

GAN ENG SENG SCHOOL
Preliminary Examination 2024



**CANDIDATE
NAME**

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CLASS

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**INDEX
NUMBER**

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PHYSICS

Paper 1 Multiple Choice

6091/01

9 September 2024
1 hour

Sec 4 Express

Additional Materials: OTAS

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class and index number on the OTAS in the spaces provided unless this has been done for you.

There are **forty** questions in this paper. Answer **all** questions. For each question there are four possible answers **A, B, C, and D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate OTAS.

Read the instructions on the OTAS very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

Total Marks
40

1 What is the unit of power expressed in base units?

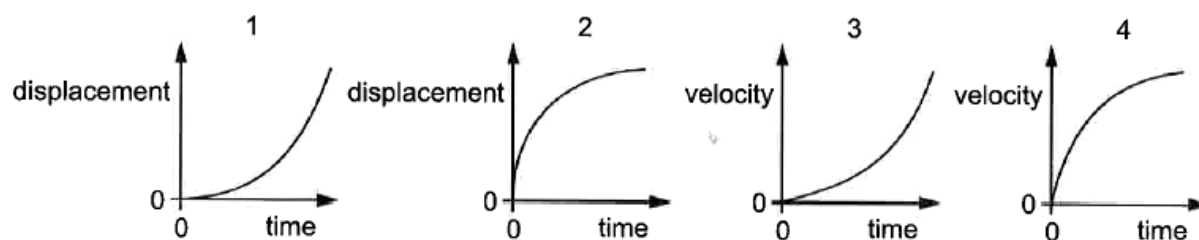
- A** $\text{kg m}^2 \text{s}^{-2}$ **B** $\text{kg m}^2 \text{s}^{-3}$ **C** J/s **D** W

2 What are the orders of magnitude for the diameter of the Earth and for the diameter of an atom?

	diameter of Earth	diameter of atom
A	$1.3 \times 10^{-6} \text{ Gm}$	$1.1 \times 10^{-5} \mu\text{m}$
B	$1.3 \times 10^{-2} \text{ Gm}$	$1.1 \times 10^{-1} \text{ nm}$
C	$1.3 \times 10^{-2} \text{ Tm}$	$1.1 \times 10^{-5} \mu\text{m}$
D	$1.3 \times 10^{-6} \text{ Tm}$	$1.1 \times 10^{-1} \text{ nm}$

3 An apple falls from a tree at the top of a tall cliff. As the apple falls, it experiences air resistance.

Graphs 1 and 2 are displacement-time graphs. Graphs 3 and 4 are velocity-time graphs.



Which graphs describe the motion of the apple?

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

- 4 A volleyball player throws a ball vertically upwards as he prepares to hit the ball as shown.



Air resistance can be ignored. What is the acceleration of the ball just after it leaves his hand and at its highest point?

	acceleration just after leaving hand	acceleration at its highest point
A	10 m/s ² downwards	0
B	10 m/s ² downwards	10 m/s ² downwards
C	10 m/s ² upwards	0
D	10 m/s ² upwards	10 m/s ² downwards

- 5 At lift off, the mass of a Falcon 9 rocket is 549 000 kg. The rocket engine produces a thrust of 7.6 MN. The gravitational field strength g is 10 N/kg. What is the initial acceleration of the rocket?

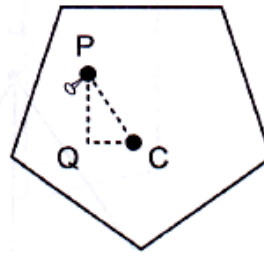
A 13 m/s² **B** 3.8 m/s² **C** 2.4 m/s² **D** 1.4 m/s²

- 6 A spacecraft travels from the Earth to the Moon. At a certain point in the journey, it has zero weight. Why is the weight zero at this point?

A The gravitational fields of the Earth and of the Moon cancel each other.
B The spacecraft leaves the Earth's atmosphere.
C The spacecraft stops moving.
D There is no air resistance on the spacecraft.

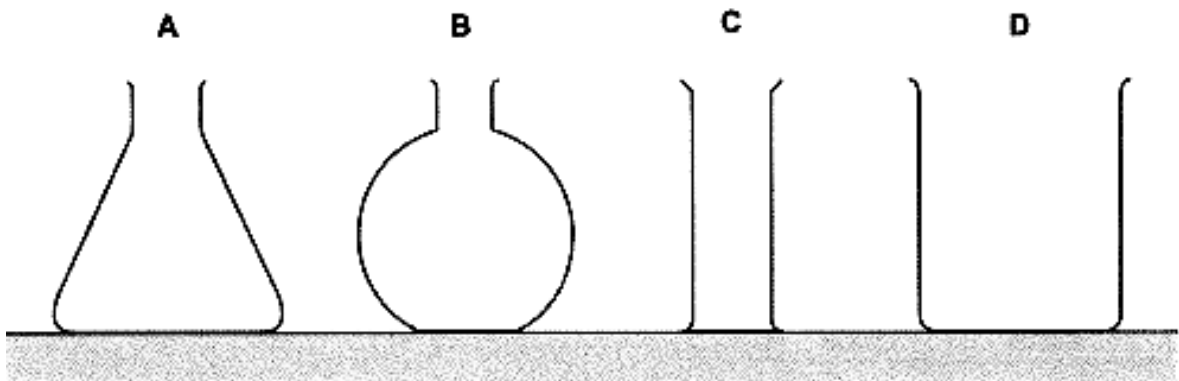
- 7 A pentagon card is freely suspended from point P. The weight of the card is 2.0 N and the centre of gravity is at C.

