Anglo-Chinese School (Barker Road)

PRELIMINARY EXAMINATION 2024

SECONDARY FOUR EXPRESS

PHYSICS 6091/01
PAPER 1

TIME: 1 HOUR

INSTRUCTIONS TO CANDIDATES:

Write your name and index number on the OMR Answer Sheet.

There are **forty** questions in this section. 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 OMR sheet.

The OMR Sheet is to be **submitted separately**.

INFORMATION FOR CANDIDATES:

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.

This question paper consists of **17** printed pages

1 Which of the following list of SI units contains base units only?

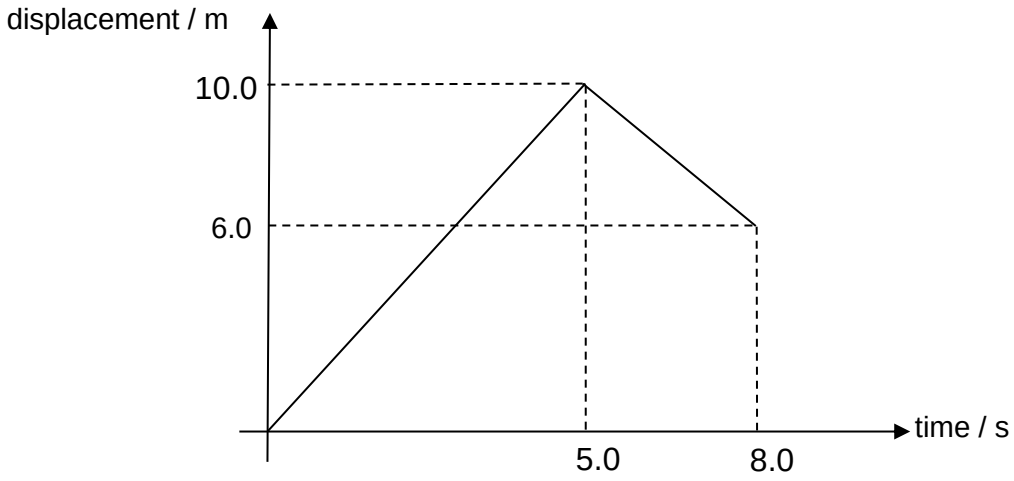
A ampere, kilogram, hour, volt
B ampere, kilogram, kilometre, second
C kelvin, metre, mole, second
D kelvin, metre, second, volt

2 Nano-technology is about manipulating substances at the nanometre scale. Within 1 nanometre space, 10 hydrogen atoms can be placed side by side.

What is the approximate diameter of one hydrogen atom?

A 10^{-4} cm **B** 10^{-4} dm **C** 10^{-4} µm **D** 10^{-4} mm

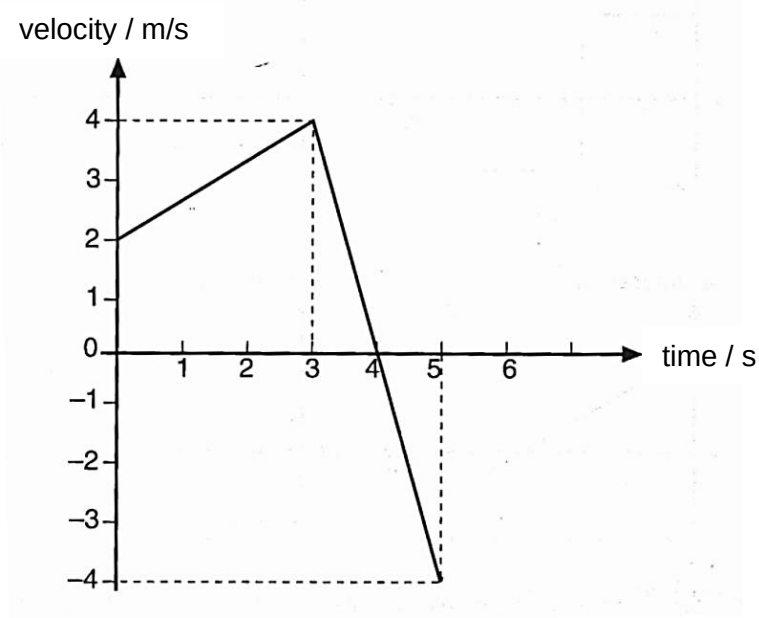
3 The diagram shows how the displacement of a car varies with time.



What is the average speed of the car?

A 0.75 m/s **B** 1.25 m/s **C** 1.75 m/s **D** 2.0 m/s

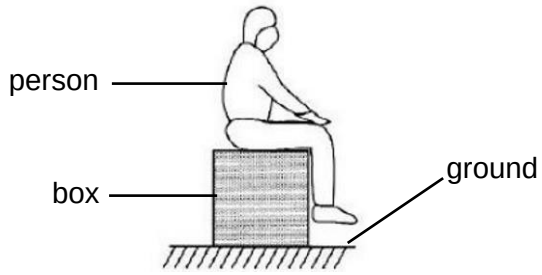
4 The diagram shows how the velocity of a body varies with time.



What is the displacement of the body at the end of 5 s?

A 4.0 m **B** 9.0 m **C** 11.0 m **D** 13.0 m

5 The figure below shows a person sitting on a box that rests on the ground.



Which of the following action-reaction pairs is correct?

A The weight of the box and the normal force from the ground on the box.

B The weight of the man and the normal force from the box supporting the man.

C The weight of the man and the contact force on the box by the man.

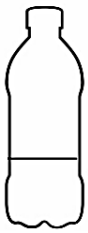
D The weight of the man and the force of man on Earth.

6 A hammer hits a nail on a piece of wood with a speed of 6 m/s. If it drives the nail 0.1 m into the wood, what is the average deceleration of the hammer?

A 18 m/s^2 **B** 60 m/s^2 **C** 120 m/s^2 **D** 180 m/s^2

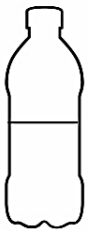
7 Four identical bottles are filled with different amounts of water. Which bottle has the lowest centre of gravity?

A



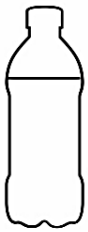
quarter-filled bottle

B



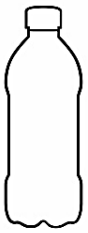
half-filled bottle

C



¾ filled bottle

D



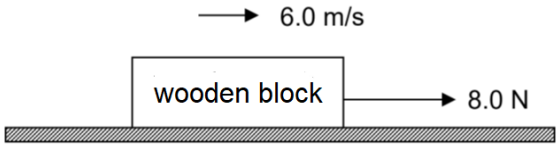
almost fully filled bottle

8 An Eskimo stands on snow wearing snow-shoes. The mass of the Eskimo is 40 kg and the snow-shoes have a total area of 0.50 m^2 in contact with the snow. The gravitational field strength *g* is 10 N/kg.

What pressure does the Eskimo exert on the snow?

A 20 N/m^2 **B** 80 N/m^2 **C** 200 N/m^2 **D** 800 N/m^2

9 A block of wood is pulled along a horizontal bench at a constant speed of 6.0 m/s by a force of 8.0 N.



How much work is done against the frictional force in 5 s?

A 40 J

B 48 J

C 240 J

D 480 J

10 In a power station, fossil fuel is used to boil the water into steam. The steam is then used to rotate turbines which power generators.

Which of the following represents the main energy conversion taking place?

A chemical potential energy→ thermal energy→ electrical energy→ kinetic energy

B chemical potential energy→ thermal energy→ kinetic energy → electrical energy

C kinetic energy→ thermal energy→ chemical potential energy→ electrical energy

D kinetic energy→ thermal energy→ electrical energy→ chemical potential energy

11 When fine pollen grains suspended in water are viewed under a microscope, they are seen to be making small erratic movements.

What is the explanation for this observation?

A There are convection currents in the water.

B The pollen grains are being bombarded by other suspended particles.

C The pollen grains are being bombarded by water molecules.

D The pollen grains are colliding with one another.

12 Air is pumped into a bicycle tyre. The volume and temperature of the tyre remains constant.

Why does the pressure increase?

A Air molecules are closer together.

B Air molecules are hitting the walls of the tyre with a higher frequency.

C Air molecules have a smaller intermolecular forces of attraction.

D Air molecules have higher kinetic energy.

13 Which statements best describe thermal energy transfer between two objects?

(i) Energy transferred from a body with higher amount of thermal energy to one with lower amount of thermal energy.

(ii) Energy transferred from a body with higher temperature to one with lower temperature.

(iii) There is no net transfer of energy when the temperatures of the two objects are the same.

