南洋女子中学校
**NANYANG GIRLS' HIGH SCHOOL**
**Preliminary Examination 2023**
**Secondary Four 'O' Level**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | |
| CENTRE NUMBER | S | | | | | INDEX NUMBER | | | |

# PHYSICS 6091/02

Paper 2 **28 Aug 2023, Monday**

**1 hour 45 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

**Sections A and B**
Answer **all** questions. Question 13 has a choice of parts to answer.
Write your answers in the spaces provided on the Question Paper.

Electronic calculators may be used.

You are advised to spend no longer than one hour on Section A and no longer than 45 minutes on Section B.
At the end of examination fasten all your work securely together.
The number of marks is given in the brackets [ ] at the end of each question or part question.

| Examiner's Use | |
|---|---|
| Paper 1 | |
| | |
| Section A | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| Section B | |
| 13 | |
| 14 | |
| 15E | |
| 15O | |
| Total | |
| | 120 |
| | % |

## Section A (50 marks)

Write your answers in the spaces provided.

**1** A list of 8 physical quantities is shown below:

| | | | |
|---|---|---|---|
| length | time | energy | force |
| speed | weight | mass | acceleration |

From the above list,

**(a)** state all the derived quantities,

……..……..

……..… [1]

**(b)** state all the vector quantities,

……..……..

……..… [1]

**(c)** state a pair of physical quantities that have the same S.I unit(s), and write down the symbol of this unit(s).

a pair of physical quantities: ……

symbol of unit(s): ……

[1]

**2** Fig. 2.1 shows the speed-time graph for a car travelling along a straight horizontal road.

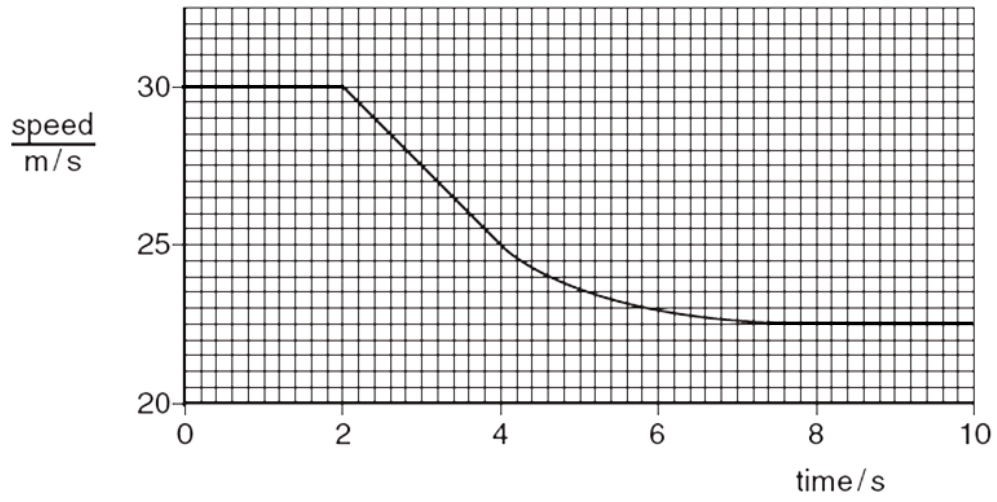



**Fig. 2.1**

**(a)** On Fig. 2.1, state the duration at which the car has a non-uniform deceleration.

From *t* = ..... to t = ..... [1]

**(b)** Calculate the deceleration of the car at *t* = 3.0 s.

deceleration = ……..... [2]

**(c)** Calculate the distance travelled by the car from *t* = 2.0 s to 4.0 s.

distance = ……..... [2]

**(d)** Between $t$ = 0 and $t$ = 2.0 s, Newton's first law of motion describes the motion of the car. Explain using ideas about forces, what happens during this part of the journey.

……..

……..

……..

……..

…… [2]

**3** Fig. 3.1 shows a crane lifting some bricks at a construction site.

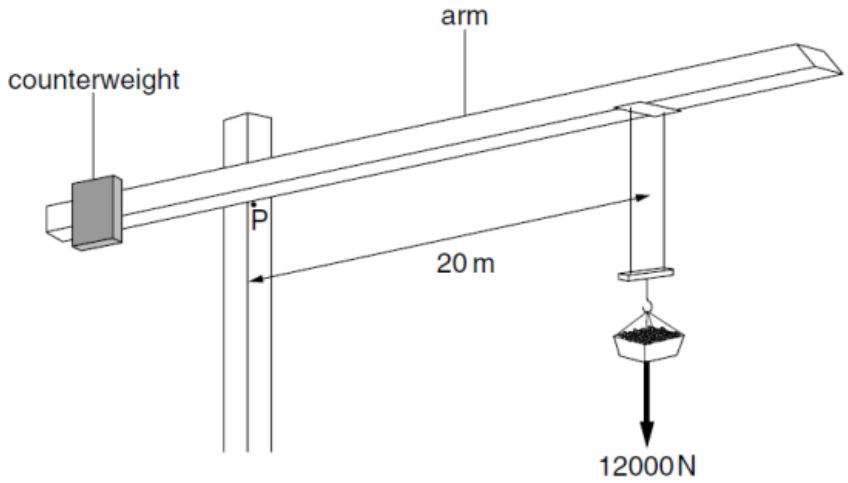



**Fig. 3.1**

The weight of a container of bricks is 12000 N. This load produces a turning moment on the arm of the crane about the point P.