$$\begin{aligned} PC &= 0.50 \text{ m} \\ PQ &= 0.40 \text{ m} \\ QC &= 0.30 \text{ m} \end{aligned}$$

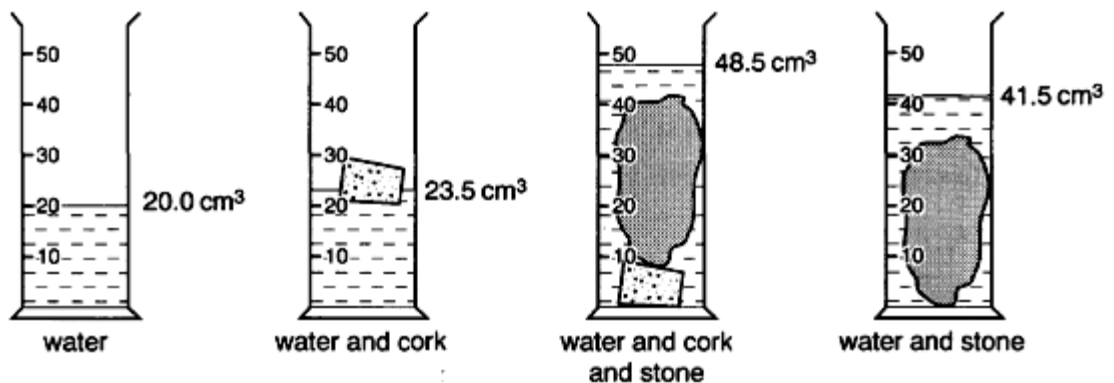


The card is displaced to the position shown. What is the moment that will cause the card to swing?

- A 0.60 N m clockwise B 0.80 N m anticlockwise
C 1.0 N m anticlockwise D 1.0 N m clockwise
- 8 The diagram shows four containers made from thin glass. Which empty container is the **least** stable?



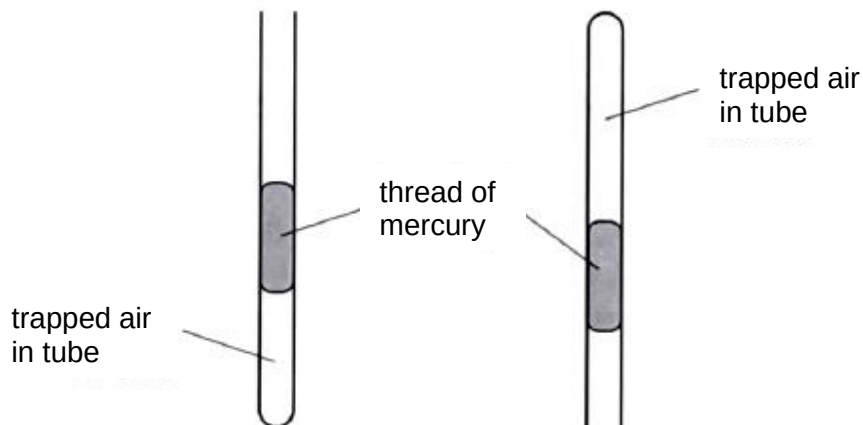
- 9 To determine the density of a piece of cork, Farren must find its mass and volume. The mass of the cork is found to be 1.7 g. To determine the volume of cork, he uses a measuring cylinder. As the cork floats, a stone is used to keep it under water. The results of each stage of the experiment are shown.



What is the density of the cork?

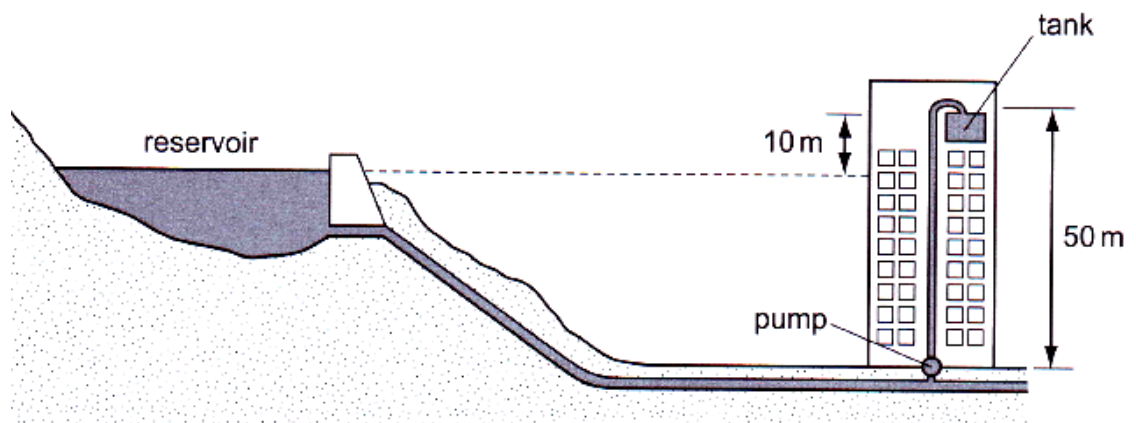
- A 0.04 g cm^{-3} B 0.10 g cm^{-3} C 0.24 g cm^{-3} D 0.49 g cm^{-3}

- 10** A uniform tube, sealed at one end, is held vertically with the closed end at the bottom. It contains a thread of mercury which traps a column of air. The other end of the tube is open to the atmosphere.



When the tube is turned upside down, the volume of the trapped air increases. Which statement explains this?

