



Paya Lebar Methodist Girls' School (Secondary)
Preliminary Examination 2026
Secondary 4 Express

CANDIDATE NAME	()	CLASS	
		TG	

CENTRE NUMBER	S				
------------------	---	--	--	--	--

INDEX NUMBER				
-----------------	--	--	--	--

Physics (G3)

6091/02

Paper 2

25 August 2026

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and index number on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams or graphs.

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

Section A

Answer all questions.

Write your answers in the spaces provided.

Section B

Answer **one** question.

Write your answers in the spaces provided. Indicate the question number in the grid provided.

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 their working in a clear and orderly manner, as more marks are awarded for the sound use of Physics than for correct answers.

At the end of the examination, fasten all your work securely together.

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
Qn _____	
Total	/ 80

This document consists of 24 printed pages.

[Turn over

Section A

Answer **all** questions. This section is worth 70 marks.

- 1 Ball A is projected upwards under the influence of Earth's gravity. There is no air resistance acting on it. Fig. 1.1 shows the velocity-time graph of this ball.

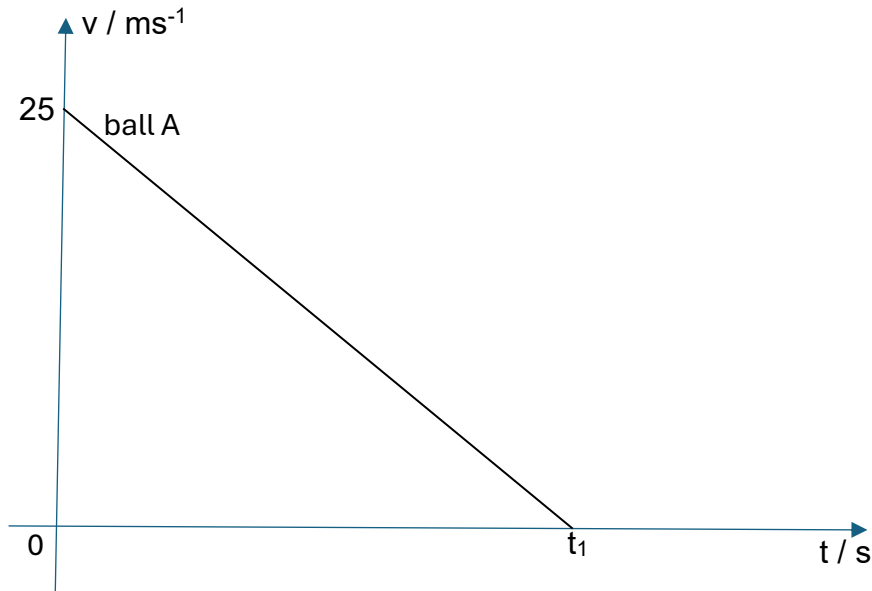


Fig. 1.1

- (a) Given that the magnitude of acceleration due to Earth's gravity is 10 m/s^2 , calculate t_1 .

$t_1 = \dots\dots\dots$ [1]

- (b) Hence, calculate the maximum height reached by ball A.

maximum height = $\dots\dots\dots$ [2]

- (c) Ball B is projected upwards with the same initial velocity as ball A. However, air resistance acts on ball B. The mass of ball B is the same as ball A.

- (i) On Fig. 1.1, sketch a graph to show the motion of ball B from the start until it reaches maximum height. Label your graph as B. [2]

- (ii) Using idea of forces and resultant force, explain the shape of your graph in (c)(i) and describe its motion.

.....

.....

.....

[2]

[total: 7 marks]

- 2 Fig. 2.1 shows a man in three different stages of a bungee jump. The chord attached to the man is elastic in nature. There is no air resistance acting on the man.