**(a)** Calculate this turning moment about P.

turning moment = ……..... [1]

**(b)** Explain why the counterweight is necessary.

……..

……..

…… [1]

**(c)** Suggest one advantage of being able to move the counterweight along the arm.

……..……..

……..……..

……..… [1]

**(d)** The motor of the crane lifts the 12 000 N through a height of 15 m in 1.5 min. Determine the power delivered by the motor, assuming that it is 100% efficient.

power delivered = ……..... [2]

**4** Fig. 4.1 shows the cross section of a cup noodle container.

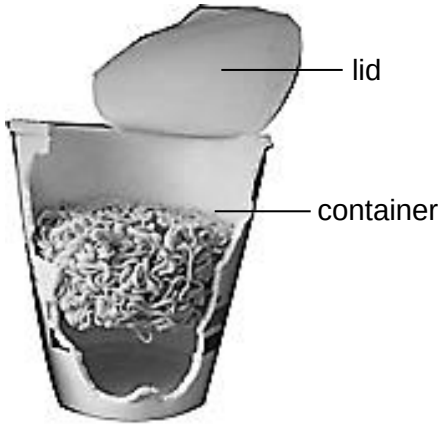



**Fig. 4.1**

**(a)** The container of the cup noodles is made of expanded polystyrene.
State and explain one advantage of using such a material to make the container.

……..

……..

……..

……..… [2]

**(b)** Explain why the inner surface of the lid is usually shiny.

……..

……..

……..

……..… [2]

**(c)** The container contains 100 g of noodles at 26 °C.

400 g of water at 90 °C is then poured into the container.

Given: specific heat capacity of water = 4200 J / (kg°C)

specific heat capacity of the noodles = 2400 J / (kg°C)

Assuming no heat is lost to the surroundings and the container, calculate the final temperature of the mixture.

final temperature = ……..... [3]

**5** Fig. 5.1 and Fig. 5.2 show a semi-circular glass block as rays of light are directed into the block at different angles. The rays are directed towards the centre C of the semi-circle so that no refraction occurs as the rays enter the block.

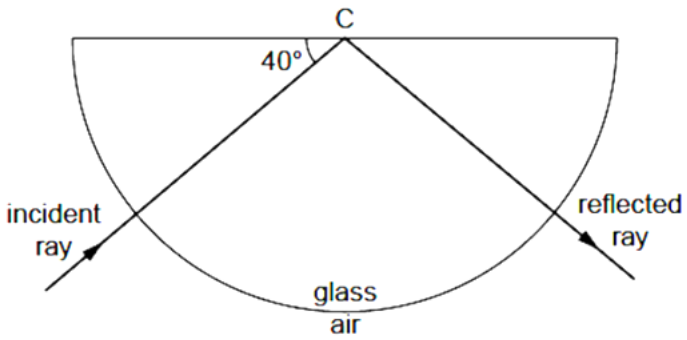



**Fig. 5.1**

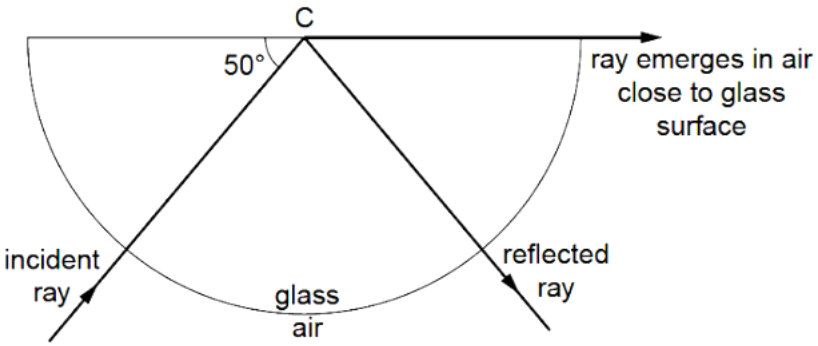



**Fig. 5.2**

**(a)** Explain why the incident light ray does not change direction as it enters the glass block.

……..……..

……..……..

……..…. [1]

**(b)** Calculate the refractive index of the glass.

refractive index = ……..... [2]

