thyroid gland. When iodine is taken as a tablet, it is absorbed by the thyroid, and the emitted gamma radiation from the decaying iodine atoms is detected outside the body as shown in the figure below.



Which one of the following gives a reason why gamma radiation is used instead of alpha or beta radiation to examine the thyroid gland?

- A Gamma radiation has low ionizing power
- B Gamma radiation has a long range in the air
- C Gamma radiation passes through the body
- D Gamma radiation is not deflected by a magnet

**b) Fill in the blanks by writing suitable word(s).**

**[5]**

i.	Explosions caused due to the collapsing of massive stars under their own gravity which can even outshine a whole galaxy is called _____.	
ii.	A body that falls at a constant velocity will be falling under the sole influence of _____.	
iii.	One of the best ways to reduce energy consumption for heating or cooling at home is _____.	
iv.	The direction of heat transfer between two bodies is determined by _____.	
v.	Radio waves are found suitable for broadcasting the radio and television programs as they can reach the signals to far places due to the _____.	

c) Write TRUE or FALSE for the following statements in the space provided in the 'Answer' column. [5]

i.	For a machine, work done by the machine can never be greater than the work done on the machine.		
ii.	Two bodies can have the same temperature even if their heat contents are different.		
iii.	Electric current flows from the region of higher concentration of electrons to the region of lower concentration of electrons across a conductor.		
iv.	Ultraviolet rays are used in treating neonatal jaundice in infants.		
v.	The atoms of unstable nuclei seek to attain a stability by receiving the extra protons or neutrons.		

d) Match each item under Column A with the most appropriate item in Column B. Write the correct letter in the space provided in the 'Answer' column. [5]

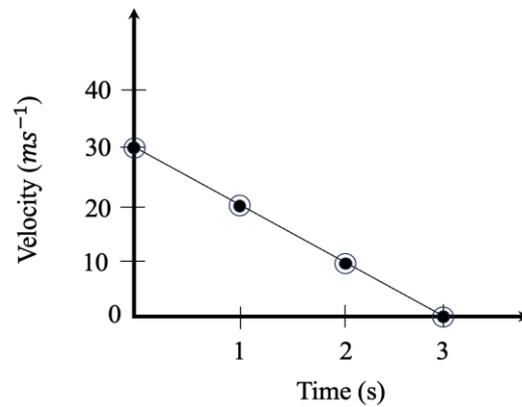
Column A	Column B	Answer
i. Product of force and velocity	a. Micro-waves	i.
ii. Snow on the mountain does not melt at once	b. Torque	ii.
iii. Satellite communication	c. Cosmological blueshift	iii.
iv. Product of force and perpendicular distance between two forces	d. Power	iv.
v. Every matter in the universe moves away from the observer	e. Specific latent heat of fusion of water	v.
	f. Cosmological redshift	
	g. Radio-waves	
	h. Specific heat capacity of water	

**SECTION B [60 MARKS]**  
**ATTEMPT ANY SIX QUESTIONS**

**Question 2**

- a) The 54 meters statue of Buddha Dordenma at Kuensel Phodrang sits atop a hill overlooking the Thimphu valley, featuring a wide base area. Why does the statue have a wider base area? **[2]**


- b) A 250 g ball is thrown vertically upward with an initial velocity of  $30 \text{ ms}^{-1}$  and the graph is plotted to show the change of velocity with time as shown in the figure below. Refer the figure below to determine the kinetic energy of the ball in 2 s. **[2]**



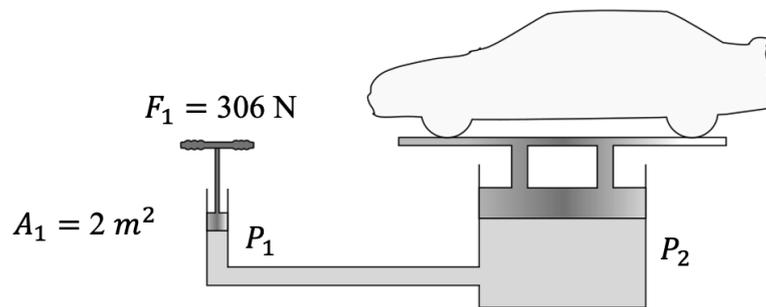

- c) A farmer in Phobjikha was listening to the weather forecast on BBS, which predicted frost. In response, he watered his vegetable garden in the evening. What could be the reason for this action? **[2]**


