

SECTION A [40 MARKS]
ANSWER ALL QUESTIONS

Question 1

a) **Direction: For each question, there are FOUR responses: A, B, C and D. Choose the corresponding letter of your response and CIRCLE it neatly. NO score will be awarded if you circle more than ONE letter.** [25]

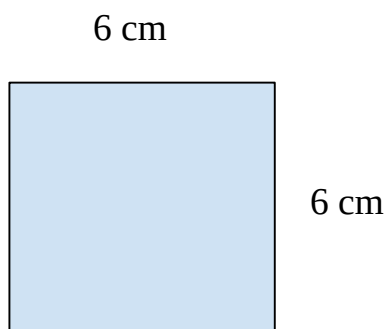
i. A hydraulic system utilizes fluid pressure to transmit power and perform various mechanical tasks. What is the main advantage of utilizing such a system?

- A Multiplying speed
- B Multiplying force
- C For fuel efficiency
- D For machine efficiency

ii. Which of the following situations results in zero work done by force?

- A Girl running upstairs
- B Woman rowing a boat in a river
- C Boy walking with a book on his head
- D Man lifting a box from the floor and placing it on a shelf

iii. Where will the centre of gravity be located in terms of coordinates in the given section?

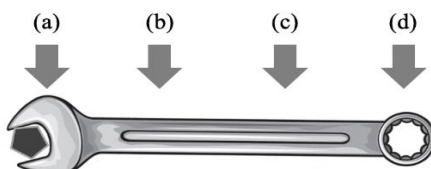


- A (6, 3)
- B (3, 6)
- C (3, 3)
- D (6, 6)

- iv. Which electromagnetic wave is commonly employed to target and eradicate cancer cells from the body?
- A Visible rays
 - B Gamma rays
 - C Infrared rays
 - D Ultraviolet rays
- v. When a class X student used a thermometer to measure the temperature of bodies A and B with the aim of investigating heat transfer, she observed no heat flow between the two bodies. This suggests that
- A both the bodies have the same temperature.
 - B the temperature of body A is higher than B.
 - C the temperature of body B is higher than A.
 - D the temperature transfer cannot be detected nor measured.
- vi. Which wireless communication technology uses microwaves for data transfer?
- A Wi-Fi
 - B Infrared
 - C Bluetooth
 - D Internet of things
- vii. In the nuclear decay given below, the particles emitted in the sequence are
- $${}^A_ZX \rightarrow {}^A_{Z+1}Y \rightarrow {}^{A-4}_{Z-2}B \rightarrow {}^{A-4}_{Z-2}B$$
- A γ, β, α .
 - B β, γ, α .
 - C α, β, γ .
 - D β, α, γ .
- viii. Which statements best describe the stability of a body based on centre of gravity and area of base of support for optimal stability?
- I.** Stability improves when the base of support is larger
 - II.** Stability improves when the centre of gravity is raised
 - III.** Stability improves when the base of support is smaller
 - IV.** Stability improves when the centre of gravity is lowered

- A I & II
- B II & III
- C III & IV
- D IV & I

ix. In the figure below, where should the force be applied for maximum moment?



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

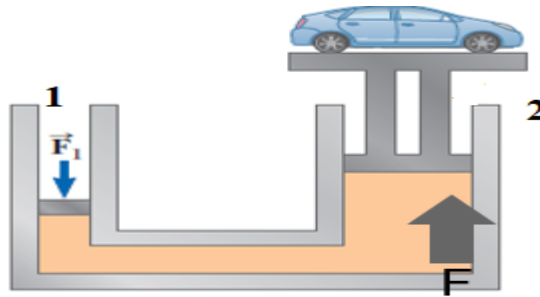
x. What is the moment of force exerted by a wrench when a 30 N force is applied to its handle which has a length of 0.5 meter?