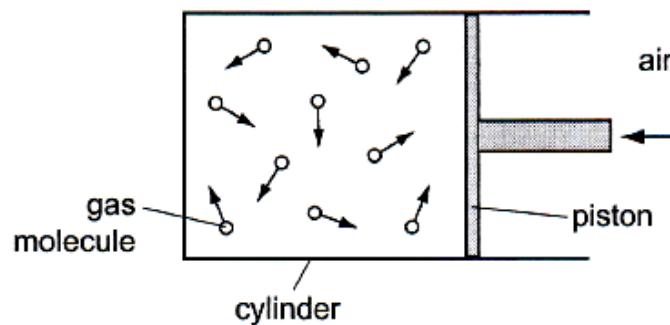
- A** The air gets hotter when the tube is turned upside down.
 - B** The atmosphere pushes less when it acts upwards on the mercury.
 - C** The pressure in the trapped air is reduced.
 - D** The trapped air molecules hit the mercury harder when travelling downwards.
- 11** An apartment block receives water from a nearby reservoir. A pump is necessary to lift the water into a storage tank at the top of the building. The gravitational field strength is 10 N/kg.



How much energy does the pump supply to lift each kilogramme of water into the tank?

- A** 50 J
- B** 100 J
- C** 400 J
- D** 500 J

- 12** A train of mass 30 000 kg is moving along a straight track. The speed of the train decreases from 25 m/s to 15 m/s. How much work is done to slow the train down?
- A** 1.5 MJ **B** 3.4 MJ **C** 6.0 MJ **D** 9.4 MJ
- 13** Which of these statements correctly describes the volume and shape of a solid or liquid at room temperature?
- A** The volume of a solid is fixed but its shape is not fixed.
- B** The volume of a solid is not fixed and its shape is not fixed.
- C** The volume of a liquid is fixed but its shape is not fixed.
- D** The volume of a liquid is not fixed and its shape is not fixed.
- 14** Gas inside a cylinder is cooled slowly to a lower temperature. The pressure inside the cylinder remains constant as the piston moves inwards.



How do the speed of the gas molecules and their rate of collision with the pistons compare with their initial values at the higher temperature?

	speed of molecules	rate of collision
A	lower	greater
B	lower	reduced
C	lower	same
D	same	reduced

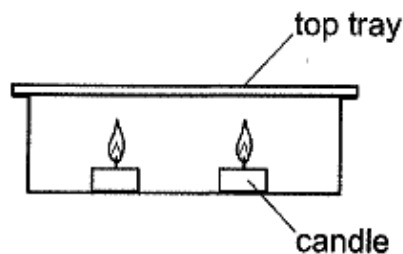
- 15** Four rods, of all exactly the same size, are each placed with one end in boiling water. The times taken for the temperature of the other end to increase by $1\text{ }^{\circ}\text{C}$ are measured.

material of rod	time for $1\text{ }^{\circ}\text{C}$ rise / s
Aluminium	5
copper	2.5
cork	400
styrofoam	600

To make a large metal tank with the least heat loss, which materials should be used for the walls of the tank and its insulation?

	tank	insulation
A	aluminium	cork
B	aluminium	styrofoam
C	copper	cork
D	copper	styrofoam

- 16** The diagram shows a plate-warmer in which candles are used as heaters.



The flames of the candles do not touch the underside of the top tray. How does heat pass to the top tray?

- A** mainly radiation and some conduction
- B** mainly convection and some radiation
- C** mainly conduction and some radiation
- D** mainly conduction and some convection

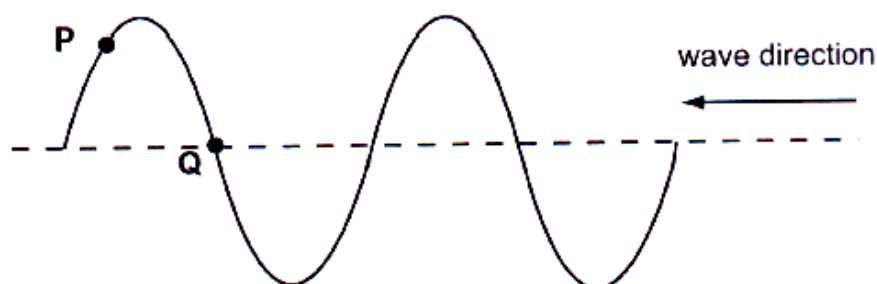
- 17** The mass of a metal pan is 1.5 kg. The pan absorbs 6 900 J of heat and this produces a temperature rise of 5.0 °C. What is the specific heat capacity of the metal and what is the heat capacity of the pan?

	specific heat capacity / J kg ⁻¹ °C ⁻¹	heat capacity / J °C ⁻¹
A	2 070	4 600
B	920	4 600
C	2 070	1 380
D	920	1 380

- 18** The energy required to change water into water vapour at the same temperature is called latent heat of vaporisation. What does this energy do?

- A** increases the average separation of the water molecules
- B** increases the average speed of the water molecules
- C** increases the temperature of the air near the water
- D** splits the water molecules into their separate atoms

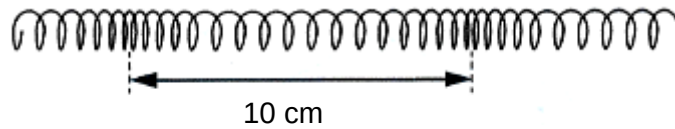
- 19** The diagram shows a wave on a string with two points **P** and **Q** marked. The wave is moving in the direction shown.



What will happen next?

- A** **P** will move to the left.
- B** **P** will move down.
- C** **Q** will not move.
- D** **Q** will move down.

- 20 The diagram shows part of a long stretched spring. A point on the spring moves backwards and forwards between two positions that are 1.2 cm apart.