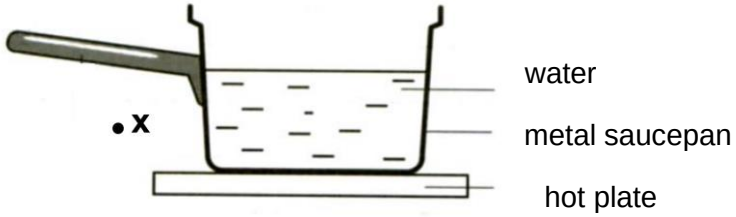
A **(i)** and **(ii)** only

B **(i)** and **(iii)** only

C **(ii)** and **(iii)** only

D All of the above

14 The diagram shows a metal saucepan filled with water and placed on a hot plate. After some time, the air at point **x** also becomes hot.



What are the main ways by which heat travels through the materials?

	through base of saucepan	through water	through air to point **x**
A	conduction	convection	convection
B	conduction	convection	radiation
C	radiation	convection	conduction
D	radiation	conduction	radiation

15 A block of iron and a volume of water both with a mass of 2.0 kg are heated to the same temperature and then allowed to cool in a room.

Why does the iron cool more quickly than the water?

A Iron has a higher specific heat capacity than water.

B Iron has a higher specific latent heat of fusion than water.

C Iron has a lower specific heat capacity than water.

D Iron has a lower specific latent heat of fusion than water.

16 Which statement about boiling and evaporation is correct?

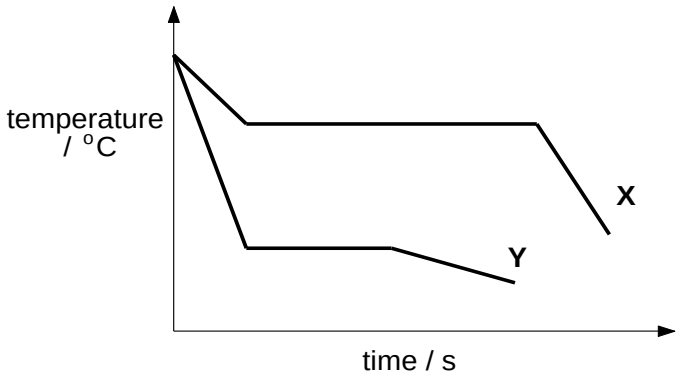
A Boiling only occurs at the surface of a liquid.

B Bubbles are not formed in the liquid during boiling.

C Evaporation is not affected by the surface area of the liquid.

D Evaporation occurs at any temperature.

17 Two liquids, X and Y are cooled in air. Their cooling curves are shown below.



If X and Y have the same mass, which of the following statements is/are correct?

I X has a higher melting point than Y.
II X has a larger specific latent heat of fusion than Y.
III X has a greater specific heat capacity of air than Y.

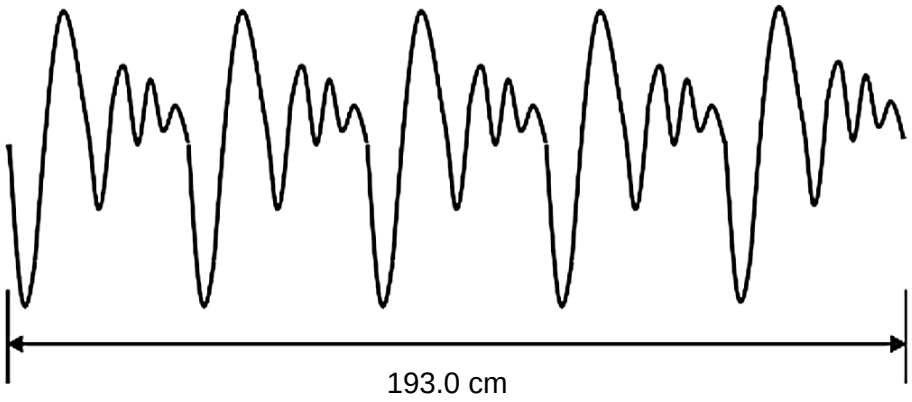
A I only

B II only

C I and II only

D I, II and III

18 The sound wave produced by a violin in an auditorium is shown in the diagram below.



What is the frequency of the sound made by the violin if the speed of sound in the auditorium is 340 m/s?

A 176 Hz **B** 352 Hz **C** 528 Hz **D** 881 Hz

19 Which of the following correctly describes the changes in the loudness and pitch of the sound heard by an observer when the amplitude and frequency of the sound wave produced by a speaker are increased?

	loudness	pitch
A	increases	increases
B	increases	decreases
C	decreases	increases
D	decreases	decreases

20 A man stands in front of a large wall. He claps two pieces of wood together regularly at 0.5 s interval such that the echo of the first clap coincides with the second clap. The speed of sound in air is 340 m/s.

What is the approximate distance between the man and the wall?

A 85 m

B 170 m

C 255 m

D 340 m

21 Which statement is correct?

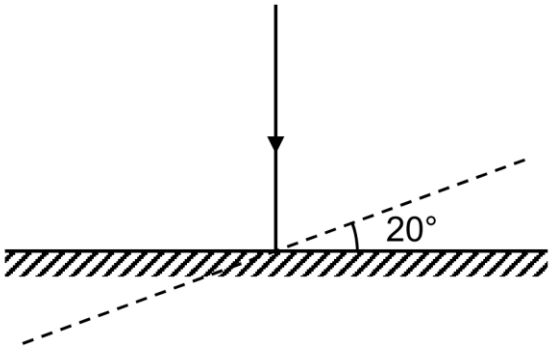
A All electromagnetic waves can ionise and damage living cells.

B All electromagnetic waves travel at the same speed in a vacuum.

C All transverse waves are electromagnetic waves.

D All transverse waves travel parallel to the direction of vibrations.

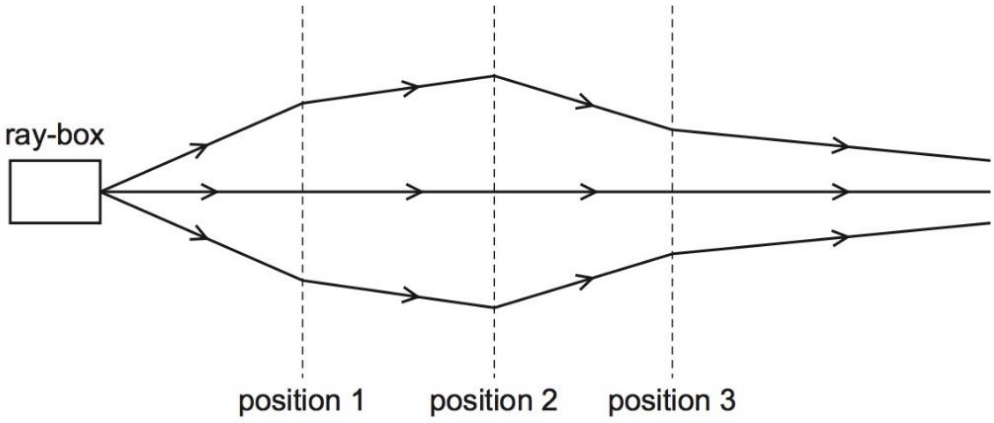
22 A ray strikes a plane mirror perpendicularly as shown in the diagram below.



If the mirror is then turned by 20°, what is the new angle between the incident and the reflected rays?

A 0 ° **B** 20 ° **C** 40 ° **D** 80 °

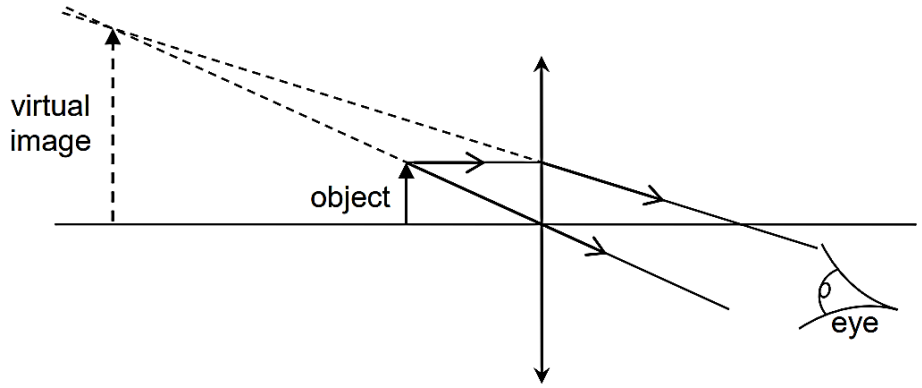
23 The rays of light from a ray-box pass through three lenses placed at positions 1, 2 and 3.