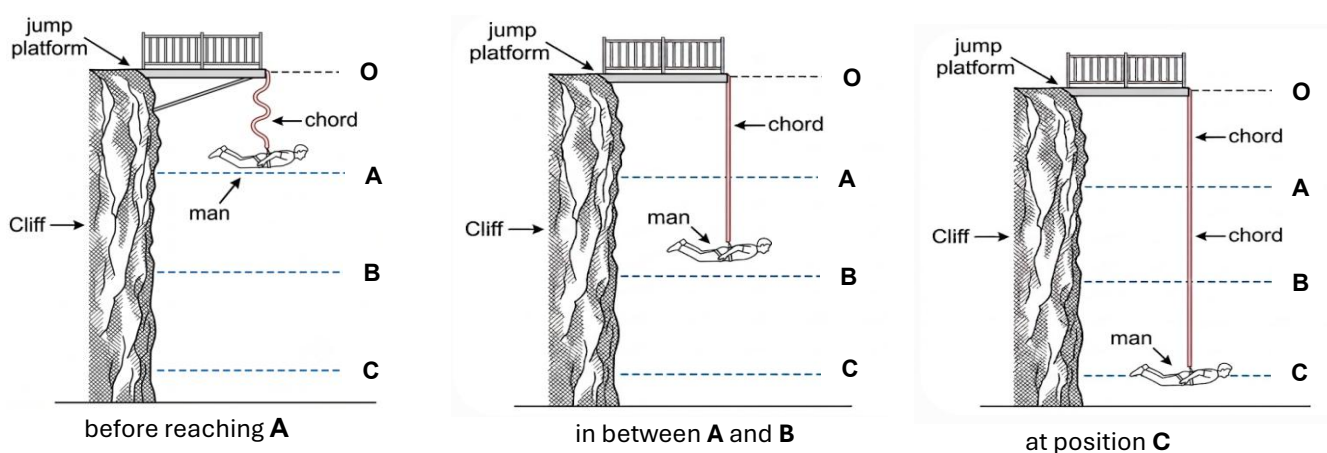


Fig. 2.1

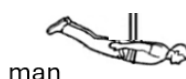
The man falls from rest at position O at the jump platform.

The chord **starts to stretch** at position A. The greater the stretching of chord, the larger its tension.

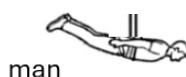
The man reaches maximum speed at position B and after B, the man starts to decelerate.

At position C, the man comes to a rest momentarily.

- (a) (i) Label the force(s) acting on the man **before** he reaches position A. Name the force(s). [1]



- (ii) Label the force(s) acting on the man when he is in between position A and B. Name the force(s). [1]



- (iii) On Fig. 2.2, sketch the speed-time graph of the man from position **O** to position **B**. [2]

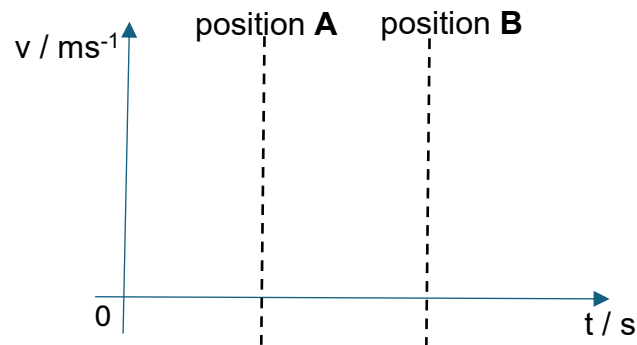


Fig. 2.2

- (b) The gravitational field strength is $g = 10 \text{ N/kg}$.

- (i) With reference to Fig. 2.1 and ideas of resultant force, explain why the man decelerates from **B** to **C**.

.....

[1]

- (ii) The man has a mass of 60kg. At position **C**, his deceleration is 3.0 m/s^2 . Calculate the upward force due to chord acting on him at this instant.

tension = [2]

[total: 7 marks]

- 3 (a) State what is meant by the centre of gravity of an object.

..... [1]

- (b) A non-uniform rod XY is pivoted at point P, as shown in Fig. 3.1.