**6** Fig. 6.1 shows an object O placed in front of a converging lens L with two focal points labelled F.

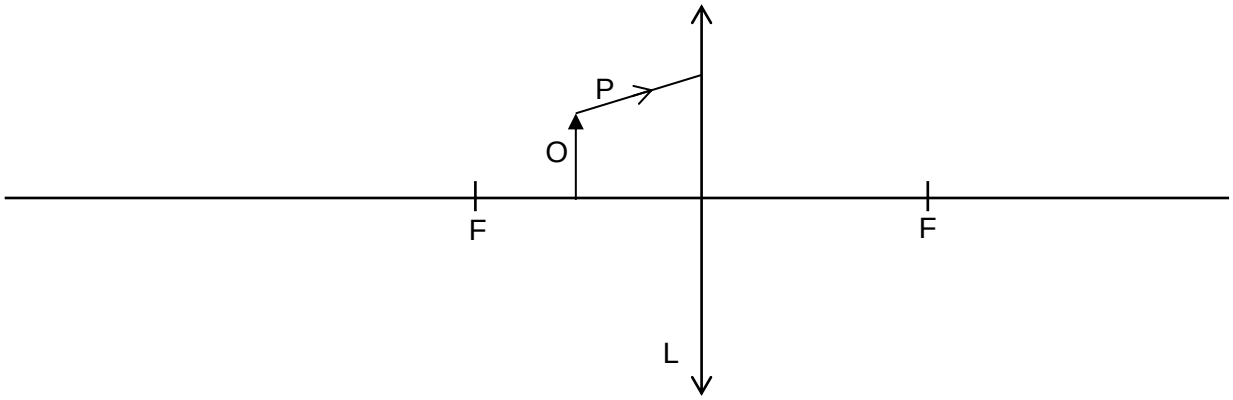



**Fig. 6.1**

**(a)** On Fig. 6.1, draw **two** rays from the top of the object O to locate the position of the image. Draw and label the image with the letter **I**. [2]

**(b)** Complete the path for light ray P after it passes the lens. [1]

**(c)** Describe two changes in the image I obtained in **(a)** if the object O is now shifted closer to the lens L.

…… [1]

**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.

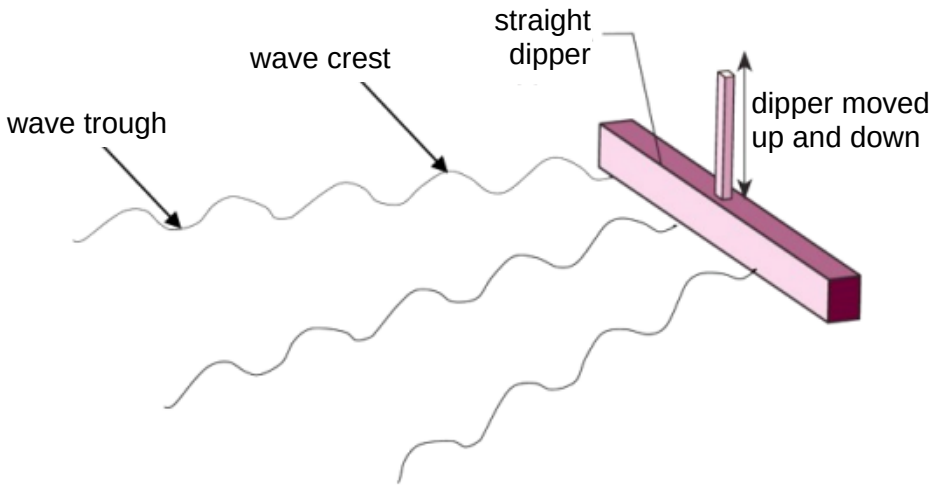



**Fig. 7.1**

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

……

…….. [1]

**(ii)** Using two dashed lines, draw two consecutive wavefronts on Fig. 7.1. [1]

**(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 a cathode ray oscilloscope (c.r.o.) trace for a sound with a frequency of 5000 Hz.

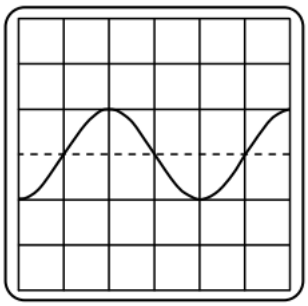


**Fig. 8.1**

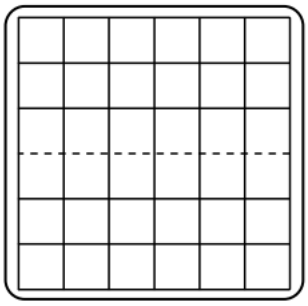


**Fig. 8.2**

On Fig. 8.2, draw the trace for a louder sound with a frequency of 10 000 Hz if the same settings are used for the c.r.o. as in Fig. 8.1. [2]

**9** Fig. 9.1 shows an electrostatic precipitator. These are fitted in the chimneys of power stations fuelled by fossil fuels. They remove smoke from the waste gases and help to reduce pollution.