- d) How is the electromagnetic spectrum organized by frequency and wavelength? What happens to the wavelength of an electromagnetic wave when its frequency increases? **[2]**


- e) Create a theoretical model to explain the formation of the solar system. Include the mechanisms that drive each stage and explain how your model accounts for the various types of planets and features observed in our solar system. **[2]**




- b) To lift an automobile, a force of 306 N is applied to a piston with an area of 2 m<sup>2</sup> in a hydraulic lift as shown in the figure below. Calculate the pressure exerted on the large piston. [2]

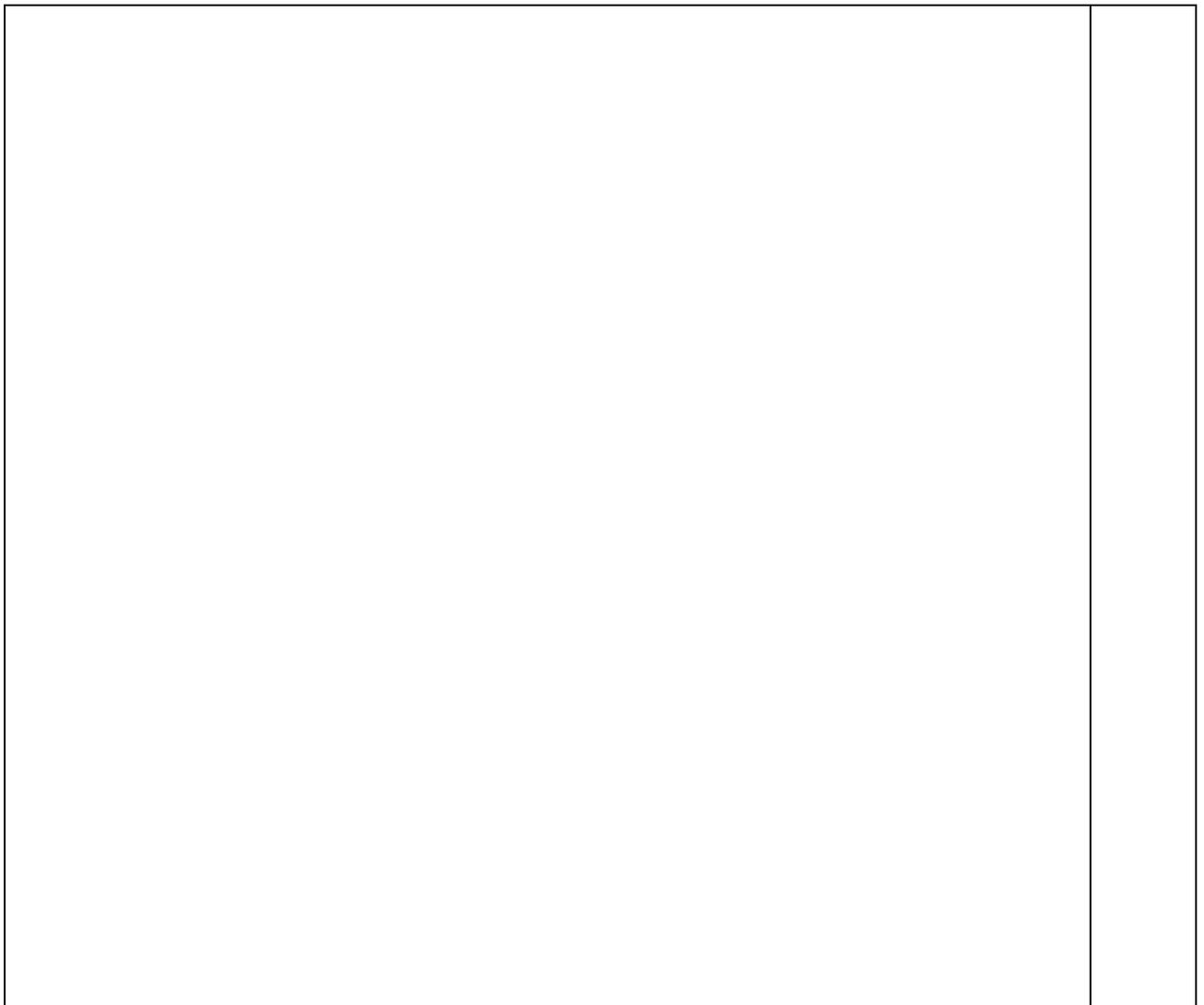


--	--

- c) A group of students conducted an experiment to find the relationship between resistance and the electric current produced across the conductor. The data of the experiment is shown in the table below. [2]

Sl. No.	R ( $\Omega$ )	I (A)
1	0	100
2	10	80
3	20	60
4	30	40
5	40	20

Plot the line graph using the above data and draw the relationship between resistance (R) and the electric current (I) produced.

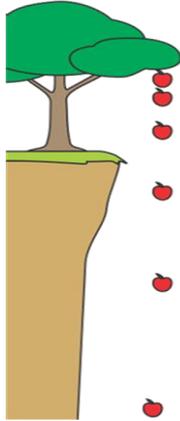


- d) How does the diffraction of radio waves affect their ability to propagate over long distances and around obstacles? **[2]**


- e) Apollo 11 conducted a crewed lunar landing in 1969. Similarly, the Mars 2020 Perseverance Rover was launched to search for signs of ancient microbial life on Mars. How do these two missions differ in terms of their advantages and limitations? **[2]**