Which row describes the wave?

	amplitude / cm	wavelength / cm
A	0.6	10
B	0.6	20
C	1.2	10
D	1.2	20

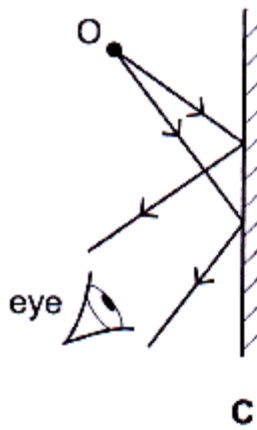
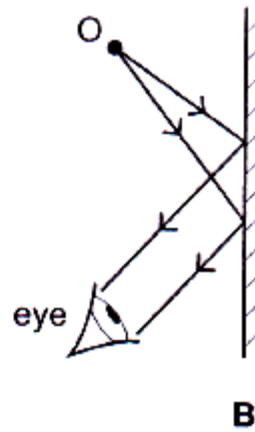
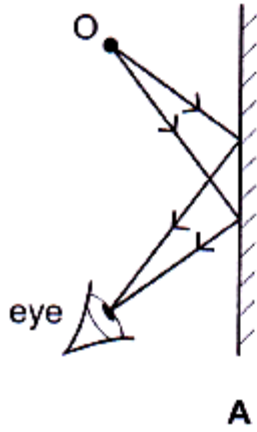
- 21 Which set shows the **widest** range in frequencies among the listed electromagnetic waves?

- A** Infrared radiation, microwaves, ultraviolet radiation and visible light
- B** Infrared radiation, microwaves, radio waves and ultraviolet radiation
- C** Gamma rays, ultraviolet radiation, visible light and X-rays
- D** Gamma rays, microwaves, radio waves and ultraviolet radiation

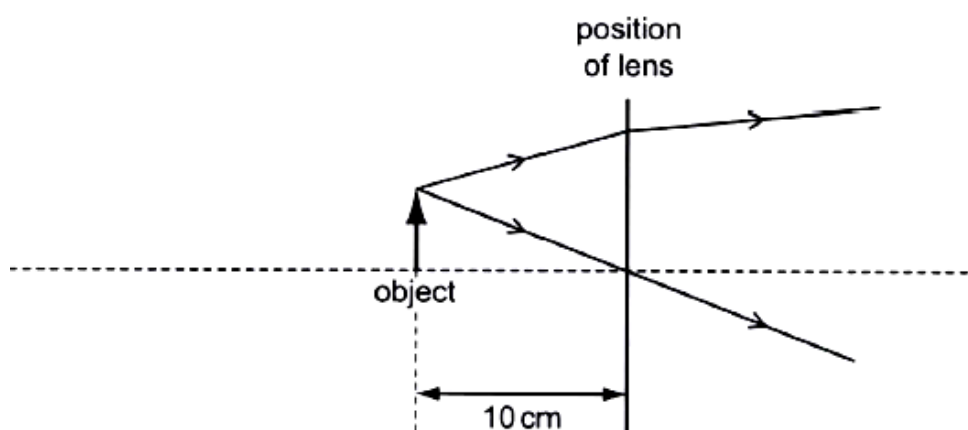
- 22 Which of the following statements about ultraviolet radiation is **incorrect**?

- A** It is used in indoor sunbeds for tanning.
- B** It is used to identify radioactive substances by detecting its emissions.
- C** It is used to kill germs in medical equipment.
- D** It is used to verify bank signatures and to sort mail by causing fluorescence.

- 23 An eye views an object O by reflection in a plane mirror. Which is the correct ray diagram?



- 24 The diagram shows the paths of two rays of light from an object. The object is 10 cm in front of a lens in the position shown.



Which type of lens is it and what is its focal length?

	lens	focal length
A	converging	less than 10 cm
B	converging	more than 10 cm
C	diverging	less than 10 cm
D	diverging	more than 10 cm

- 25 Yu Kai holds a rod in one hand and rubs the rod with a thin sheet of material held in his other hand. Both the rod and the thin sheet become charged and remain charged. From what could the rod and the thin sheet be made?

	rod	thin sheet
A	copper	silk cloth
B	glass	aluminium foil
C	iron	paper handkerchief
D	nylon	woollen duster



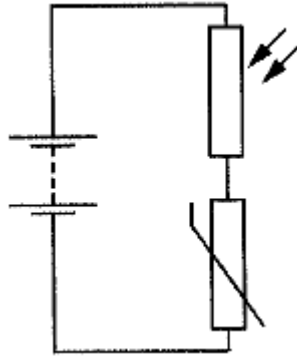
- A** The spaces between their feathers act as insulators.
- B** Their bodies have a very high resistance.
- C** Their feet are very good insulators.
- D** They are not connected to earth.