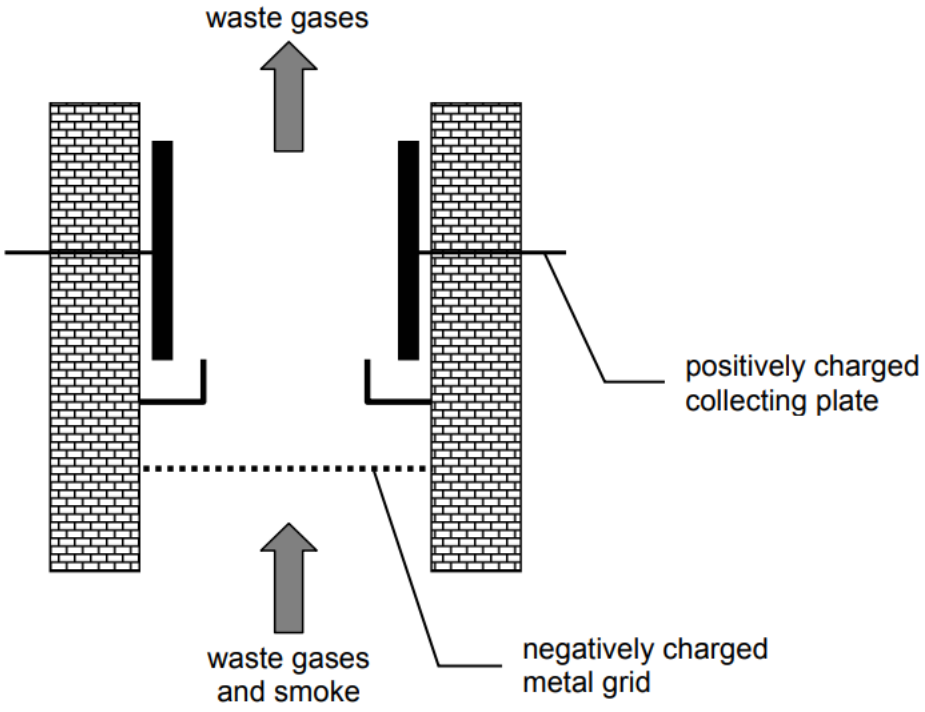



**Fig. 9.1**

**(a)** Explain why does smoke rise up the chimney.

……..

…… [1]

**(b)** When smoke particles pass through the metal grid near the bottom, they become negatively charged. Explain how the metal grid and the collecting plate help to remove the smoke particles from the waste gases.

……..

……..

……..

…… [2]

**10** **(a)** The resistance *R* of a light-dependent resistor (LDR) varies with illuminance (the amount of light energy per unit area hitting a surface) as shown in Fig. 10.1.

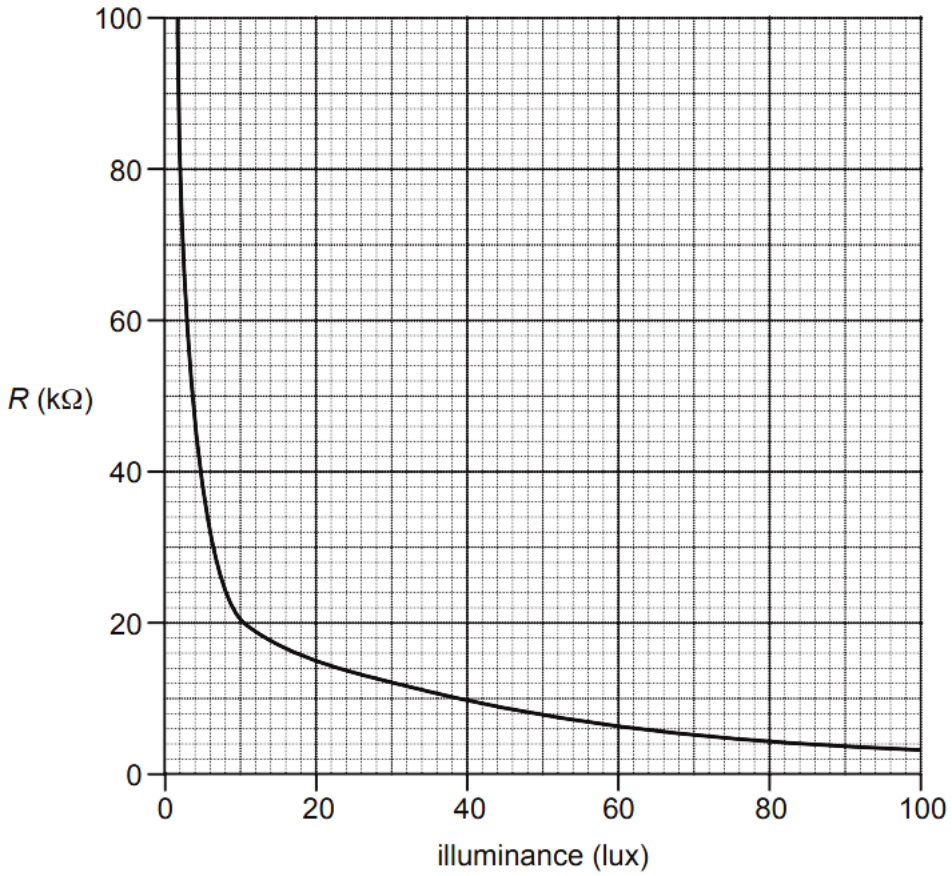



**Fig. 10.1**

**(i)** Describe how resistance *R* changes with illuminance as shown in Fig. 10.1.

……

…….. [1]

**(ii)** Use the graph to estimate the change in resistance of the LDR when the illuminance increases from 10 lux to 70 lux.

change in resistance = ……..... [2]

**(b)** The LDR is connected in series with a fixed resistor of resistance 10 kΩ and a 4.5 V battery as shown in Fig. 10.2.