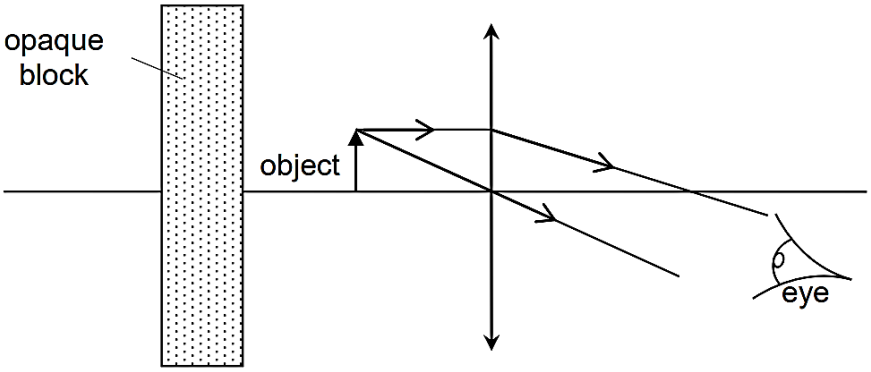
What type of lens is used at each position?

	position 1	position 2	position 3
A	converging	converging	converging
B	converging	converging	diverging
C	diverging	converging	diverging
D	diverging	diverging	converging

24 A thin converging lens is used to form a virtual image observed by an eye as shown below.



An opaque block is then placed behind the object as shown below.



What will be the image observed by the eye?

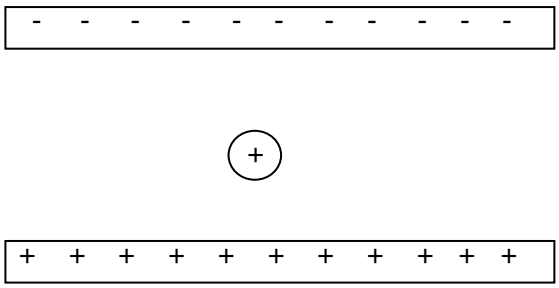
A A real image will be observed.

B A virtual image will be observed but less sharp.

C No image will be observed.

D The same virtual image will be observed with no changes.

25 The diagram below shows a side view of a charged oil droplet at rest between two charged metal plates.



The voltage across the charged plates is doubled. What will happen to the oil droplet?

A The oil droplet rises a little.

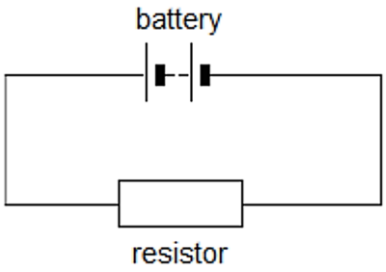
B The oil droplet rises all the way until it touches the negative plate.

C The oil droplet moves parallel to the plates.

D The oil droplet remains stationary.

26 The diagram shows a resistor connected to a battery.

40 J of energy are delivered by the battery to the resistor. 5 C of charge flow through the resistor in 1.25 s.



Which statement is correct?

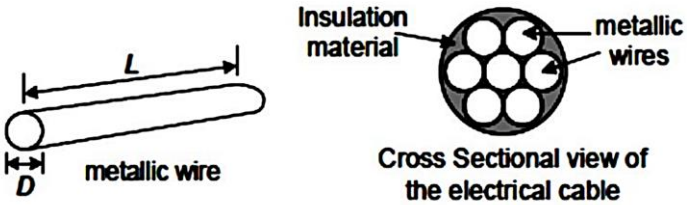
A The current flowing through the battery is 6.25 A.

B The electromotive force is 8 V.

C The power dissipated by the resistor is 50 W.

D The resistance of the resistor is 32 Ω.

27 A metallic wire of resistivity ρ has a length L and a diameter D. Seven strands of this wire is bundled together to create an electrical cable as shown.



Which of the following is true?

A The electrical cable has resistance about 7 times that of the original wire.

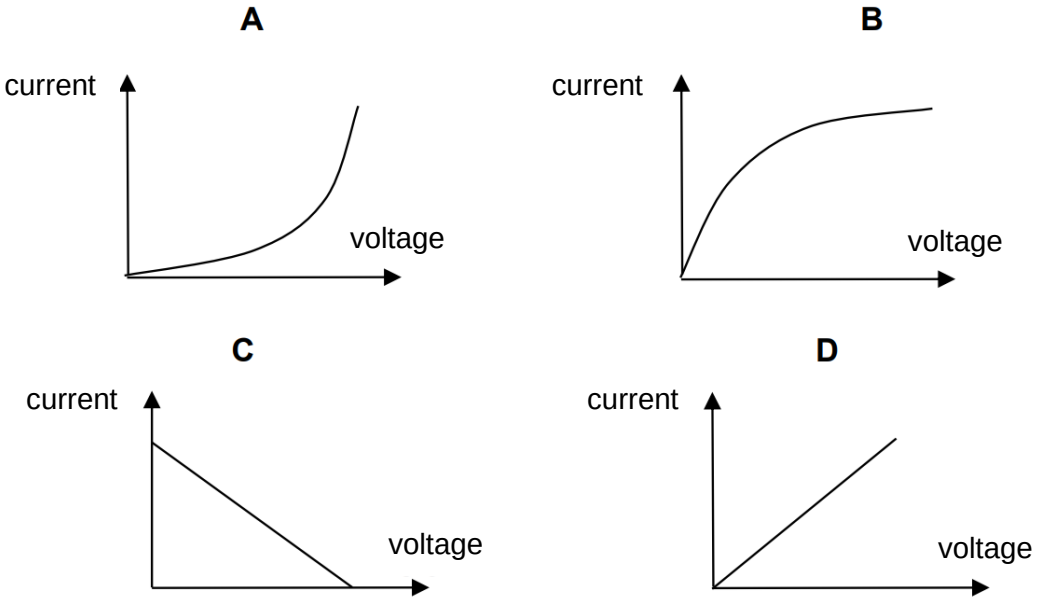
B The electrical cable has resistance about 1/7 times that of the original wire.

C The resistance of the electrical cable is equivalent to a single wire of diameter 7D.

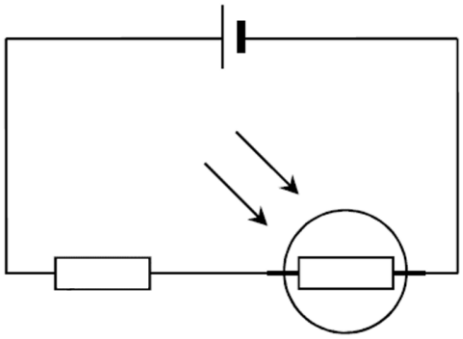
D The resistance of the electrical cable is equivalent to a single wire with diameter 3D.

28 An electrical component has a variable resistance such that its resistance decreases with increasing current flowing through it.

Which one of the following graphs best represents how the current varies with the voltage of the electrical component?



29 The circuit diagram below shows a fixed resistor and a LDR connected in series in a circuit.



What happen to the resistance of the LDR and the potential difference across it when the circuit is placed in a dark place?

	resistance	potential difference
A	decrease	increase
B	decrease	decrease
C	increase	increase
D	increase	decrease

30 A 240 V electrical appliance is used for 5.0 minutes. The current in the appliance is 4.0 A.

How much electrical energy is used?

A 3.2 J

B 190 J

C 4800 J

D 288 000 J

31 Four 200 W lamps and two 120 W fans are switched on in a house. The unit cost for electricity is 15 cents per kWh.

What is the total cost of using all the lamps and fans for 8 hours?

A $0.38

B $0.53

C $1.25

D $1.10

32 A fuse should not be placed in the neutral wire. Which of the following best explains why?

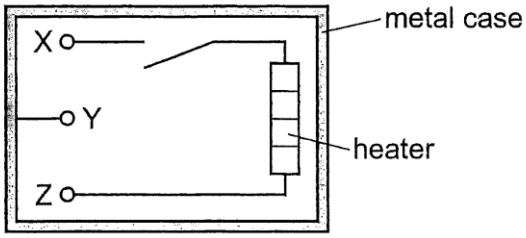
A The fuse cannot melt as the current does not flow through the neutral wire.

B The fuse cannot melt as the neutral wire has zero voltage.

C When the fuse melts, current can still flow through the live wire.

D When the fuse melts, the live wire will still be at a high voltage.

33 The diagram shows the wiring of a heater in a metal case.



The terminals X, Y and Z are connected to the wires from a mains plug.

Which wire is connected to each terminal?

	X	Y	Z
A	live	earth	neutral
B	live	neutral	earth
C	neutral	earth	live
D	neutral	live	earth

34 Which statement best describes an example of induced magnetism?

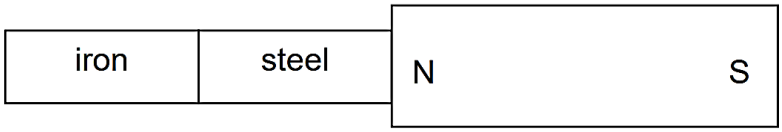
A A bar magnet attracts a piece of soft iron.

B A bar magnet loses its magnetism if it is repeatedly dropped.

C A bar magnet, swinging freely, comes to rest pointing North-South.

D Two North poles repel each other but a North pole attracts a South pole.

35 A light steel bar and a light iron bar are attracted to a magnet as shown.



What will happen when the magnet is removed?

A Both steel and iron bars lose their magnetism.