- A 10 Nm
- B 15 Nm
- C 20 Nm
- D 25 Nm

xi. A bag that provides comfort to school children for carrying books is the one with a

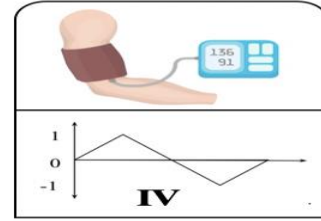
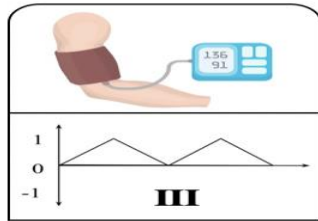
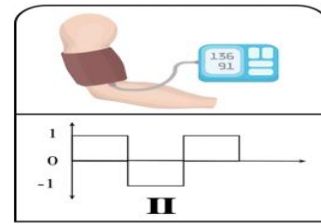
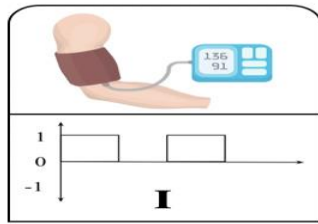
- A thin strap.
- B wide strap.
- C thin strap made of hard canvas cloth.
- D wide strap made of soft canvas cloth.

- xii. Which statement accurately describes the relationship between the applied force at area 1 and the resulting output force at area 2 in the figure of a hydraulic lift given below?



- A The force at area 1 is less than at area 2.
 B The force at area 1 is greater than at area 2.
 C The pressure at area 1 is less than at area 2.
 D The pressure at area 1 is greater than at area 2.
- xiii. How is X-ray used in the field of biomedical engineering?
 A Removes tumours in the body
 B Detects strokes and tumours
 C Sterilizes medical equipment
 D Kills bacteria around the infected organs
- xiv. Among the given symbols, which one represents alpha decay?
- | | | | |
|---------------|----------------|------------|--------------|
| ${}^1_0\beta$ | ${}^2_4\alpha$ | ${}^4_2He$ | ${}^0_{-1}e$ |
| I | II | III | IV |
- A I
 B II
 C III
 D IV
- xv. What is the amount of work done while ploughing a 15 m field with a pair of bullocks exerting a force of 1000 N on the plough?
 A 1000 J
 B 15000 J
 C 20000 J
 D 25000 J

- xvi. Which, among the following graphs, correctly depict the digital signal generated by a blood pressure monitor?



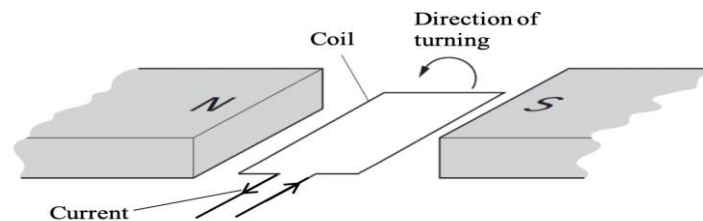
- A I
B II
C III
D IV
- xvii. Voyager 1, designed for exploring the outer solar system with a focus on Jupiter and Saturn, holds the record for the longest flight duration and farthest distance travelled among all spacecrafts. Thus, Voyager 1 is an exemplar of
- A orbital spacecraft.
B flyby space mission.
C rover space exploration.
D human space exploration.
- xviii. Which of the following applications extensively utilizes analogue signals?
- A Digital control systems
B Telecommunication networks
C Television and radio broadcasting
D Data transmission and networking

xix. Based on the data given in the table below, which are the ohmic conductors?

SL. No.	Copper wire		Aluminum wire		Tungsten wire		Nichrome wire	
	V	I	V	I	V	I	V	I
1	2	0.1	2	0.1	2	0.1	2	0.2
2	4	0.2	4	0.1	4	0.2	4	0.4
3	6	0.3	6	0.1	6	0.4	6	0.6
4	8	0.4	8	0.5	8	0.4	8	0.8
5	10	0.5	10	0.5	10	0.4	10	1.0