The illuminance is 30 lux and the **total** resistance in this circuit is 22 000 Ω.

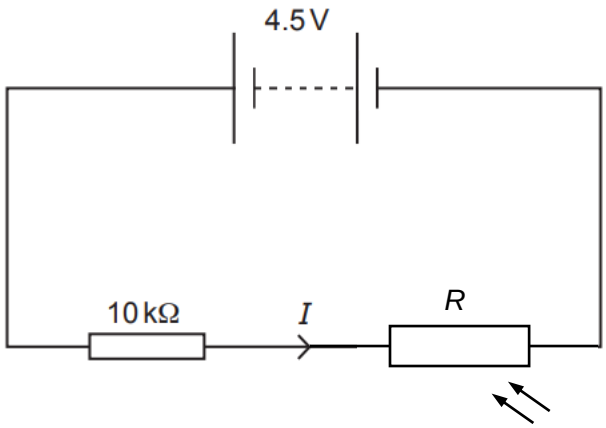



**Fig. 10.2**

**(i)** Calculate the current $I$ in the circuit.

current = ……..... [2]

**(ii)** Calculate the potential difference (p.d.) across the fixed 10 kΩ resistor when the illuminance is 30 lux.

p.d. = ……..... [1]

**(iii)** State and explain, without any calculations, how the p.d. across the fixed resistor will change when the illuminance increases from 30 lux to 100 lux.

……

……

……

…….. [2]

**11** The Fig. 11.1 shows the inside of a three-pin plug.

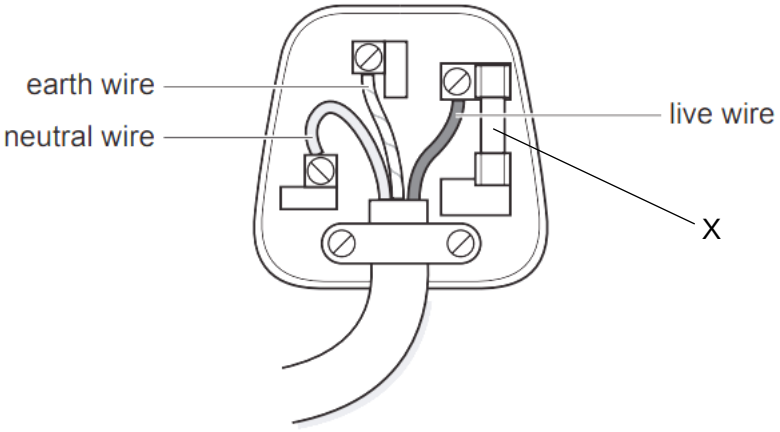



**Fig. 11.1**

**(a)** State which wire(s) is/are connected to the national power grid which supplies electricity to all parts of Singapore.

…… [1]

**(b)** Name the component X and draw its circuit symbol in the box below. [1]

X is a ……

**12** Fig. 12.1 shows the magnetic field around a bar magnet.
Three points are labelled A, B and C.

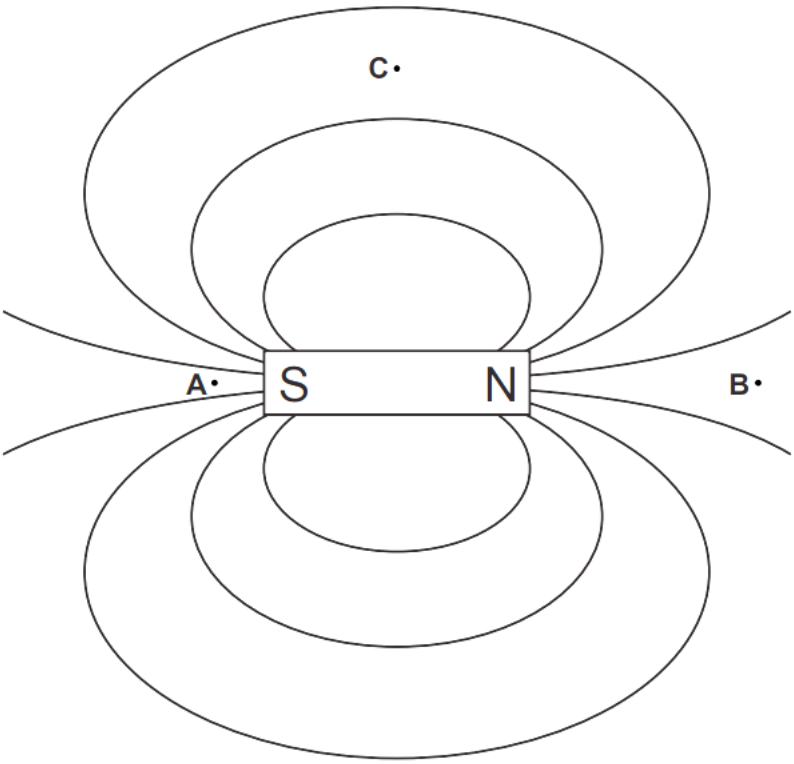



**Fig. 12.1**

**(a)** State at which labelled point in Fig. 12.1 the magnetic field is the strongest.

…… [1]