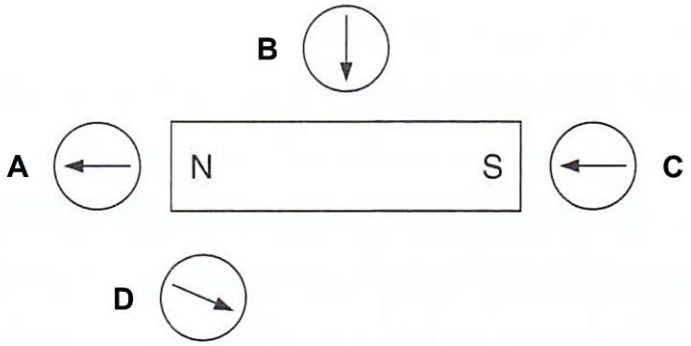
B The iron bar retains its magnetism and steel bar loses its magnetism.

C The steel and iron bars remain attracted to each other.

D The steel and iron bars repel each other.

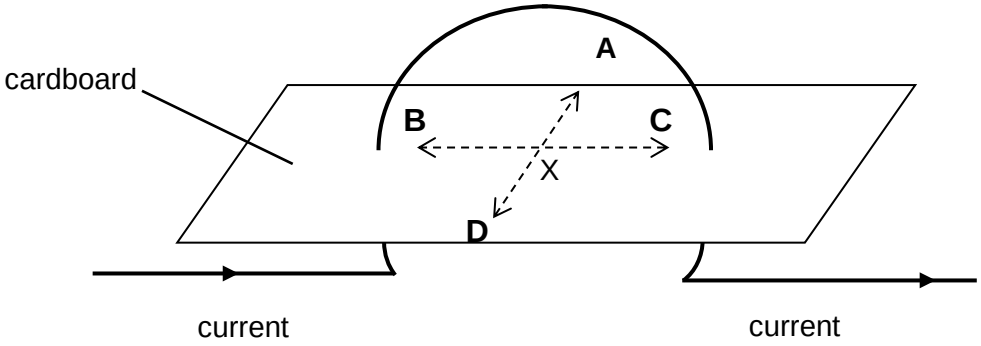
36 The diagram shows four compasses placed around a bar magnet.

Which compass is pointing in the wrong direction?

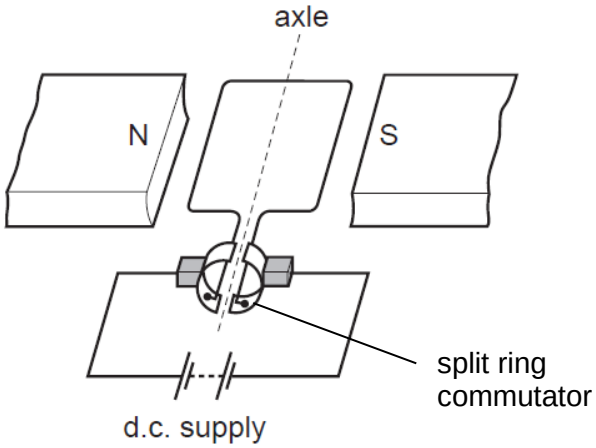


37 An electric current flows through a wire from left to right as shown. A compass is placed at X on the cardboard.

In which direction will the compass needle points?



38 The diagram shows a simple d.c. motor with its coil horizontal.



What is the main function of the split ring commutator?

A To allow current to flow in the coil.

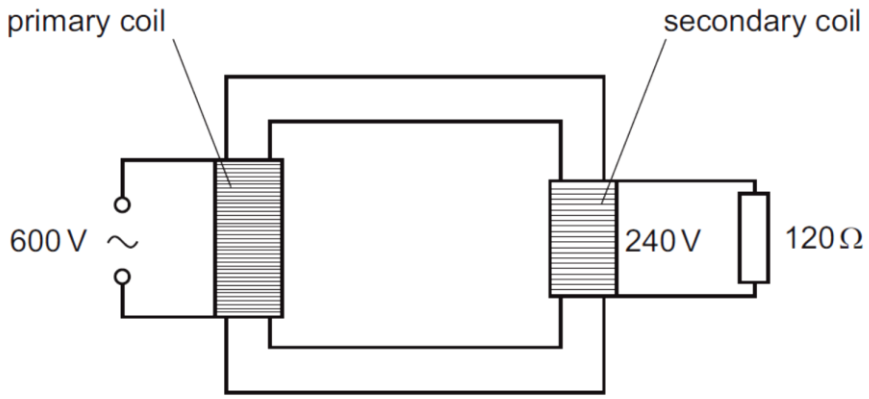
B To prevent the wires from twisting.

C To reverse the current direction in the coil after every half rotation.

D To split the current direction in the coil after every half rotation.

39 An ideal transformer has a primary voltage of 600 V and a secondary voltage of 240 V.

The secondary coil is attached to a resistor of resistance 120 Ω.



What is the power dissipated in the resistor and the current in the primary coil?

	power / W	current / A
A	120	0.20
B	120	5.00
C	480	0.80
D	480	1.30

40 Electric power cables transmit electrical energy over large distances using high-voltage, alternating current.

What are the advantages of using a high voltage and of using an alternating current?

	advantage of using a high voltage	advantage of using an alternating current
A	high current is produced in the cables	the resistance of the cables is reduced
B	high current is produced in the cables	the voltage can be changed using a transformer
C	less energy is wasted in the cables	the resistance of the cables is reduced
D	less energy is wasted in the cables	the voltage can be changed using a transformer

Name:	Class:	Index No.:

Anglo-Chinese School
(Barker Road)

PRELIMINARY EXAMINATION 2024

SECONDARY FOUR EXPRESS

PHYSICS 6091

PAPER 2

TIME: 1 HOUR 45 MINUTES

READ THESE INSTRUCTIONS FIRST

Write your name, class & index number in the box provided at the top of this page.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **one** question only. Question **15** has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for the sound use of Physics than correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	**/ 70**
Section B	**/ 10**
Total	**/ 80**

*This question paper consists of **24** printed pages.*

SECTION A (70 marks)

Answer **all** the questions in this section.

1 Fig. 1.1 is the speed-time graph for a rocket from the moment that the fuel starts to burn at time $t = 0$.

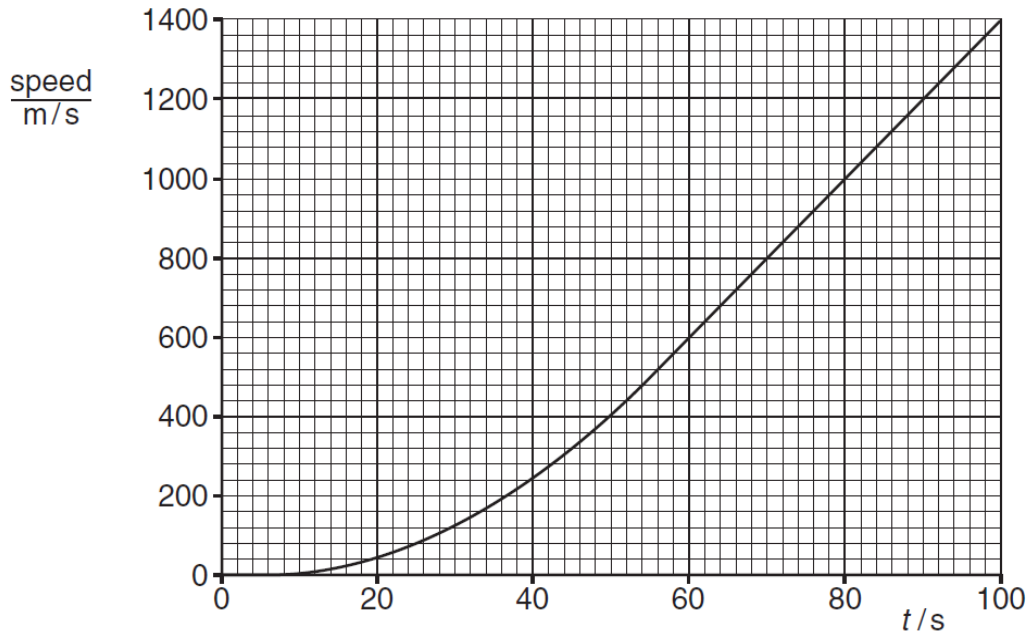


Fig. 1.1

(a) State the magnitude of the acceleration of the rocket at $t = 0$.

acceleration = …….. [1]

(b) Describe the motion of the rocket between $t = 5$ s and $t = 80$ s.

……

…… [2]

(c) Calculate the acceleration of the rocket at $t = 90$ s.

acceleration = …….. [2]

2 A rock climber, of total weight 620 N, holds herself in equilibrium against a vertical cliff. She pulls on a rope that is fixed at the top of the cliff and presses her feet against the cliff.

Fig. 2.1 shows her position.