**Question 4**

- a) For falling objects, the speed of fall increases downward every second. Fill up the missing values in the table below and draw a conclusion regarding the speed of the fall. **[2]**



Time (s)	Speed (m/s)
0	0
1	9.8
2	(i) .....
3	(ii) .....
4	39.2


- b) 8400 joules of heat is needed to heat 0.08 kg of metal with a specific heat capacity of  $1050 \text{ Jkg}^{-1}\text{C}^{-1}$  to a temperature T. Given the initial temperature of the metal is  $30^\circ\text{C}$ , calculate the final temperature. **[2]**

--	--

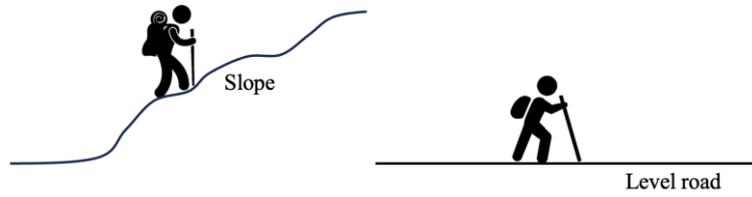
- c) Transformers adjust voltage levels, enabling efficient long distance electricity transmission and safe distribution to homes and businesses. However, they are not 100% efficient. Why? [2]


- d) Uranium ( $U_{92}^{238}$ ) undergoes alpha decay to form one nucleus of thorium (Th). Subsequently, thorium emits a beta particle and forms one nucleus of Protactinium (Pa). Write down the equation for the decay process. [2]

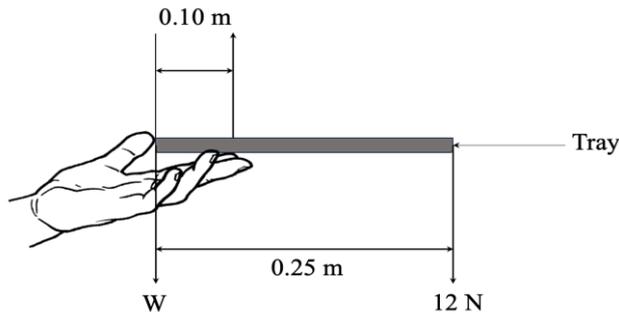

- e) During an experiment, a student's skin got burned. To relieve the pain, he applied ice to the burn area. Why does applying ice help alleviate the pain? [2]


**Question 5**

- a) A man climbs a slope and another walks the same distance on a level road as shown in the figure below. Which of the two expends more energy and why? [2]