- | | | | | | |
|----------|--------------|---|----|----|----|
| A | voltage / V | 0 | 1 | 2 | 3 |
| | current / mA | 0 | 6 | 12 | 18 |
| B | voltage / V | 0 | 1 | 2 | 3 |
| | current / mA | 0 | 10 | 20 | 30 |
| C | voltage / V | 0 | 1 | 2 | 3 |
| | current / mA | 0 | 20 | 40 | 60 |
| D | voltage / V | 0 | 1 | 2 | 3 |
| | current / mA | 0 | 25 | 45 | 60 |

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A brighter than normal **B** dimmer than normal

C normal **D** very dim (cannot be seen)



A bright and cold **B** bright and hot

C dark and cold **D** dark and hot

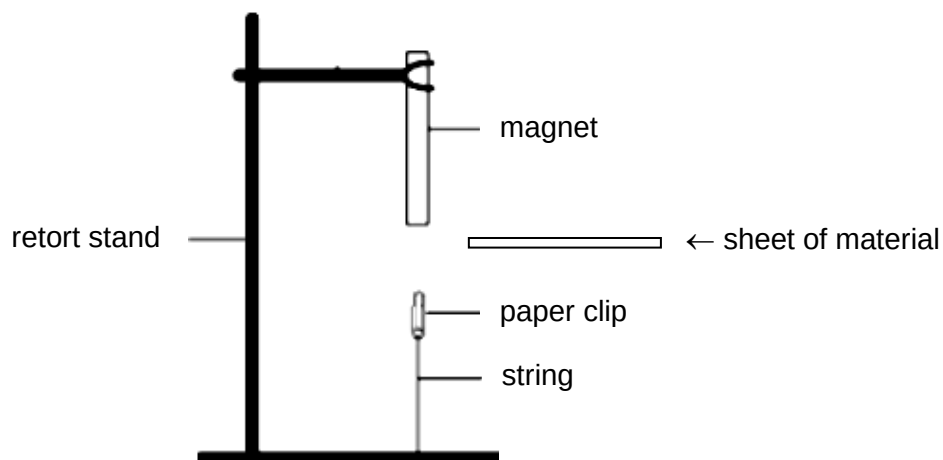
cost of wind turbine	cost of installation	cost of maintenance yearly	power output of wind turbine	average period of effective wind daily
\$5 000	\$2 000	\$200	1 kW	12 h

A 5 years **B** 10 years **C** 15 years **D** 20 years

A The fuse in the plug blows. **B** The metal case becomes live.

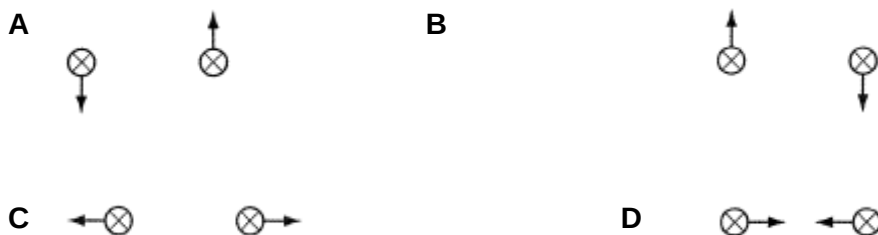
C The vacuum cleaner catches fire. **D** The vacuum cleaner does not work.

- 33** What correctly describes the field produced in the region surrounding a solenoid that carries a steady current?
- A** A region where electric charges gain energy.
 - B** A region where magnetic poles gain energy.
 - C** A region where magnetic poles experience a force.
 - D** A region where stationary electric charges experience a force.
- 34** A paper clip is held stationary in the air by the force of attraction from a magnet as shown.

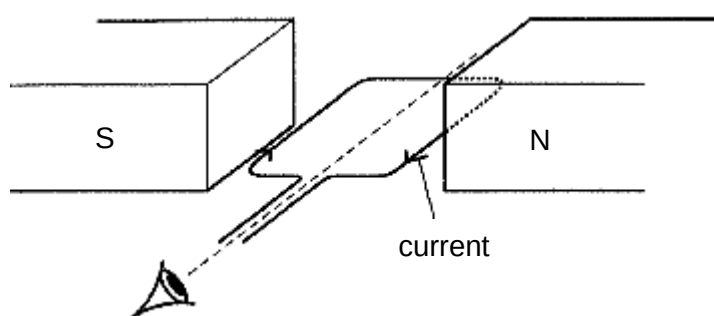


Four different sheets of material (copper, iron, plastic and steel) are inserted in between the magnet and the paper clip (one sheet at a time). Which material(s) will cause the paper clip to drop?

- A** copper
 - B** plastic
 - C** copper and plastic
 - D** iron and steel
- 35** Each diagram is a cross-section through two parallel current-carrying conductors. Which diagram shows the forces on the two conductors?



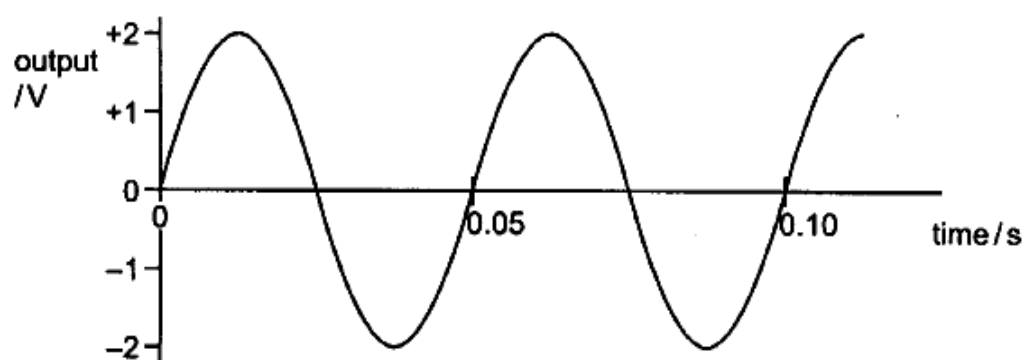
- 36** The diagram shows a pivoted coil held between the two poles of a magnet. The pivoted coil carries a steady current in the directions shown.