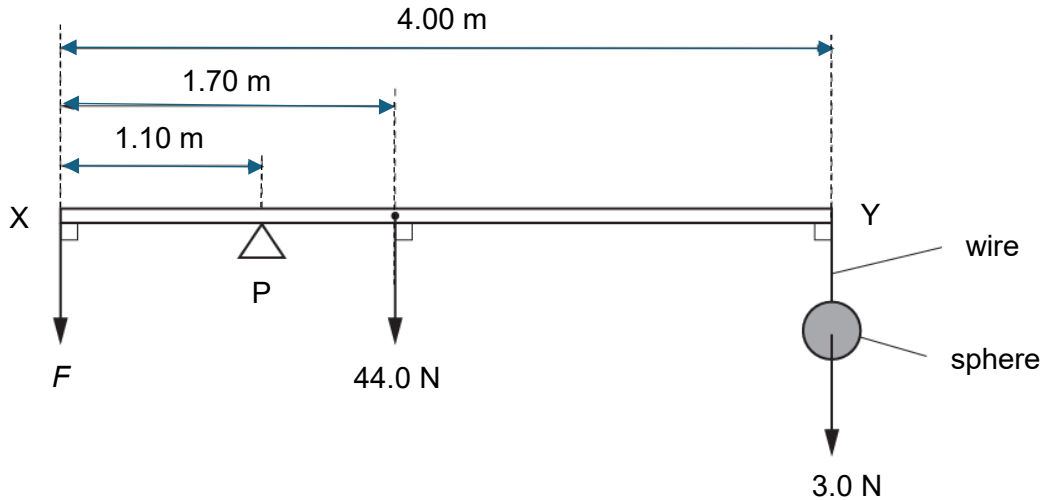


Fig. 3.1 (not to scale)

The rod has length 4.00 m and weight 44.0 N. The centre of gravity of the rod is 1.70 m from end X of the rod. Point P is 1.10 m from end X.

A sphere hangs by a wire from end Y of the rod. The weight of the sphere is 3.0 N. The weight of the wire is negligible.

A force F is applied vertically downwards at end X so that the horizontal rod is in equilibrium.

- (i) Calculate the mass of the sphere.

mass = [1]

- (ii) By taking moments about P, calculate F .

F = [2]

- (iii) Calculate the force exerted on the rod by the pivot.

force = [2]

[total: 6 marks]

- 4 A child of weight 330 N is at point X at the top of a slide. The slide is at the edge of a swimming pool, as shown in Fig. 4.1.

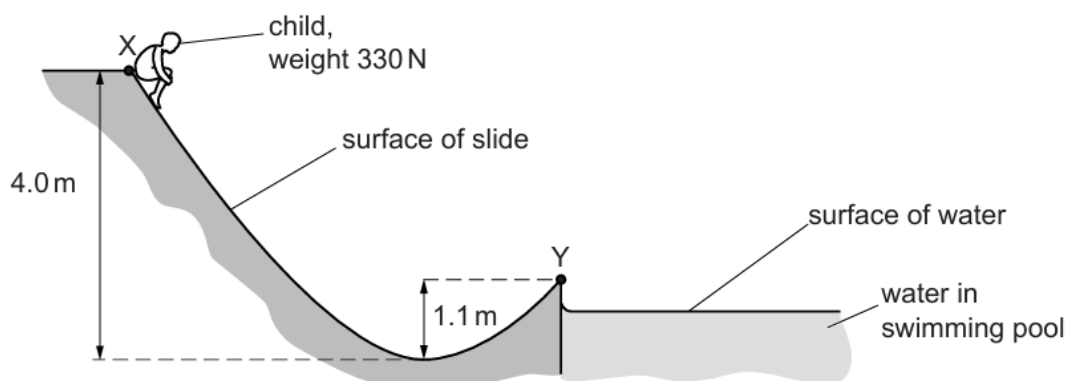


Fig. 4.1

The child moves from rest to the lowest point of the slide that is a vertical distance of 4.0 m below X.

The child continues moving towards point Y which is at the end of the slide and a vertical distance of 1.1 m above the lowest point.

The energy in the kinetic store of the child at Y is 540 J.

- (a) Calculate the difference in the energy in the gravitational potential store of the child at points X and Y.

difference in energy =J [2]

- (b) An average frictional force of 52 N acts on the child when moving from X to Y. By considering energy transfer, determine the distance moved by the child from X to Y.

distance moved =m [2]

- (c) With the concept of energy stores, describe how energy in the gravitational potential store is transferred as the child moves from X to Y.

.....

.....

[2]

- (d) Calculate the speed of the child at point Y.

speed =m/s [2]

[total: 8 marks]

- 5 Fig. 5.1 shows a U-tube glass with uniform cross sectional area of 0.80 cm^2 . It is used to determine the density of oil. The density of mercury and water are 13600 kg/m^3 and 1000 kg/m^3 respectively. The atmospheric pressure is taken to be 101000 Pa .