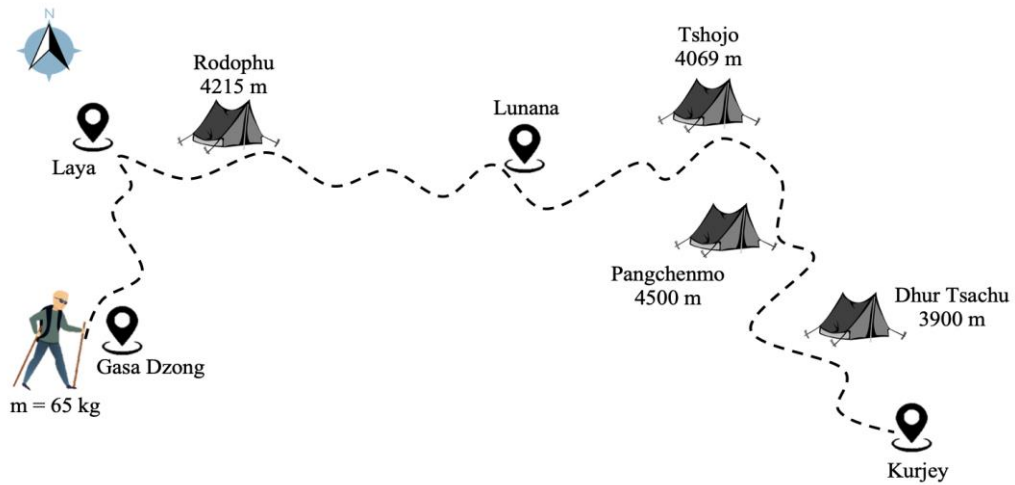
- A Copper and silicon wires
- B Tungsten and copper wires
- C Copper and nichrome wires
- D Tungsten and nichrome wires

xx. In the figure below, a flat rectangular coil is positioned between the poles of a magnet. The coil rotates in a specific direction due to the presence of an electric current. What modification would cause the coil to rotate in the opposite direction?



- A Decreasing the current in the coil
- B Increasing the number of turns on the coil
- C Reversing the direction of the current in the coil
- D Reversing both the current direction in the coil and the magnet's poles

- xxi. On October 13, 2022, Bhutan hosted the Snowman Race (SMR), a high-altitude ultra-marathon aimed at raising awareness about climate change. The figure below shows the race trail of a participant. Calculate the gravitational potential energy of the participant when he camped at *Pangchenmo*.



- A 2535000 J
B 3510000 J
C 2529000 J
D 2925000 J
- xxii. A rocket engine generates a thrust of 10,000 newtons. The area of the rocket nozzle is 2 m^2 . Calculate the pressure exerted by the rocket engine.
- A 2500 Pa
B 5000 Pa
C 10000 Pa
D 20000 Pa
- xxiii. Which specific electromagnetic waves would you select for a space telescope considering that longer wavelengths are favored for better penetration through dense cosmic gas and dust, resulting in reduced scattering and absorption?
- A X-ray
B Visible light
C Radio waves
D Infrared radiation

- xxiv. Which statement best describes robotic exploration in space?
- A Sending humans to conduct research and exploration activities
 - B Study of astrophysical phenomena using advanced instruments
 - C Use of autonomous spacecraft to study and explore celestial bodies
 - D Observing space from the earth using telescopes and remote sensing techniques
- xxv. The device which operates on Faraday's law of electromagnetic induction is
- A electric bell.
 - B electric motor.
 - C electric heater.
 - D electric generator.

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

[5]

i.	The net force resulting from a couple is always	
ii.	Acceleration due to gravity for a falling object remains unaffected by its	
iii.	There is no change in when a substance changes its state from solid to liquid or from liquid to gas.	
iv.	The decay process which americium nucleus undergoes in the given equation is ${}_{95}^{241}\text{Am} \rightarrow {}_{93}^{237}\text{Np} + \dots\dots\dots$	
v.	The resistance of a wire decreases when its cross-sectional area	

c) State whether the following statements are TRUE or FALSE.

[5]

i.	If the same amount of work is done in different time intervals, the power expended is always the same.		
ii.	Energy is produced in the cores of main sequence stars when lighter elements undergo fusion into heavier elements.		
iii.	Renewable energy sources such as solar or wind power can decrease the reliance on fossil fuels.		
iv.	A falling coin on the moon is an example of a free fall.		
v.	If both liquid A and liquid B receive equal amounts of heat, but the temperature of liquid A increases more than that of liquid B, it indicates that liquid A is more effective as a heat reservoir.		

d) Match each item under Column A with the item in Column B. Write the correct pairs by writing the letter against the number in the answer column.