- b) A waiter holds a tray horizontally in one hand between fingers and thumb as shown in the figure below. Refer the figure to calculate the magnitude of force the thumb needs to exert to balance the tray. [2]

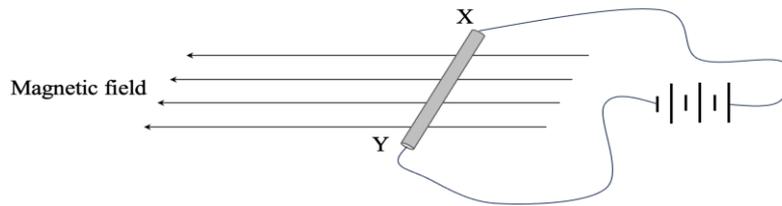


--	--

- c) Tobgay went to a car workshop along with his father. He was surprised to see that a small hydraulic jack could lift a huge car as shown in the figures below. Explain the working mechanism of hydraulic jack. [2]




- d) A copper rod XY is placed in a uniform magnetic field, with its ends connected to a battery using wires as shown in the figure below. Copy the diagram and indicate the direction of current and the force experienced by the rod. [2]



--	--

e) Is nuclear energy and radioactivity the same thing? Explain your answer. [2]


**Question 6**

a) A water bucket got toppled and the water splashed on the floor as shown in the figure below. An empty bucket rolled over the floor for some time and finally got settled. In which state of equilibrium, the bucket is? Why? [2]



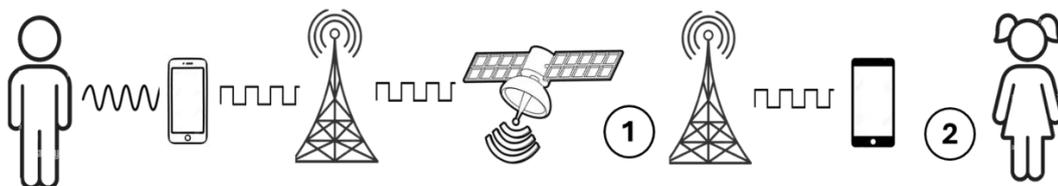

b) The resistance of an electric hair dryer when hot is 55 ohms. Calculate the wattage of the electric hair dryer when it operates at 220 volts. [2]

--	--

- c) We cut an apple more easily using the sharp side of the knife than the blunt side. This indicates that the magnitude of pressure is impacted by the surface area. Write down the relationship between surface area and the pressure. [1]


- d) Why does turning a screwdriver qualify as an example of the application of a couple? [1]


- e) A cell phone uses the combination of analogue and digital signals in transmitting the information to a longer distance. Refer the figure below and identify the types of signals between satellite and the tower (1) and mobile and the person (2). [2]





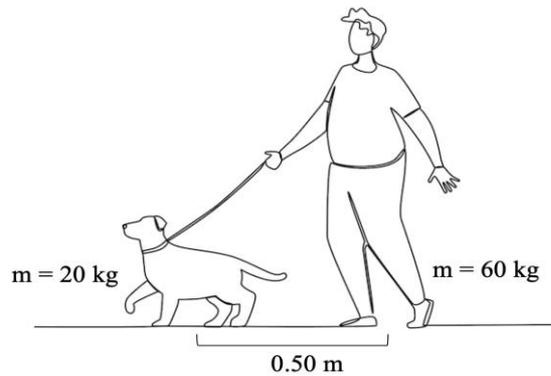
- f) The Japanese prime minister ate fish caught off Fukushima's coast on August 30, 2023 after the release of treated radioactive water to dispel safety concerns about fish from the region where a nuclear accident happened in 2011. What conclusions do you draw from the statement above regarding the impacts of nuclear radiation on living organisms? **[2]**


**Question 7**

- a) It is common to see elderly individuals walking with a walking stick. How does a walking stick help them maintain stability? **[1]**