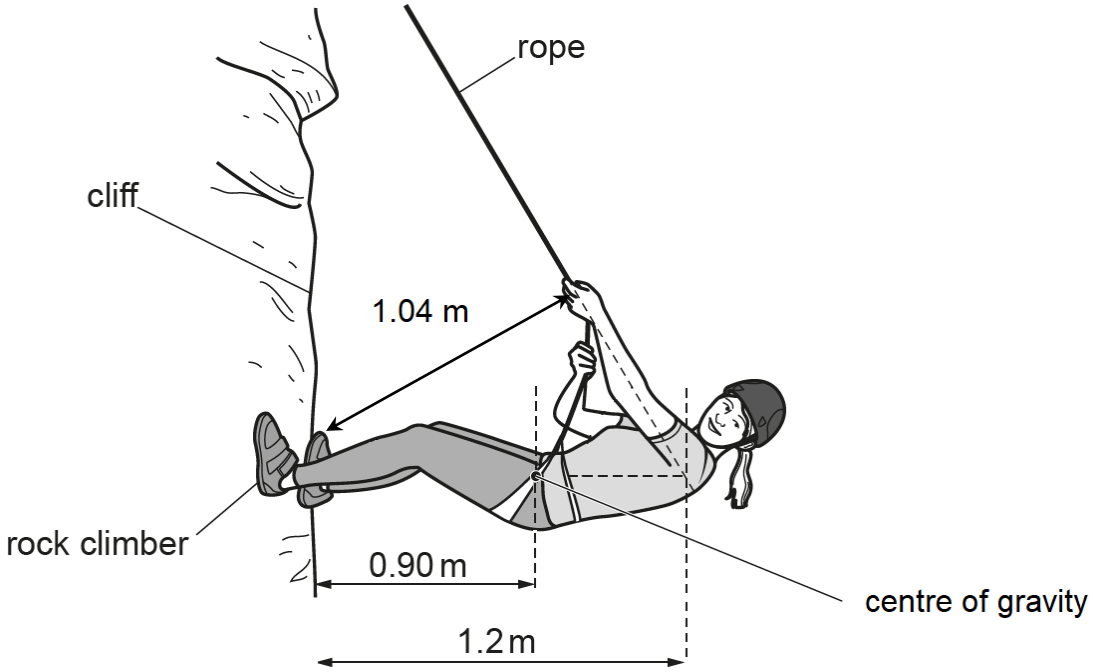


Fig. 2.1

The climber's centre of gravity is 0.90 m from the cliff.

(a) Calculate the moment due to her weight about her feet.

moment = …….. [1]

(b) The rope is at an angle to the horizontal and the distances are as shown in Fig. 2.1.

Determine the tension in the rope.

tension = …….. [2]

3 Fig. 3.1 shows a mercury manometer. The left arm of the manometer contains some trapped gas. The density of mercury is 13 600 kg/m^3. The gravitational field strength g is 10 N/kg.

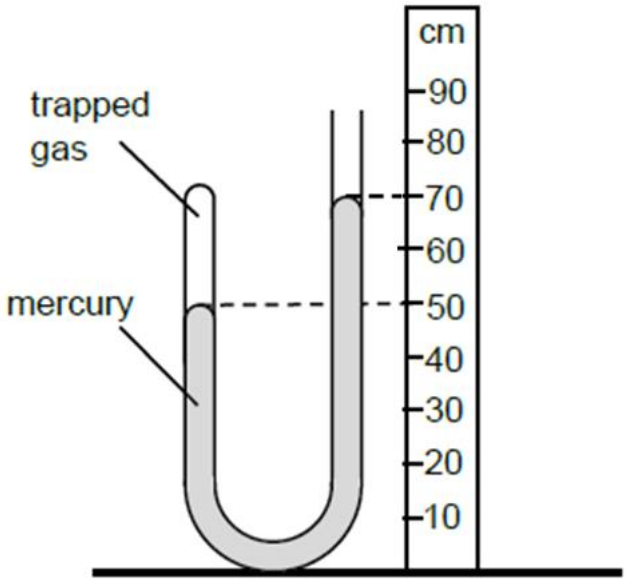


Fig. 3.1

(a) **(i)** The atmospheric pressure is 76.0 cm Hg.

Calculate this pressure in Pascals.

pressure = …….. [1]

(ii) Calculate the pressure of the trapped gas.

Calculate this pressure in Pascals.

pressure = …….. [2]

(b) A small hole is discovered in the left arm of the manometer such that the trapped gas can escape to the surroundings.

By drawing on Fig. 3.2, indicate the new mercury levels in both arms of the manometer. [1]

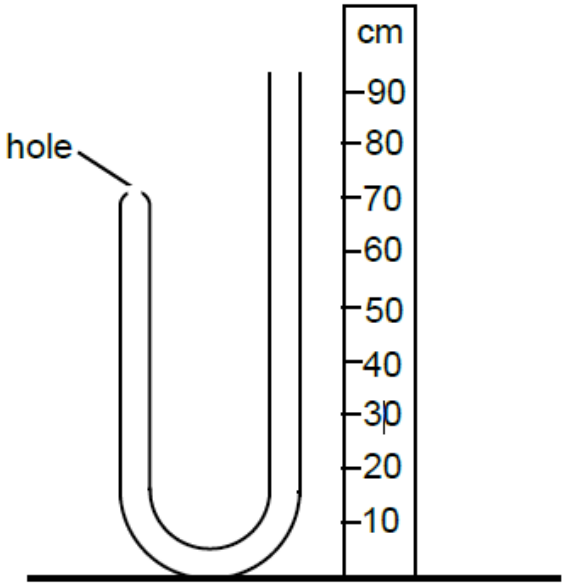


Fig. 3.2

4 A plastic tray has fifteen sections as shown in the Figure 4.1 below.

Fig. 4.1

When it is filled with water and placed in the freezer compartment of a refrigerator, the water freezes to form ice cubes.

(a) Describe the change(s), if any, that occur(s) to the arrangement and to the motion of the molecules as the water becomes ice.

arrangement: ……

……

……

motion: ……

……

…… [2]

(b) Each section contains a mass of 20 g of water that is initially at a temperature of 28 °C. The specific latent heat of fusion of ice is 330 J/g and the specific heat capacity of water is 4200 J/(kg°C).

(i) Define *specific heat capacity*.

……

…… [1]

(ii) Calculate the total amount of energy released from the water for all the water in the tray to become ice at 0 °C.

energy = …….. [3]

(iii) The freezer compartment takes energy from the water at a rate of 30 W.

Calculate the time taken for all the water in the tray to become ice.

time taken = …….. [2]

5 Fig. 5.1 shows the horizontal forces as a cyclist travels forward.

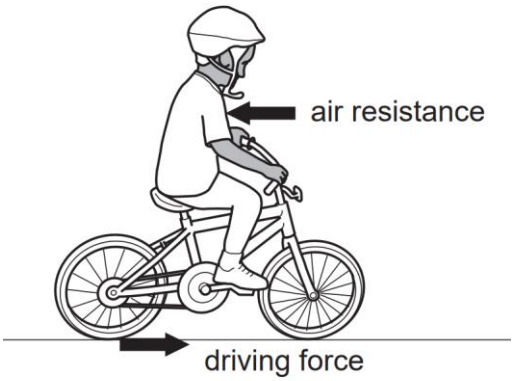


Fig. 5.1

The cyclist produces the driving force that acts on the back wheel.

As the bicycle moves, energy is transmitted from the pedals to the back wheel. Fig. 5.2 shows what happens to the energy input to the pedals.

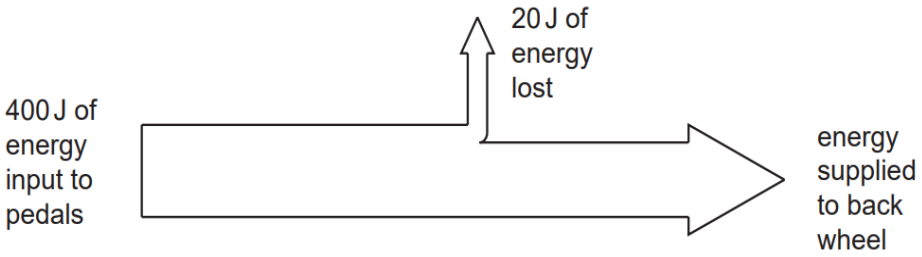


Fig. 5.2

(a) State the *principle of conservation of energy*.

……

…… [2]

(b) Calculate the efficiency of the bicycle in transmitting energy from the pedals to the back wheel.

efficiency = …….. [2]

6 Two identical metal saucepans, pan **A** and **B**, contain the same mass of hot water at the same initial temperature.

One of the saucepans is painted black, while the other is painted white. Both saucepans are not covered and they are cooled under the same conditions.

The cooling curves for the water in the two saucepans are shown in Fig. 6.1.