[5]

Answer	Column A	Column B	
i.	i. Non-ohmic conductor	a. fomentation	
ii.	ii. Acceleration due to gravity is zero	b. transformer	
iii.	iii. High specific heat capacity of water	c. terminal velocity	
iv.	iv. Device that transfers electrical energy between two or more circuits	d. variable resistance	
v.	v. Base of cooking pans are thicker	e. low specific heat capacity	
		f. A.C. generator	
		g. increased heat capacity	

SECTION B [60 MARKS]
ATTEMPT ANY SIX QUESTIONS

Question 2

- a)** List **TWO** benefits of using energy-efficient appliances in households and offices. **[2]**

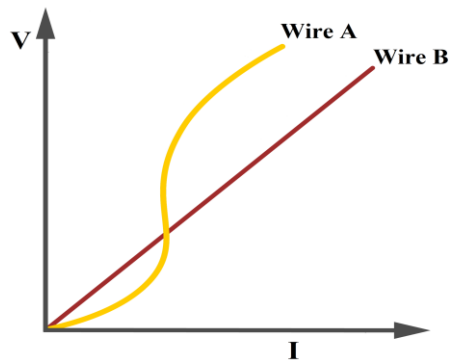
- b)** How does Pascal's Principle apply to the engineering of hydraulic jacks? **[2]**

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- c)** State **ONE** difference between moment of force and moment of couple and provide an example to illustrate each. **[2]**

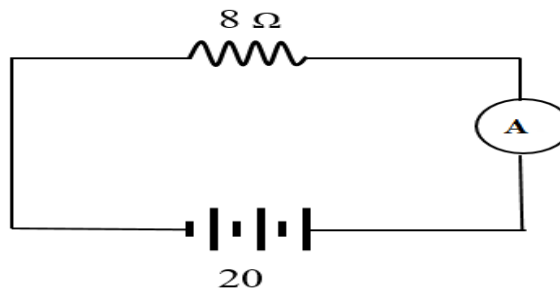
Moment of force	Moment of couple	

- d) The figure below shows a graph plotted for two distinct wires, A and B. Considering the characteristics of the graph, which wire follows Ohm's law? Also, what are the conditions that must remain constant to verify Ohm's law? [2]



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- e) What will be the magnitude of current passing through the ammeter in the depicted circuit? [2]

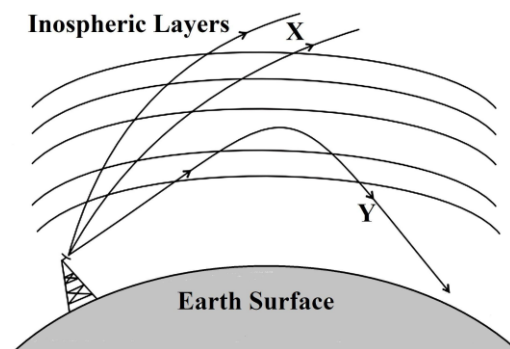


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Question 3

- a) Explain **TWO** factors that influence the Law of Universal Gravitation. [2]

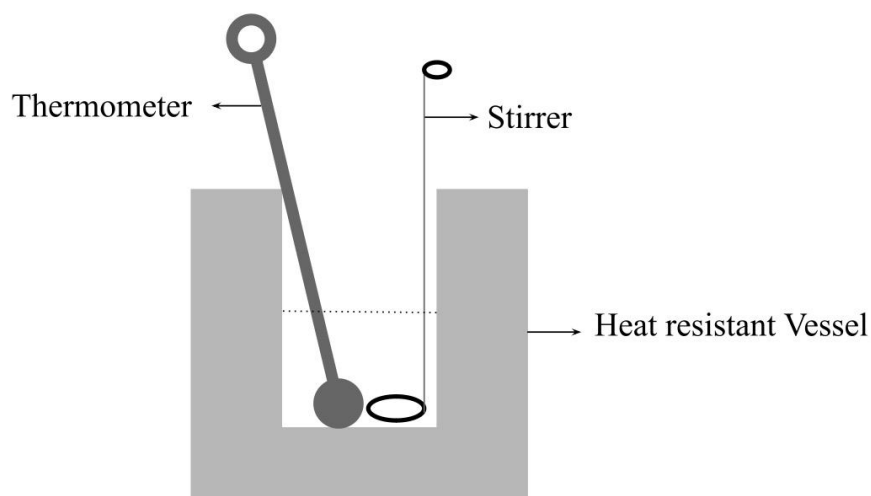
- b) Provide a concise overview of waves X and Y, considering the traits depicted in the figure below. Explain the reason behind wave Y being the primary choice for radio programming by Bhutan Broadcasting Services. [2]