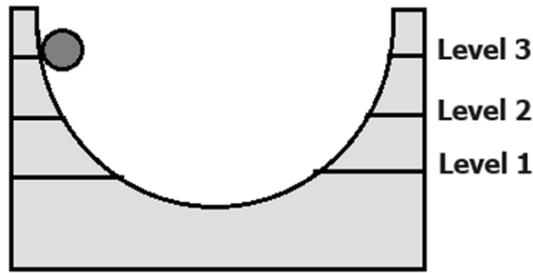

- b) The remarkable observation that all free-falling objects fall at the same rate was first proposed by Galileo, nearly 400 years ago. State TWO motion characteristics that are true for a free-falling body. [1]


- c) A man with a mass of 60 kg and his dog with a mass of 20 kg walk in a park as shown in the figure below. Refer the figure to calculate the gravitational force of attraction between the person and the dog. (Take  $G = 6.67 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$ ) [2]



--	--

- d) A ball is made to roll over a curved track as shown in the figure below. Assume there is no friction between the surface of the track and a ball. [2]



Till what level a ball would roll on the other side of the track? Why?


- e) The table below shows nature of light waves, sound waves and X- ray.

	Light waves	Sound waves	X- Ray
<b>1</b>	transverse	transverse	longitudinal
<b>2</b>	transverse	longitudinal	transverse
<b>3</b>	longitudinal	longitudinal	transverse
<b>4</b>	longitudinal	transverse	longitudinal

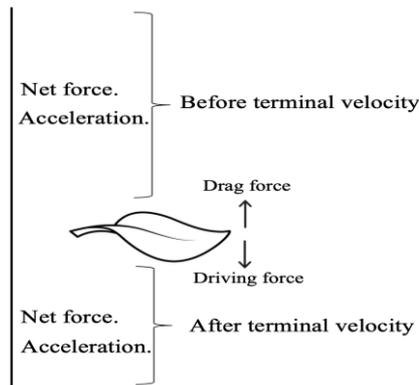
- i. Which row shows the correct nature of light waves, sound waves and X- ray? [1]


ii. How can you make a distinction between longitudinal and transverse waves? [1]


f) The Desuup Skilling Program Solar Initiative successfully commissioned a 250 kW rooftop solar power plant at the Centenary Farmers Market and a 500 kW ground-mounted solar power plant at Dechencholing, Thimphu, in 2023. Why do you think Bhutan is investing in solar energy? [2]


**Question 8**

a) A leaf falling from a tree branch is influenced solely by gravity as shown in the figure below. Refer the figure to explain how the net force and acceleration change before and after reaching terminal velocity. [2]

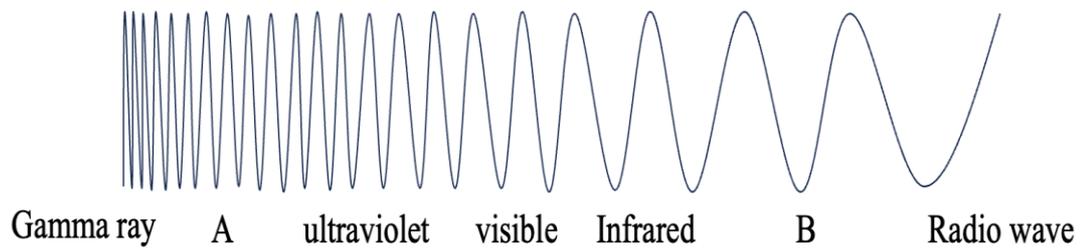



- b) A wooden block of 5 m long and 0.5 m wide lies flat on the ground. If it weighs 300 kg in air, what is the pressure exerted on the ground? **[2]**

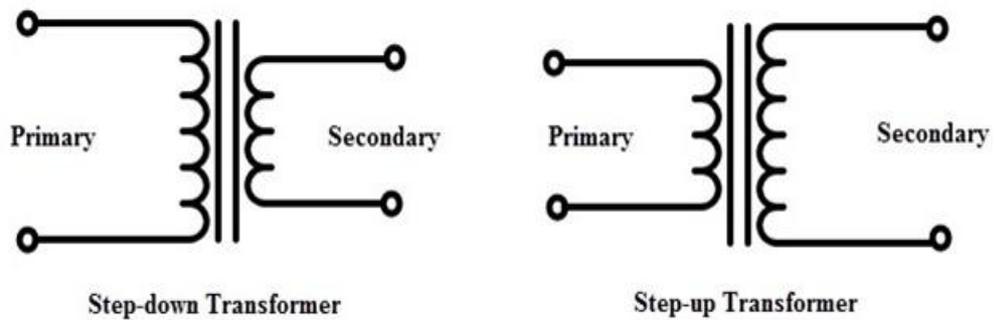
--	--

- c) Why does the temperature drop significantly after a sudden downpour during a hot summer? **[2]**