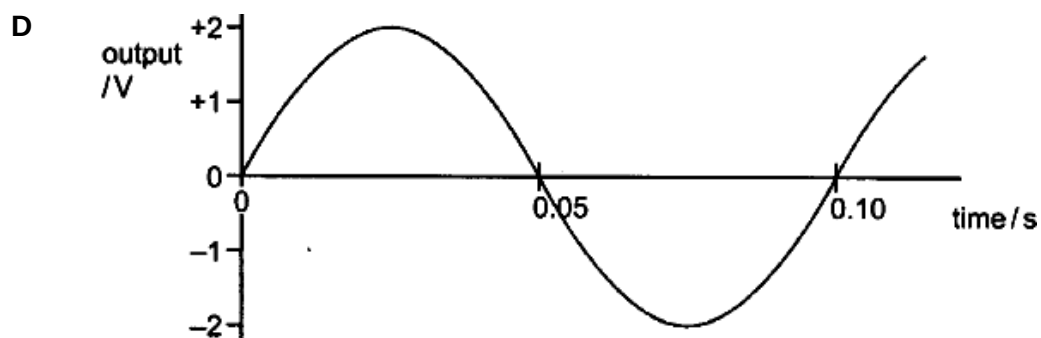
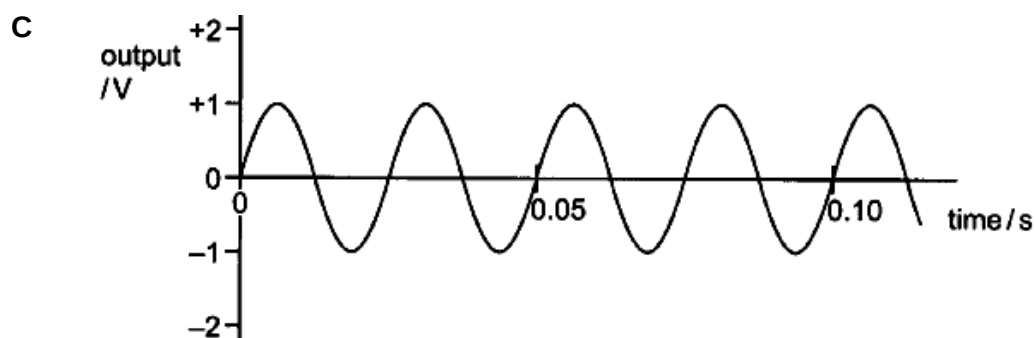
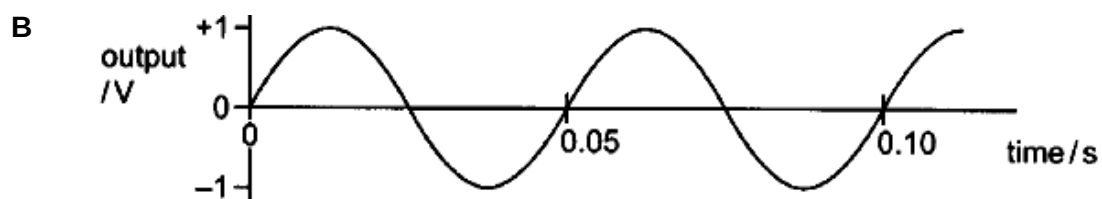
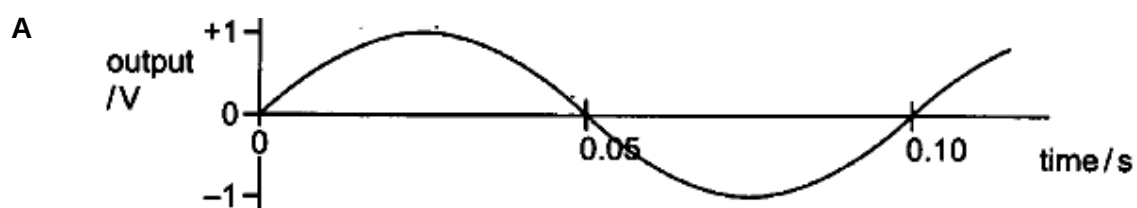
When the coil is released, it rotates and then stops at angle θ to its initial position. When viewed as shown, in which direction does the coil rotate and what is the value of θ ?

	direction	$\theta / ^\circ$
A	anticlockwise	90
B	anticlockwise	180
C	clockwise	90
D	clockwise	180

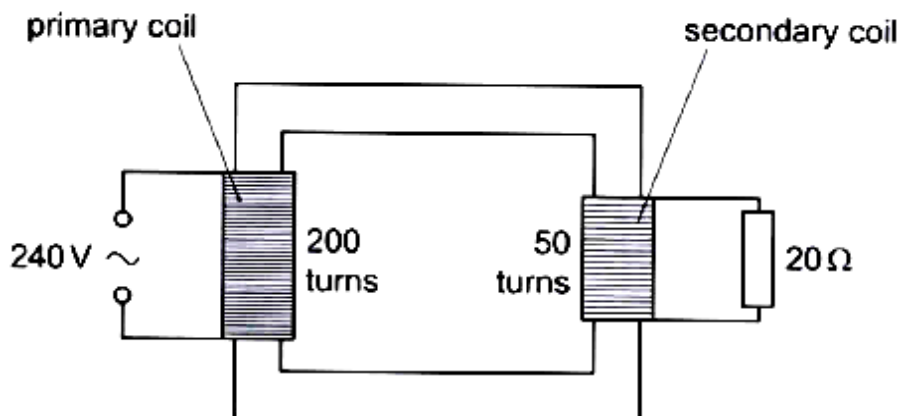
- 37 The graph shows the output of an a.c. generator. The coil in the generator rotates 20 times in one second.



Which graph shows the output when the coil rotates 10 times in one second?