Wave X	Wave Y	
Reason:		

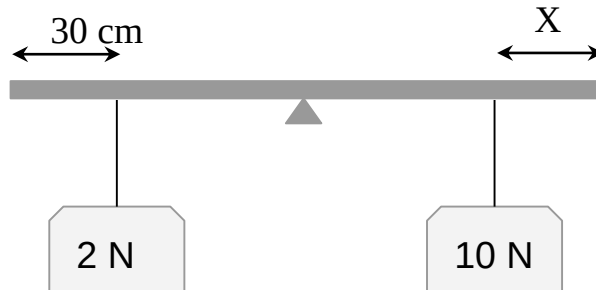
- c) Does Pascal's Principle hold true for gas? What is the reason behind its applicability? **[1]**

- d) A calorimeter measures the change in temperature of substances. To eliminate heat loss to the surroundings and ensure accurate temperature measurements, the calorimeter depicted in the figure below would need to be modified. How would you modify it to achieve zero heat loss to the surroundings? **[2]**



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- e) The figure below shows a 1 m ruler, pivoted at its midpoint. At what distance (X) from the right-hand end of the ruler must the 10 N force be applied to balance the ruler? [3]



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Question 4

- a) In the figure given below, there is a noticeable difference in the distribution of rain droplets. Those closer to the ground are evenly spread out while the droplets closer to the cloud exhibit irregular spacing. Explain. [2]



b) What is the significance of minimizing voltage drop in an electric design? [1]

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c) Design an energy-efficient classroom that integrates efficient appliances, [2]
insulation, and advanced technology, aiming to decrease energy consumption and
waste, conserve natural resources, and minimize environmental impact.

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- d) At the Punakha scouting event, a team of students participated in the creation of a makeshift raft using empty barrels. The objective was to construct a raft that could be propelled in a fast-moving river. Illustrations below are the designs for two such rafts. Complete the table to compare the stability of the two raft designs. [3]

Design A



Design B



	Stability	Position of C.G	Reason	
Design A				
Design B				

- e) A metal piece of mass 0.05 kg and temperature 27°C requires $2.4 \times 10^3 \text{ J}$ of heat to raise the temperature to 327°C. Calculate the specific heat capacity of the metal. [2]

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Question 5

- a) The table below shows the data of an experiment conducted by a student to verify the principle of calorimetry using a calorimeter. [2]

Heat energy lost by substance A	500 J
Heat energy gained by substance B	450 J

Based on the data, was the student able to confirm the principle of calorimetry? Justify your answer.

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- b) An electric wheelchair with the power rating of 300 W and a mass of 50 kg, and a 50 kg occupant, is ascending a long ramp at a steady velocity. How long will it take for the wheelchair to reach the summit of the 10 m high ramp? [2]

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- c) To study the possibility of life in outer space, why is it necessary to examine the conditions necessary for life on the Earth? [2]

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- d) If you were to work in a nuclear power plant, what safety precautions would you prioritize? Suggest **TWO** safety precautions. [2]

- e) Radio waves and gamma rays share similarities in being transverse and electromagnetic waves, as well as having the same speed in a vacuum. However, there are certain differences between the two waves. Write **TWO** differences between them? [2]

Radio Waves	Gamma Rays	

Question 6

- a) An engineering student designed a hydraulic pump to lift a crate weighing 1000 N. The pump consists of two pistons connected by a fluid chamber. The student calculated that the smaller piston, with an area of 50 cm², applies a force of 500 N. What is the area of the larger piston to achieve the desired force? [2]

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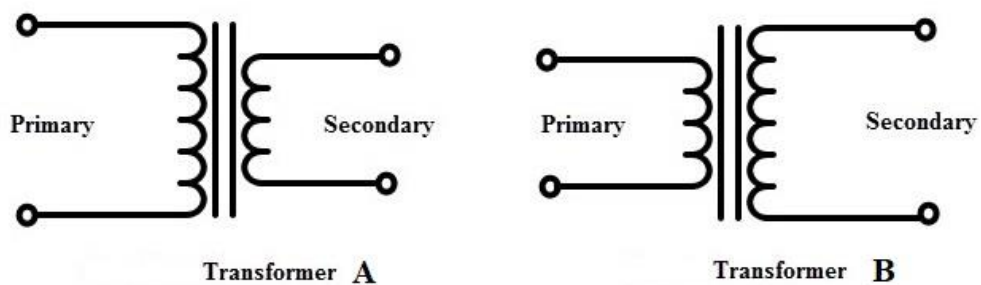
- b) On June 18, 2023, the submersible named Titan suffered a "catastrophic implosion" while descending to the Titanic wreckage site, at an estimated depth of 3,500 m below sea level. Answer the following questions:
- i. What factors could have contributed to this accident? [2]