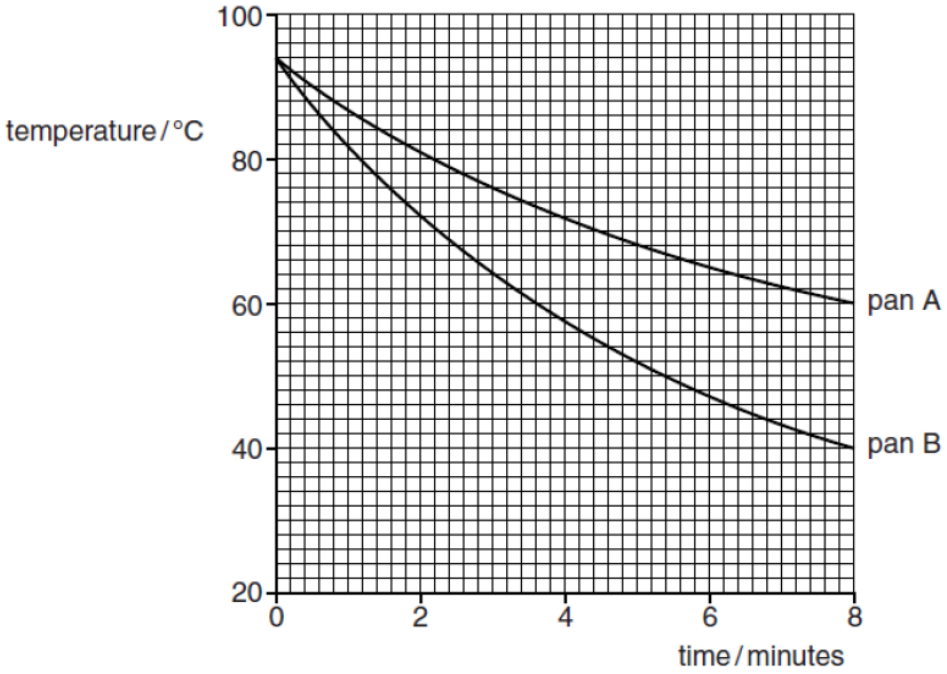


Fig. 6.1

(a) State and explain, with reference to Fig. 6.1, which of the pans (**A** or **B**) was painted black.

……

……

……

……

…… [3]

(b) Describe and explain, using the concept of thermal energy transfer, how Fig. 6.1 will be different if the experiment is repeated with both pans each covered with a lid.

……

……

……

…… [2]

7 Fig. 7.1 shows a straight dipper vibrating near the water surface of a ripple tank.

Water waves forming crests and troughs, are observed as a series of wavefronts moving away from the dipper.

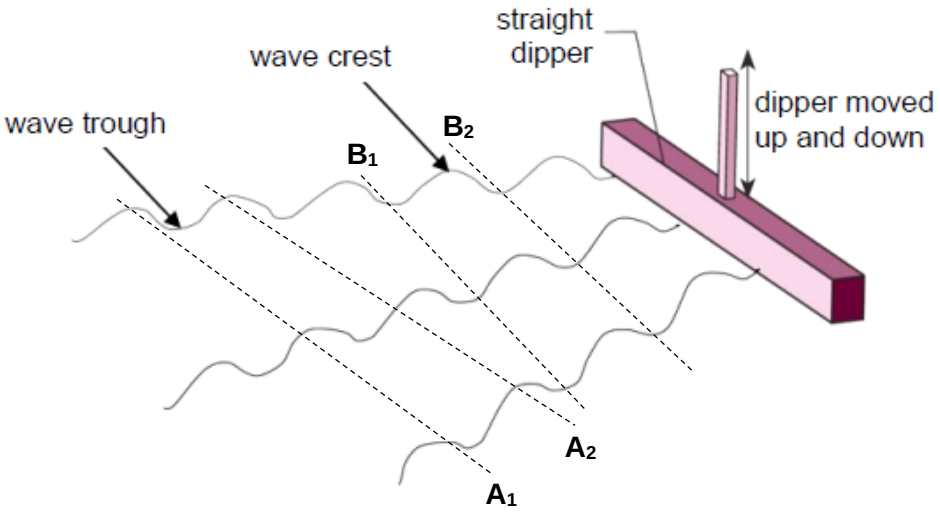


Fig. 7.1

(a) **(i)** Explain what is meant by a *wavefront*.

……

…… [1]

(ii) Tick one of the boxes to show the correct pair of dotted lines that show two consecutive wavefronts. [1]

A_1 and A_2	☐	A_1 and B_1	☐
A_2 and B_2	☐	B_1 and B_2	☐

(b) Two students conduct an experiment using the ripple tank in Fig. 7.1 to measure the speed of water waves. The measurements are recorded as follows:

average number of wave crests passing a point in 10 seconds = 5
average distance between two consecutive wave crests = 8.0 cm
average distance from the crest to the trough of the wave = 4.0 cm

Determine the speed of the water waves.

speed = …….. [2]

8 Fig. 8.1 shows the various regions of the electromagnetic spectrum arranged in order of increasing frequency.

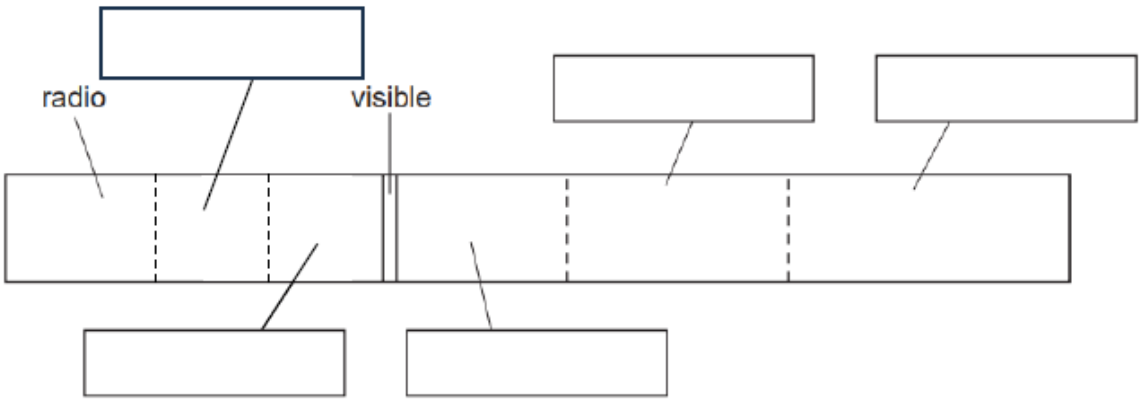


Fig. 8.1

Two of the regions have been labelled.

(a) In the boxes provided in Fig. 8.1, write the names of the other regions. [2]

(b) Some components of the electromagnetic spectrum cause ionisation. They are known as ionising radiation.

State what is meant by *ionisation* and state one region in **(a)** that is **not** an ionising radiation.

……

……

…… [2]

9 Fig. 9.1 shows the path of a ray of blue light as it passes through a glass prism.

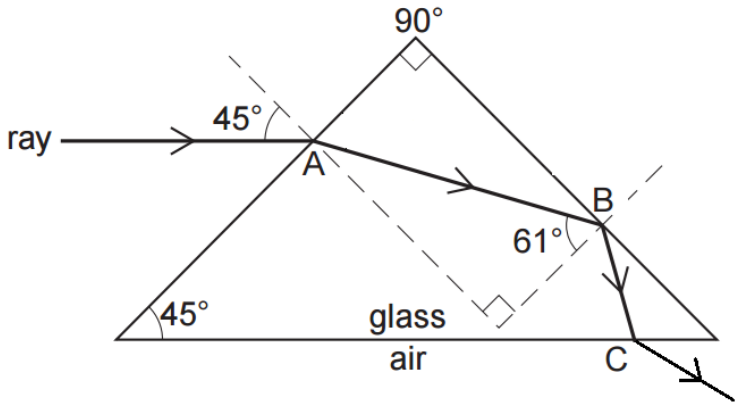


Fig. 9.1

(a) Explain why the ray changes direction at **A**.

……

…… [1]

(b) Determine the angle of refraction at **A** and hence, the refractive index of the glass.

angle of refraction at **A** = ……..

refractive index = …… [3]

(c) Explain why the ray does not emerge into the air at **B**.