**(b)** State at which labelled point(s) in Fig. 12.1 a plotting compass needle would point towards the right.

…… [1]

## Section B (30 marks)

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

**13** 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.

…

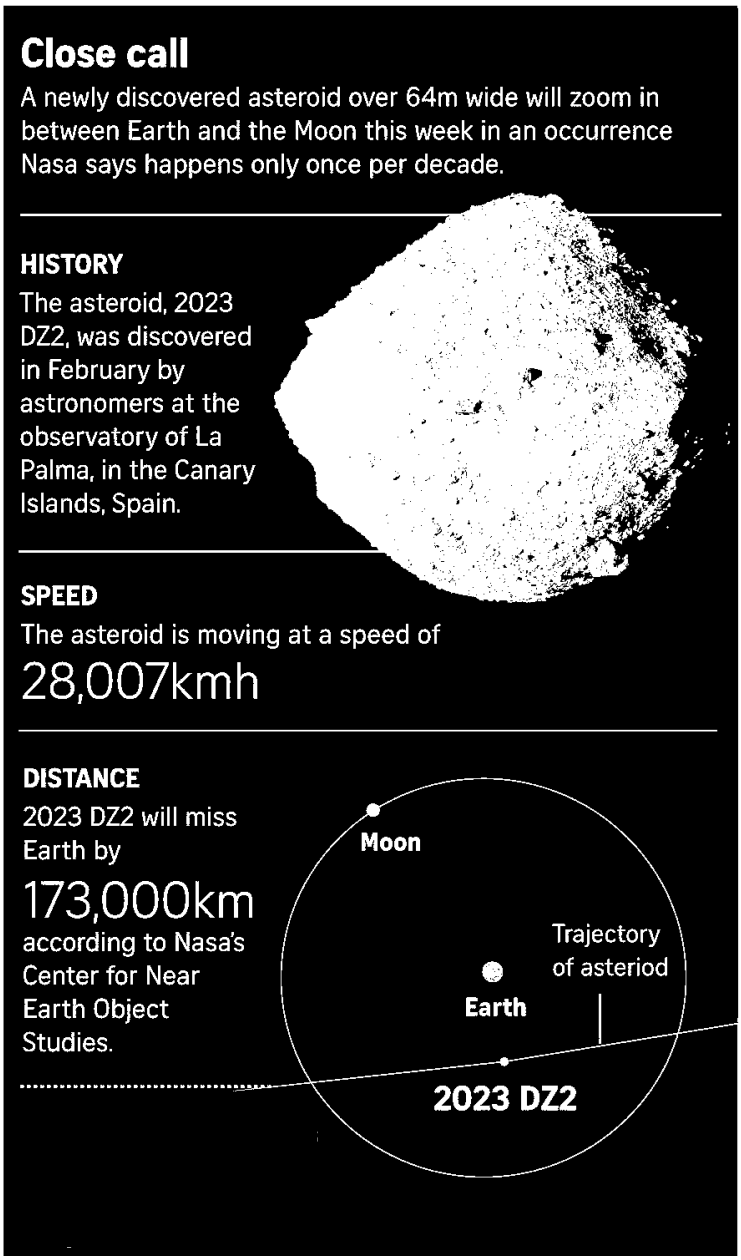
…

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.




*Sources: Earthsky.org, NASA, USA Today*
*Straits Times Graphics*

**(a)** Based on the data given, estimate the distance from Earth to the moon in metres (m).

distance = ……..... [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 the representation of this speed.

…….. [1]

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

speed = ……..... [2]

**(c) (i)** Using a simple model of this asteroid as a sphere of diameter 64 m, calculate its volume, given:

volume of sphere = $\frac{4}{3}\pi r^3$ , 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 = ……..... [2]

**(d)** *"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.*

**(i)** Briefly explain what you think is an *asteroid threat*.

…….

…….

……..…. [1]

**(ii)** Suggest how the knowledge gained by these astronomers during the observation of this asteroid may be useful in the future.

…….

…….

…….. [1]

**14** A parachutist jumps from rest from a helicopter 300 m above the ground on National Day. The parachutist free falls for a while before opening the parachute. Table 14.1 shows the variation of her velocity with time over the first 10 s of her jump.

**Table 14.1**

| time<br>*t* / s | velocity<br>*v* / m/s |
|---|---|
| 0 | 0 |
| 1 | 10 |
| 2 | 20 |
| 3 | 30 |
| 4 | 40 |
| 5 | 50 |
| 6 | 60 |
| 7 | 30 |
| 8 | 20 |
| 9 | 14 |
| 10 | 14 |