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- ii. Why do you think it suffered an implosion rather than an explosion? [1]

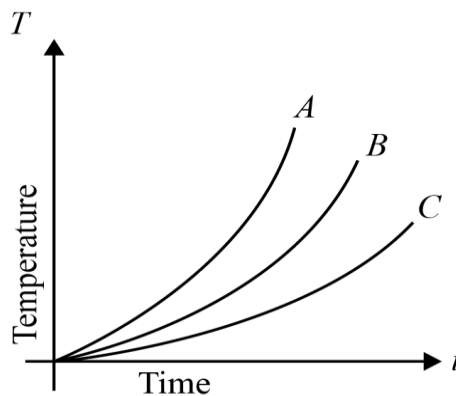
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- c) The figure below shows two different types of transformers, transformer A and transformer B. Which transformer, A or B, would you select to utilize in your cottage industry if you require a higher electrical voltage than what is currently provided by the Bhutan Power Corporation? Provide a reason. [2]



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- d) The figure below illustrates the relationship between temperature changes of three different liquids A, B and C over a period of time.



- Which liquid would you suggest as a coolant for a car radiator? Why? [2]

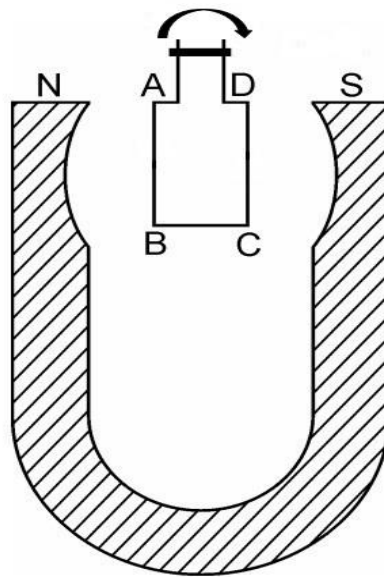
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- e) Does velocity remain constant during free fall? Explain. [1]

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Question 7

- a) In the figure below, a rectangular coil ABCD is suspended between concave pole pieces of a permanent magnet in an AC generator. The coil is parallel to the magnetic fields and rotates in a specified direction. Determine the direction of the current in coil ABCD? Mention the rule used to determine the direction of current. [2]

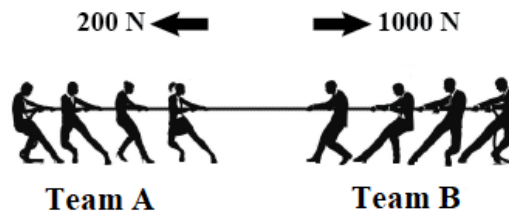


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- b) Considering the increasing number of cell phone users and the widespread adoption of wireless technology in Bhutan, there is a growing apprehension about potential health risks associated with increased exposure to electromagnetic radiation. In your opinion, is it necessary to exercise caution regarding the possible dangers? Provide your reasons. [2]

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- c) The force exerted by each team A and B in a tug of war is shown in the figure below.



[2]

Which team performed positive work? Justify with **ONE** reason.

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- d) Cell phone transmitters are usually located on hill tops. Justify the statement mentioning the characteristics of the microwave. [2]

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- e) A satellite and the Earth experience a gravitational force of 500 N. The distance from the satellite to the center of the Earth is 10×10^6 m. The mass of the Earth is approximately 6×10^{24} kg. Using $G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$, calculate the mass of the satellite. [2]

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Question 8

- a) Which type of electromagnetic wave does a counterfeit money detector utilize? [2]
What specific characteristics of this wave makes it suitable for the device?

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- b) Between the two physical characteristics of mass and charge, which characteristic [2]
determines the ionization potential of particles (α, β, γ), and which characteristic
determines its penetration depth?