……

……

…… [2]

10 Fig. 10.1 shows a method of producing sandpaper using static electricity.

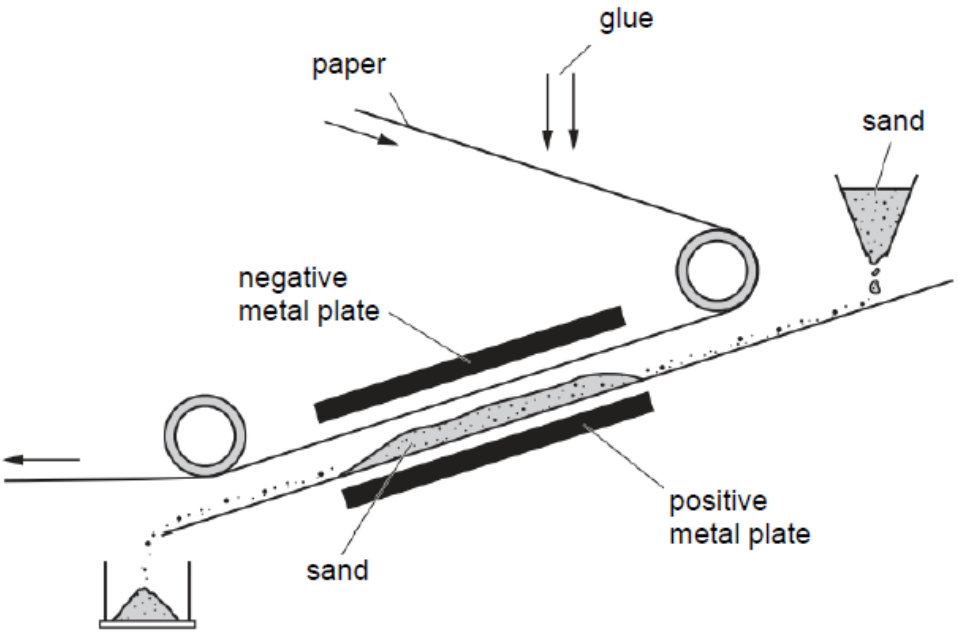


Fig. 10.1

Glue is sprayed on to moving paper. The sticky paper then passes between two metal plates. One of the plates is positively charged and the other plate is negatively charged. There is an electric field between the plates.

(a) On Fig. 10.2, draw and show the direction of the electric field between the two metal plates. [2]

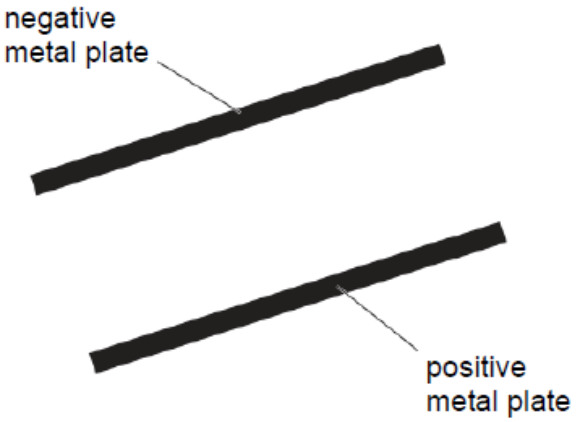


Fig. 10.2

(b) Grains of sand are present just below the sticky paper. Each grain of sand is given a charge. Fig. 10.3 shows two layers of sand grains in the space between the two plates.

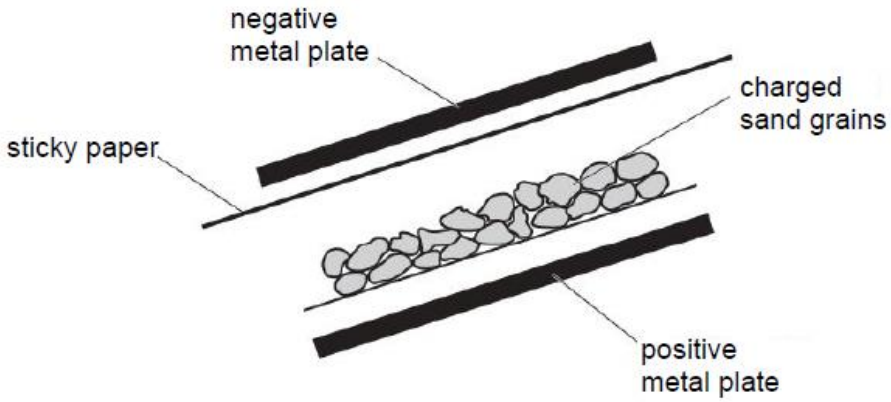


Fig. 10.3

Sand grains are attracted to the negative metal plate.

State and explain whether the sand grains are positively or negatively charged.

……

……

…… [2]

(c) A man accidentally touches the exposed part of the positive plate. The potential difference between the hand and the metal is 1500 V and the charge transferred is 4.0×10^{-4} C.

Calculate the energy transferred when the charges pass through him.

energy = …… [2]

11 The primary coil of a simple soft iron-cored transformer is connected to the a.c. mains supply.

Fig. 11.1 is a diagram of the arrangement.

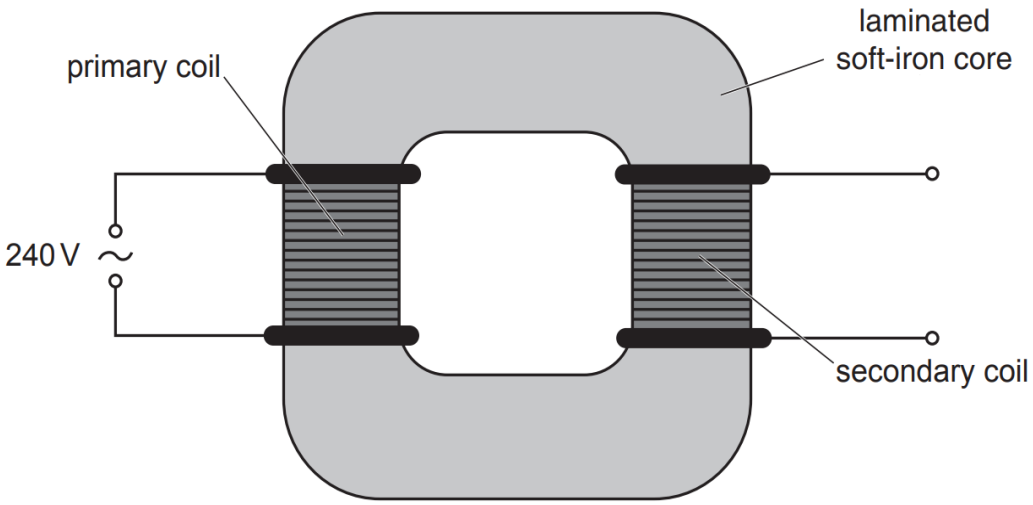


Fig. 11.1

(a) Suggest why the core is laminated.

……

…… [1]

(b) Using Faraday's law of electromagnetic induction, explain why a transformer will not operate using a direct current input.

……

……

……

……

…… [2]

12 The count rate from a sample of radioactive material is measured every 20 seconds for 2 minutes. The results which has been corrected for background radiation, are shown in Fig 12.1.

time / s	0	20	40	60	80	100	120
count rate / count/s	280	210	164	122	88	72	54

Fig. 12.1

(a) Suggest one possible source for the background radiation.

……. [1]

(b) From the table, without attempting a graph, estimate the half-life of the radioactive material.

half-life = …….. [1]

(c) The radioactive material emits only α-particles.

Describe an experiment to prove that no β-particles or γ-radiation are emitted from the radioactive material. Draw a labelled diagram of the set-up of the experiment to be conducted.

…….

…….

…….

…….

…….

……. [2]

(d) State one precaution that should be taken for safe handling of the radioactive material.

…….

……. [1]

13 Fig 13.1 represents the radioactive decay of a $^{238}_{92}U$ nucleus.

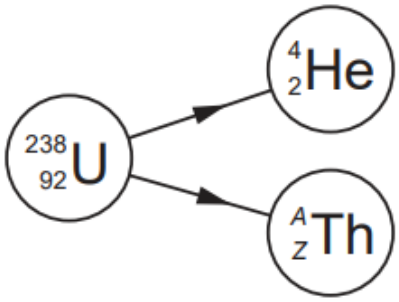


Fig. 13.1

In the space below, write the nuclear equation for this decay, including the numerical values of A and Z.

[2]

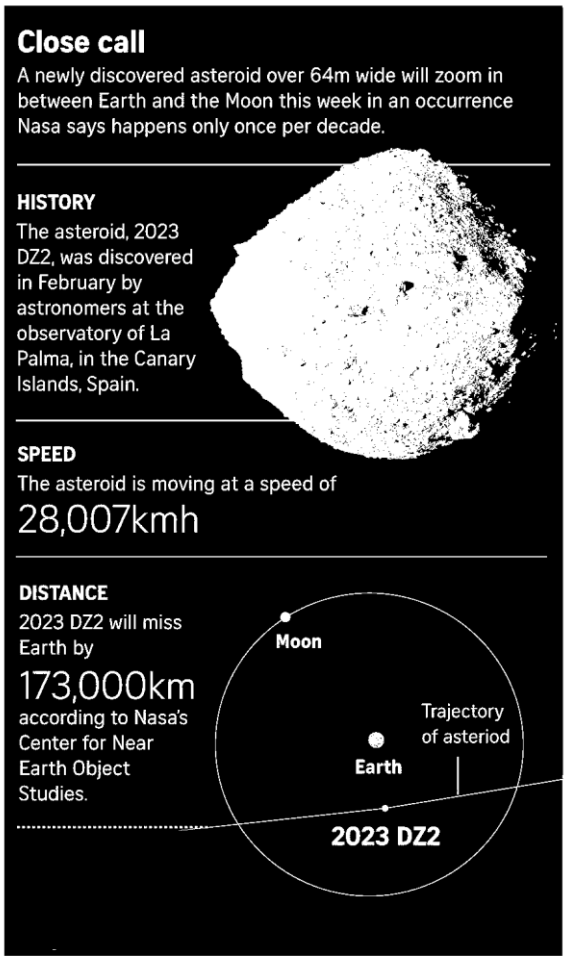
14 The following excerpt is adapted from
'City killer' asteroid to pass between Earth and Moon harmlessly on March 25 weekend.
[26 Mar 2023, The Straits Times]

A newly discovered asteroid big enough to wipe out a city will pass harmlessly between Earth and the Moon's orbit this weekend, offering astronomers the opportunity to study the space rock closely.