**(a) (i)** On Fig. 14.1, plot a graph of *v* against *t* using the data from Table 14.1. [2]

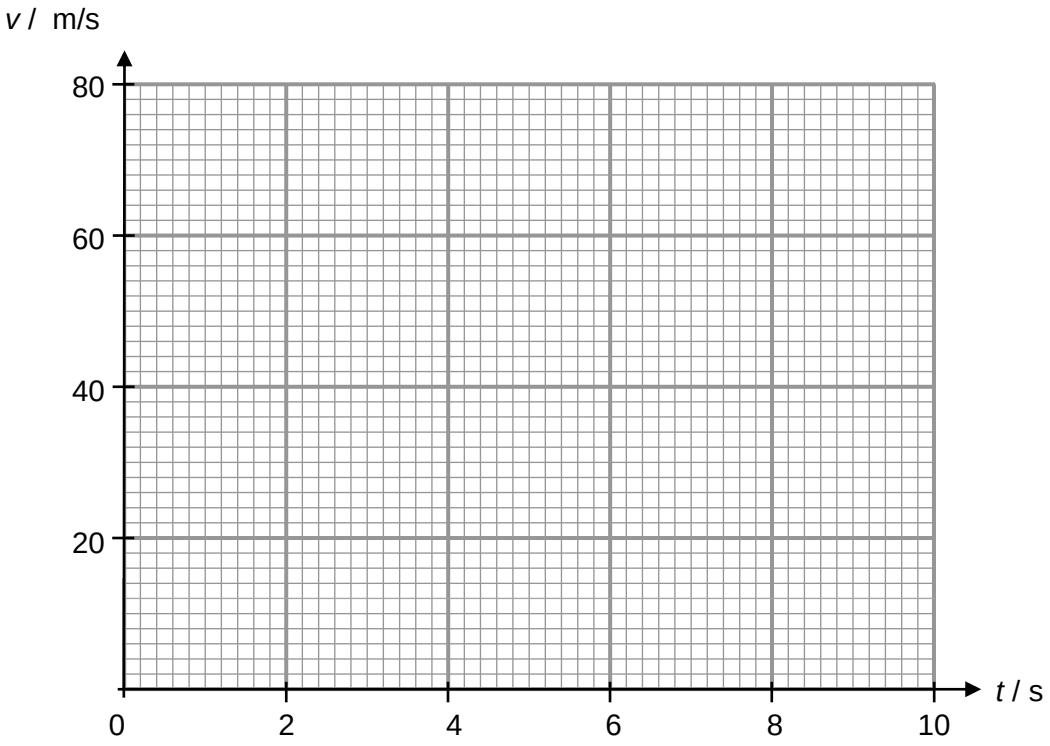
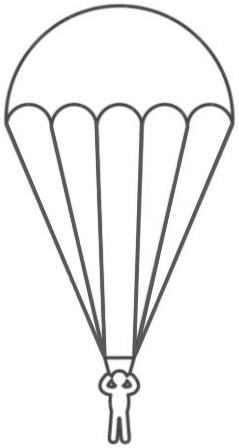



**Fig 14.1**

**(ii)** State the magnitude of the terminal velocity of the parachutist.

terminal velocity = ……..... [1]

**(b)** Fig. 14.2 shows the parachutist with her parachute fully opened.
Draw and label the forces acting on this system. [1]



Source: https://thumbs.dreamstime.com/z/black-outline-icon-parachute-white-background-line-icon-side-view-parachutist-black-outline-icon-parachute-white-99200505.jpg?w=768

**Fig. 14.2**

**(c)** Explain, using ideas about forces, how she reaches terminal velocity from the instant the parachute is fully opened at $t$ = 6 s.

……..

……..

……..

……..

……..

……..

…… [2]

**(d) (i)** The total mass of the parachutist and the parachute is 90 kg.
The gravitational field strength *g* is 10 N/kg.

Calculate the total gravitational potential energy when she just jumps from the helicopter.

gravitational potential energy = ……..... [2]

**(ii)** If the total kinetic energy of the parachutist and parachute is 8820 J just before she hits the ground, determine the total energy lost by the parachutist and the parachute due to air resistance.

total energy lost = ……..... [1]

**15 EITHER**

An electric heating unit is to be fitted in a house. The heater is rated as 10.5 kW, 230 V.

The heater unit is connected to the 230 V mains supply by 2 copper wires of length 16 m each, as shown in Fig. 15.1.

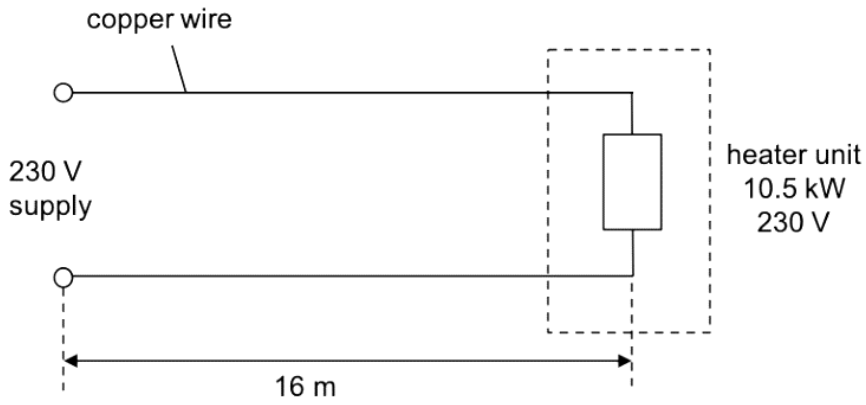



**Fig. 15.1**

**(a)** Calculate the current in the heater when it is operating at 230 V.

current = ……..... [1]

**(b)** Explain why the resistance of the two wires causes the potential difference across the heater unit to be lower than 230 V.