- d) Electromagnetic waves have greatly improved our lives but can also have harmful effects. How would you minimize prolonged exposure from electromagnetic waves A and B shown in the figure below? [2]

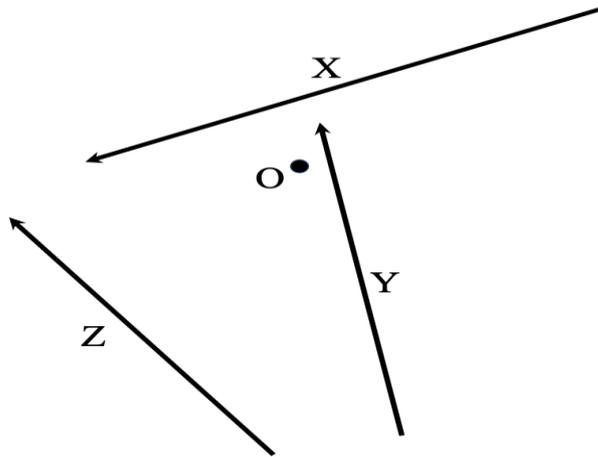



- e) Transformers are used to transport electrical energy over a long distance. Why is the step-up transformer used instead of a step-down transformer to transport electricity from the hydropower station to the far flung places? [2]




**Question 9**

- a) X, Y and Z are three different forces which act about point O as shown in the figure below.

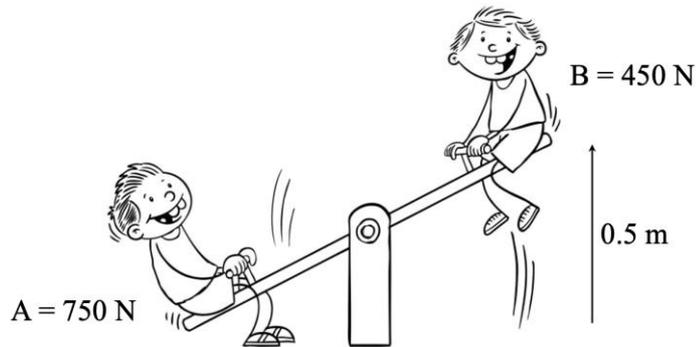


Point O lies in the same plane. Given,  $X = Y = Z = 25 \text{ N}$

- i. Which force has the least moment about O? Give a reason. **[1]**


- ii. Which force has the greatest moment about O? Give a reason. **[1]**

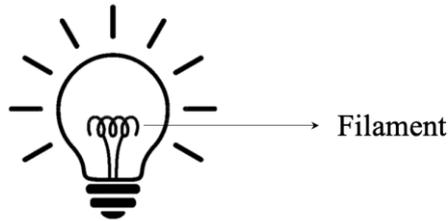

- b) Two people are on opposite sides of a seesaw as shown in the figure below. Person A weighs 750 N, and person B weighs 450 N. If person B is lifted 0.5 m above the ground when person A sits down, what is the efficiency of the seesaw? **[2]**



--	--

- c) Pascal's law is the fundamental principle that enables hydraulic power in heavy construction machines to function. Explain Pascal's law. **[1]**


- d) The filament lamp is commonly used for home lighting and glows brightly as it heats up as shown in the figure below. Why does the filament become red hot after the switch is turned on? [1]




- e) A calorimeter operates on the principle of the Law of Conservation of Energy. Explain how is this principle applied. [2]


- f) To solve the weak TV signal issue in your area, you are given a choice between copper cable and optical fiber cable. Which one would you prefer and why? Provide **TWO** reasons for your choice. [2]



## Rough Work

## Rough Work

## Rough Work