- 38 A transformer has 200 turns on the primary coil and 50 turns on the secondary coil which is connected to a $20\ \Omega$ resistor. The current in the primary coil is 0.60 A . Losses in the transformer cause the current in the secondary coil to be 90 % of the value for an ideal transformer.

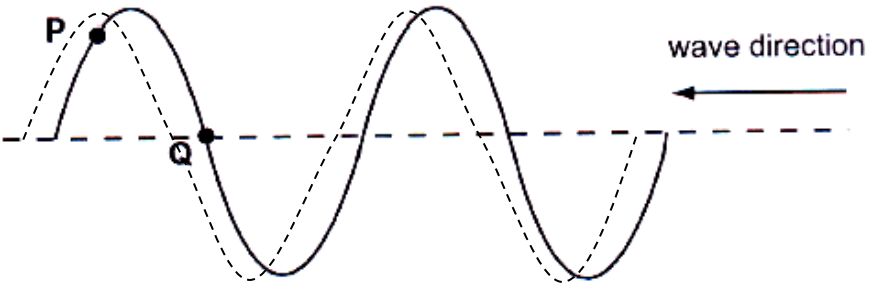


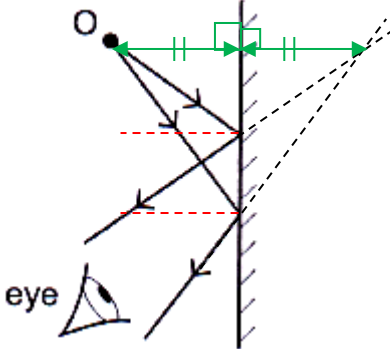
What is the current in the **secondary** coil?

- A 2.16 A B 2.40 A C 2.70 A D 3.00 A
- 39 A radioactive nuclide $^{226}_{88}\text{Ra}$ decays by emission of two alpha particles, one beta particle and gamma rays. Which of the following is the resulting nuclide X?
- A $^{218}_{85}\text{X}$ B $^{218}_{83}\text{X}$ C $^{222}_{85}\text{X}$ D $^{222}_{87}\text{X}$
- 40 The half-life of a radioactive substance Y is 6 days. The mass of Y is 16 mg. What will be the mass of Y that has decayed after 18 days?
- A 2 mg B 5.3 mg C 10.7 mg D 14 mg

END OF PAPER

Question	Answer	Explanation
1	B	$[\text{power}] = \text{work done} / \text{time}$ $= (\text{force} \times \text{distance}) / \text{time}$ $= (\text{kg m s}^{-2} \times \text{m}) / \text{s}$ $= \text{kg m}^2 \text{s}^{-3}$
2	B	The diameter of Earth is $1.3 \times 10^7 \text{ m}$ (i.e. $1.3 \times 10^{-2} \text{ Gm}$) and the diameter of an atom is $1.1 \times 10^{-10} \text{ m}$ (i.e. $1.1 \times 10^{-1} \text{ nm}$).
3	D	As the apple falls, it experiences increasing air resistance and falls at an increasing velocity at a decreasing rate until its weight is the same as air resistance. Then it will fall at terminal velocity (Graph 4). Since its velocity is increasing and the gradient of displacement-time graph represents velocity, the gradient of the displacement-time graph must be getting steeper (Graph 1).
4	B	The acceleration due to gravity, g , on Earth is 10 m/s^2 towards the Earth (i.e. downwards). Since the ball is moving vertically, it experiences g .
5	B	$\uparrow (7.6 \times 10^6) - (549\,000 \times 10) = 549\,000 \text{ a}$ $\uparrow a = 3.8 \text{ m/s}^2$
6	A	Earth will exert a gravitational force on the spacecraft. Moon will also exert a gravitational force on the spacecraft. The weight of the spacecraft will be zero if these two forces cancel each other.
7	A	Taking moment about P, the card will rotate in the clockwise direction. $\text{Moment} = 2.0 \text{ N} \times 0.30 \text{ m}$ $= 0.60 \text{ N m}$
8	C	It has the smallest base area. When displaced, the line of action of its weight falls outside its original base area first as compared to the other three containers.
9	C	$\text{density} = \text{mass} / \text{volume}$ $= 1.7 / (48.5 - 41.5)$ $= 0.24 \text{ g cm}^{-3}$
10	C	When the tube is upright, atmospheric pressure + mercury pressure = trapped air pressure. When the tube is inverted, trapped air pressure + mercury pressure = atmospheric pressure. For a fixed mass of gas at constant temperature (i.e. room temperature), its pressure is inversely proportional to its volume. Since trapped air pressure has decreased when the tube is inverted, its volume must increase.
11	B	The reservoir is at 40 m above the pump while the tank is at 50 m above the pump. $E_p = mgh$ $= 1 \text{ kg} \times 10 \text{ N/kg} \times 10 \text{ m}$ $= 100 \text{ J}$
12	C	$E_k = \frac{1}{2} mv^2$ $= (\frac{1}{2} \times 30\,000 \times 25^2) - (\frac{1}{2} \times 30\,000 \times 15^2)$ 6 MJ
Question	Answer	Explanation