Estimated to be between 40m and 90m in diameter, the asteroid named 2023 DZ2 will be within 515,000 km of the Moon on Saturday and, several hours later, fly past the Earth at about 28,000 kmh.
It will miss Earth by about 173,000 km, a little less than half the distance to the Moon.

The Virtual Telescope Project said the significant size of the asteroid will make it easy for people to observe with good binoculars and small telescopes a few hours before the fly-by.

"Astronomers with the International Asteroid Warning Network are using this close approach to learn as much as possible about 2023 DZ2 in a short time period – good practice for #PlanetaryDefence in the future if a potential asteroid threat were ever discovered," Nasa tweeted.



(Not drawn to scale)

(a) Based on the data given, estimate the distance between the Earth and the moon in metres.

distance = …….. m [1]

(b) In the text as well as the graphics in this news article, the speed of the asteroid when it fly past the Earth is given as about "28,000 kmh".

(i) State the error in representation of this speed.

…….. [1]

(ii) Using the correct representation of the speed, calculate the speed of the asteroid in metres per second and express this in standard form.

speed = …….. m/s [2]

(c) Scientist use a method called mathematical modelling to give estimates and predictions of physical phenomenon. It involves the conversion of physical situations into mathematics with some assumptions as parameters to aid in the modelling.

(i) Using a simple model of the asteroid as a sphere of diameter 64 m, calculate the volume of the asteroid.

volume of sphere, $V = \frac{4}{3}\pi r^3$,where r = radius of sphere.

volume = …….. [2]

(ii) Assume the average density of this asteroid is 2700 kg/m^3.

Calculate the mass of this asteroid.

mass = …….. [1]

(iii) Hence, estimate the kinetic energy of this asteroid at the given speed in **(b)(ii)**.

kinetic energy = …… [1]

(d) The following excerpt is adapted from
Asia: Biographies and Personal Stories Part II
[Fall 2015, Education About Asia Magazine]

On August 6, 1945, the US dropped an atomic bomb on Hiroshima, Japan. The nuclear bomb exploded over the center of the city, completely devastating it. The area within 1.2 miles of the hypocenter was entirely leveled and burned. According to the city of Hiroshima, approximately 140,000 people had died by the end of December 1945. The atomic bomb "Little Boy", an enriched Uranium nuclear fission bomb released the equivalent energy of 15 kilotons of TNT.	

The power of nuclear explosion is expressed in terms of its relationship to TNT (a type of explosive material) due to the enormous power possessed by a single weapon. The explosive energy available is equivalent to thousand of tons (kilotons) or millions of tons (megatons) of TNT.

Use the information contained in the excerpt to answer the following questions.

(i) State what is meant by *nuclear fission*.

……...

……... [1]

(ii) If asteroid 2023 DZ2 were to hit Earth, calculate the energy equivalent of the number of bombs dropped on Hiroshima.

1 kiloton of TNT = 4.2×10^{12} J

number of bombs = …….. [2]

SECTION B (10 marks)

Answer only one of the two alternative questions in **Question 15**.

15 EITHER

The power supply in an electric circuit is a battery of electromotive force (e.m.f.) 12 V.

(a) State **two** ways in which the e.m.f. of a battery differs from that of an alternating current (a.c.) power supply.

1 ……..

2 …… [2]

(b) The circuit includes three resistors and two open switches, S_1 and S_2.

Fig. 15.1 shows the circuit.

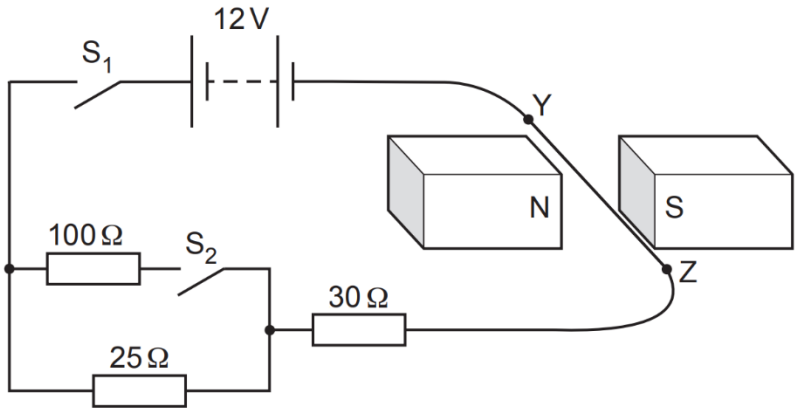


Fig. 15.1

YZ is a straight, horizontal section of connecting wire that lies between two magnets.

S_1 is now closed.

(i) Explain why YZ experiences a force.

……

……

…… [2]

(ii) Tick the box which describes the direction of the force on YZ.

towards N	☐	towards Z	☐
towards S	☐	downwards	☐
towards Y	☐	upwards	☐

[1]

(c) Switch S_2 in the circuit in Fig. 15.1 is now closed.

(i) Calculate the total resistance of the circuit.

resistance = …….. [2]

(ii) Explain what happens to the force on YZ as switch S_2 is closed.

……

……

…… [2]

(iii) The current in the 25 Ω resistor is I_{25}. The current in the 100 Ω resistor is I_{100}. State a value for the ratio of I_{100} to I_{25}.

ratio = ……. [1]

15 OR

Fig.15.2 below shows a drone. It can hover and travel through the air.

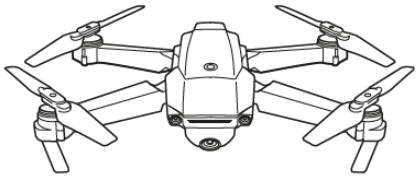


Fig. 15.2

A student flies the drone on a journey from **A** to **B** to **C** to **D** at a constant height.

Fig. 15.3 shows the path of the drone, viewed from above.

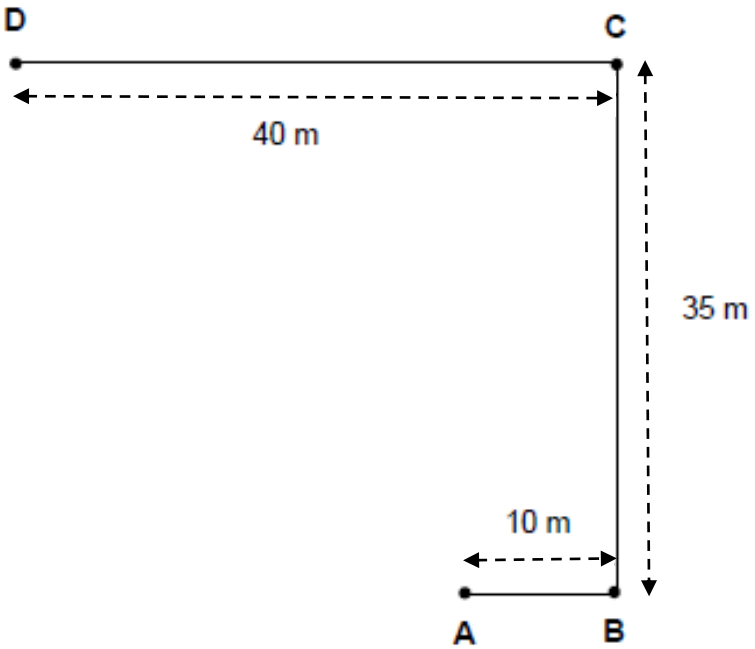


Fig 15.3

(a) (i) Determine the total distance travelled by the toy drone.

distance = ……. [1]

(ii) Determine the scale used to construct Fig 15.3.

1 cm on the diagram represents …….. on the path. [1]

(iii) Hence, determine the magnitude of the displacement of the drone.

Show your working in the space below.

displacement = ……. [2]

(b) The mass of the drone is 5.50 kg. It is hovering at a constant height above the ground.

The gravitational field strength g is 10 N/kg.

(i) State the upward force produced by the drone.

upward force = …… [1]

(ii) The upward force is now increases to 100 N.

Calculate the acceleration of the drone.

acceleration = …… [2]

(iii) When the drone hovers at **D**, its motor fails, and it falls. It reaches uniform velocity as it falls.

Explain, in terms of the forces and acceleration, what happens as the drone falls and reaches terminal velocity.

……

……

……

…… [3]

END OF PAPER