……..……..

……..……..

……..……..

……..……..

……..……..

……..… [2]

**(c)** The potential difference across the heater unit must not be less than 225 V. The two wires in the cable are made of copper of resistivity $1.8 \times 10^{-8}$ Ω m.

Given that the current in the wire is 40 A, calculate

**(i)** the maximum resistance of the cable,

maximum resistance = ……..... [2]

**(ii)** the minimum area of cross-section of each wire in the cable.

minimum area = ……..... [2]

**(d)** Explain why connecting the heater unit using wires of small cross-sectional area is dangerous.

……..……..

……..……..

……..……..

……..……..

……..… [2]

**(e)** A live wire may accidentally come into contact with the metal casing of the heater unit and this is a dangerous situation. Describe the connection of two electrical components to prevent this dangerous situation.

……..……..

……..… [1]

**15 OR**

Fig. 15.2 below shows an a.c. generator being used to light a small filament bulb.

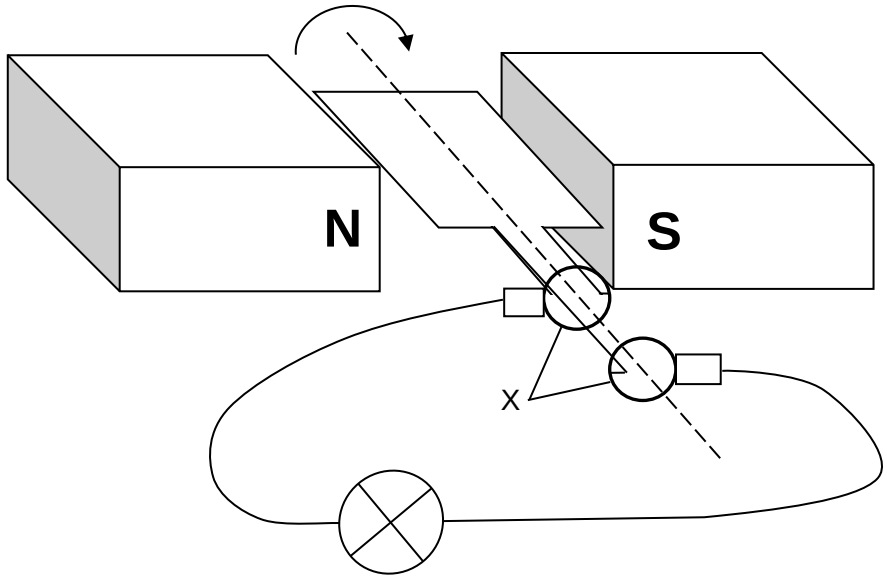



**Fig. 15.2**

When the coil is rotated, an electromotive force (e.m.f.) is produced in the coil.

**(a)** Explain why an e.m.f. is produced.

……..

……..

…… [2]

**(b)** State the purpose of the two components labelled X in Fig. 15.2.

……..

…… [1]

**(c)** At the instant shown in the Fig. 15.2, indicate clearly

**(i)** the direction of the induced current in the coil, [1]

**(ii)** the direction of the forces on both sides of the coil due to the induced current in the coil. [1]

**(d)** State how the answers to **(c)** would be different if the light bulb is removed (and the circuit is left opened).

……..

……..

…… [1]

**(e)** State **two** changes that could be made to the generator to make the bulb glow brighter.

……..

……..

……..

…… [2]

**(f)** Fig. 15.3 shows the variation of current flowing through the bulb as the generator coil is rotated at 20 Hz.

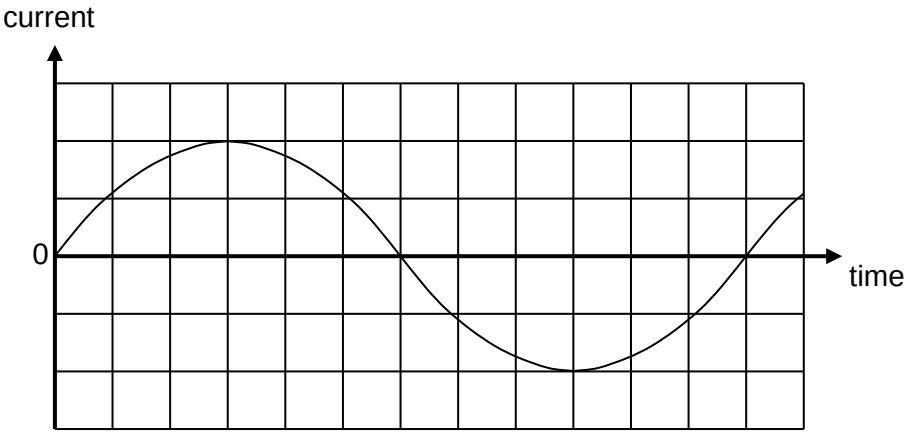



**Fig. 15.3**

On Fig. 15.3, draw the output from the same generator when the rate of rotation of the coil is increased to 30 Hz. [2]

**End of paper**

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