13	C	A solid has fixed volume and fixed shape whereas a liquid has a fixed volume but no fixed shape.
14	A	As the temperature decreases, gas molecules move at a lower speed and hit the cylinder with a smaller force. The volume of piston decreases, thus the number of gas molecules per unit volume increases and the rate of collision becomes greater. Hence the pressure inside the cylinder remains the same.
15	B	Copper is a better conductor of heat than aluminium. Styrofoam is a better insulator than cork. To make a large metal tank with the least heat loss, aluminium and styrofoam should be used as both of them take a longer time to increase temperature by 1 °C when compared to copper and cork respectively.
16	B	Air is a poor conductor of heat. Hence, heat transfer by conduction is the minimal. Heat from the flames of the candles will set up convection currents whereby warm, less dense air rises while cool, denser air sinks. Radiation occurs everywhere. The main heat transfer to the top tray is by convection from the air and some radiation.
17	D	$Q = mc\Delta\theta$ $6\,900 = 1.5 \times c \times 5$ $c = 920 \text{ J kg}^{-1} \text{ }^{\circ}\text{C}^{-1}$ $C = mc$ $= 1.5 \times 920$ $= 1\,380 \text{ J }^{\circ}\text{C}^{-1}$
18	A	To change from liquid to gas, the arrangement of water molecules changed from closely packed (i.e. water) to far apart (i.e. water vapour). The average separation of the water molecules increases.
19	D	
20	A	A point on the spring moves backwards and forwards between two positions (i.e. covered two amplitudes) that are 1.2 cm apart. Hence, amplitude = 0.6 cm. Wavelength is the distance between two successive centres of compression (i.e. 10 cm).
21	D	The electromagnetic spectrum consists of radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays and gamma rays (in order of increasing frequencies). Hence, the widest difference in frequencies is between radio waves and gamma rays.
22	B	The emission of gamma rays is detected to identify radioactive substances.
Question	Answer	Explanation

23	C	 The angle of incidence is equal to the angle of reflection. The perpendicular distance between object O and mirror is the same as that between image and mirror.
24	B	The top light ray is converging (whether it is travelling from left to right or right to left of the lens by the principle of reversibility of light). Hence the lens is a converging lens. To have a virtual, upright and magnified image as shown in the diagram, the object must be placed less than one focal length. Hence the focal length of the lens is more than 10 cm.
25	D	Both the rod and the thin sheet must be insulators so that they can be charged by friction upon rubbing. Otherwise, it will be earthed by Yu Kai who is a large neutral conductor.
26	B	The negative charge will be attracted to the positive plate as unlike charges attract. The negative charge will be repelled from the negative plate as like charges repel. Hence the positive plate is on the left and the negative plate is on the right of the charge. The direction of electric field is from the positive to the negative plate (i.e. horizontally to the right).
27	D	As the birds are not connected to earth (i.e. 0 V), there is no potential difference between them and the line, thus current does not flow.
28	D	A torch bulb is non-ohmic. At higher voltage, the temperature of the bulb increases and its resistance becomes larger.
29	A	The total resistance of the circuit decreases when lamp Z is connected in parallel with lamp Y. There will be more current flowing through the circuit, thus lamp X will be brighter than normal.
30	D	The lower the light intensity (i.e. dark), the higher the resistance of LDR. The higher the temperature (i.e. hot), the lower the resistance of thermistor. For p.d. across the thermistor to be the smallest, its resistance must be the lowest. Since LDR and thermistor are connected in series, the p.d. across them are shared according to their resistance. The higher the resistance, the higher the p.d. across it.

Question	Answer	Explanation
31	A	Energy output yearly = $1 \text{ kW} \times 12 \text{ h} \times 365 \text{ days}$ $= 4\,380 \text{ kWh}$ Amount of money saved yearly = $4\,380 \times \\$0.40$ $= \\$1\,752$ Number of years to recover cost = $(5\,000 + 2\,000) / (1\,752 - 1\,552)$ $\approx 5 \text{ years}$
32	B	When the live wire touches the earth wire, an electric shock or a fire is likely to occur as this would make a complete circuit from the mains supply to the ground (i.e. earth). The metal case becomes live and an electric shock or a fire is likely to occur.
33	C	When there is a current flowing through a solenoid, it creates a magnetic field around the solenoid. A magnetic field is a region where magnetic poles experience a force.
34	D	Magnetic field lines prefer to flow in magnetic materials. Copper and plastic are non-magnetic materials and magnetic field lines will pass through them to attract the paper clip. Iron and steel are magnetic materials which will absorb magnetic field lines (i.e. magnetic shielding).
35	D	Current in both wires is flowing into the page. There is a clockwise magnetic produced around each wire. There is a stronger magnetic field around the wires than in between the wires. Hence, the two wires will be attracted to each other.
36	C	Using Fleming's Left-Hand Rule on the left side of the coil, middle finger points into the page, index finger points to the left (from N to S), the thumb will point up. There is an upward force acting on the left side of the coil and a downward force acting on the right side of the coil. Hence, the coil rotates in a clockwise direction. It will stop at 90° as there is no split ring commutator to reverse the direction of current in it to ensure continuous rotation in one direction.
37	A	When the coil rotates 10 times in one second, its speed is halved (from 20 s^{-1} to 10 s^{-1}). The time taken for one rotation will be 0.10 s. The magnitude of the induced e.m.f. in the coil will also be halved (from 2 V to 1 V).
38	A	$N_p / N_s = V_p / V_s$ $200 / 50 = 240 / V_s$ $V_s = 60 \text{ V}$ 90 % of input power = output power $0.9 \times 0.60 \times 240 = I_s \times 60$ $I_s = 2.16 \text{ A}$
39	A	${}^{226}_{88}\text{Ra} \rightarrow {}^{218}_{85}\text{X} + 2 {}^4_2\alpha + {}^0_{-1}\beta + \gamma$
40	D	Y will undergo $18 / 6 = 3$ half-lives. $16 \text{ mg} \rightarrow 8 \text{ mg} \rightarrow 4 \text{ mg} \rightarrow 2 \text{ mg}$ The mass of Y that has decayed is $16 - 2 = 14 \text{ mg}$.