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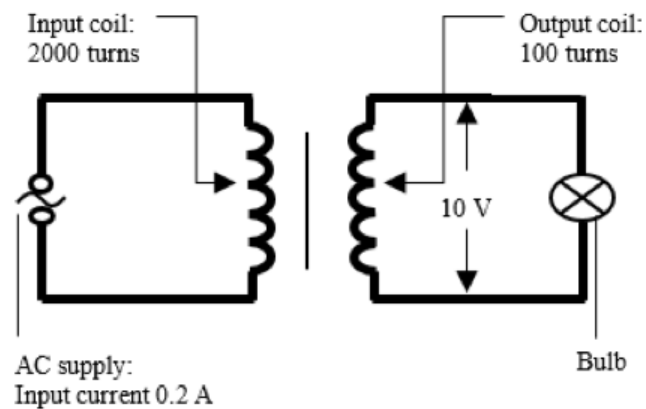
- c) Design a flowchart to determine the center of gravity of an irregular piece of [2]
cardboard.

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- d) Which cools a soft drink faster: (i) ice cubes at 0°C or (ii) iced-water at 0°C ? [2]
Provide a reason for your answer.

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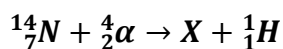
- e) The figure below shows a type of transformer. Assuming that the transformer has an efficiency of 100%, calculate the supply voltage. [2]



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Question 9

- a) The bombardment of alpha particles onto nitrogen-14 nuclei releases protons. The nuclear reaction equation describing this process is

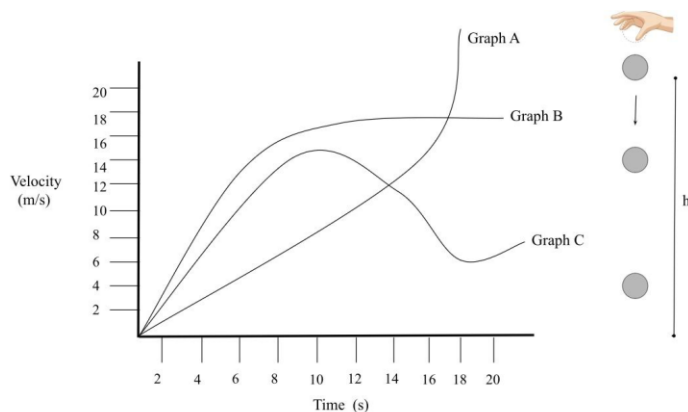


Determine the proton number and nucleon number of nucleus X.

[2]

- b) The figure below represents different types of graphs for the motion of a ball from a height h to reach the terminal velocity. Which graph best depicts this event? Justify your answer with a reason.

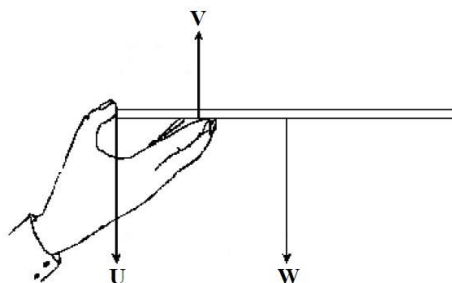
[2]



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- c) In the figure below, a tray is held horizontally using fingers and thumb. The tray experiences three forces, labelled as U, V, and W.

[2]



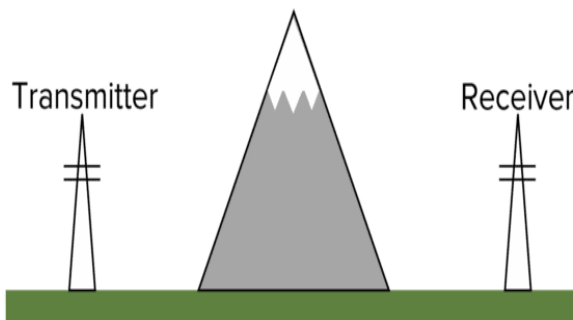
If the tray is to remain horizontal and in equilibrium, identify **TWO** relationships that must hold true between the forces.

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- d) A car with a mass of 1200 kg is moving at a velocity of 15 ms^{-1} . The driver applies the brake, reducing the car's speed by half. Determine the kinetic energy of the car after the brake is applied. [2]

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- e) How do the use of radio waves facilitate communication within the depicted scenario in the figure given below? [2]



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