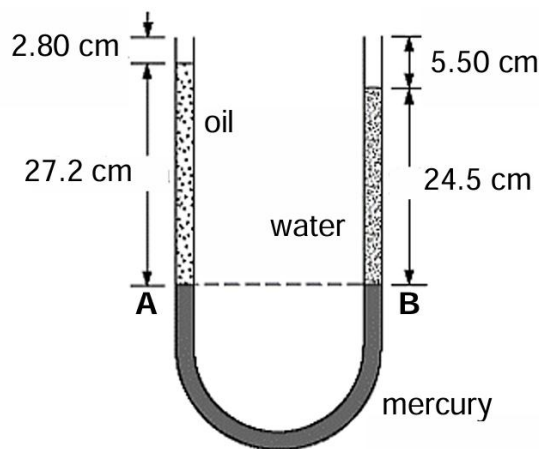


Fig. 5.1

- (a) By considering the relationship between the weight of oil and water, calculate the density of the oil.

density of oil = kg/m^3 [2]

- (b) Calculate the pressure at B.

pressure =Pa [2]

- (c) Fig. 5.2 shows another tube, identical to the U-tube except for a cone-shaped opening on the left, is filled with the same volume of mercury as in the previous set-up.

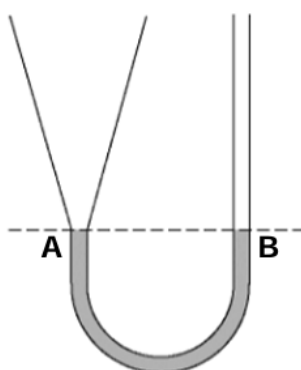


Fig. 5.2

Oil and water are poured respectively into the left and right sides of the tube. The volume of water that is poured into this set-up is exactly the same as the previous one.

State and explain if the height of the oil in this set-up will be equal, less than or greater than the previous one in order to maintain the height of the mercury at A and B.

.....

.....

..... [2]

[total: 6 marks]

- 6 Fig. 6.1 shows an air cooler that cools the air in a room by evaporation.

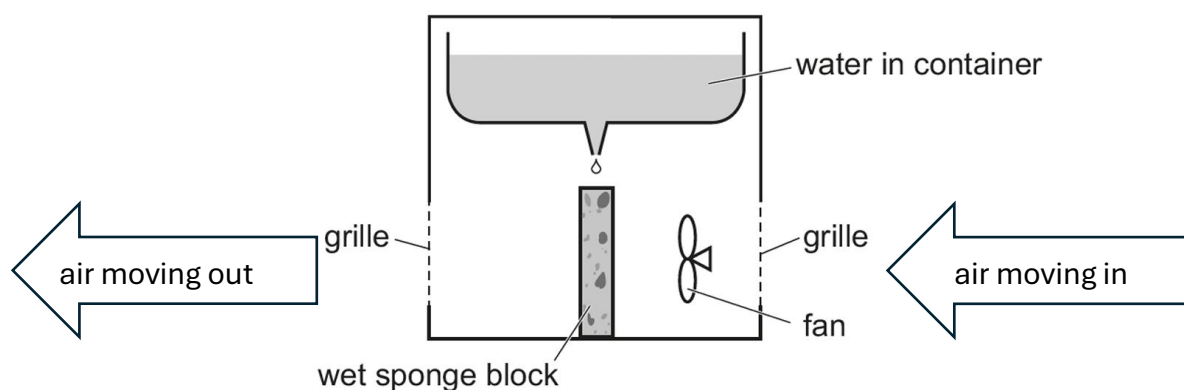


Fig. 6.1

Water drips from a container onto a sponge block and keeps the block wet. A fan draws air in through one grille and drives the air out through the grille on the other side. As the air flows through the wet sponge block, the water in the sponge block evaporates.

- (a) When the water evaporates, the temperature of water remaining in the sponge block decreases. Explain, in terms of the movement of particles, why this decrease in temperature occurs.

.....

.....

.....

..... [2]

- (b) Water in the sponge evaporates at a rate of 0.020 g per second. The specific latent heat of water is 3.34×10^5 J/kg. The input power to operate the fan is 45 W. Calculate the percentage efficiency of air cooler.

% efficiency =% [3]

[total: 5 marks]

- 7 Two sound waves X and Y travel along a straight line from point A to point B. Both waves have the same speed. The variation of displacement of the waves with distance from A at an instant in time is shown in Fig. 7.1.

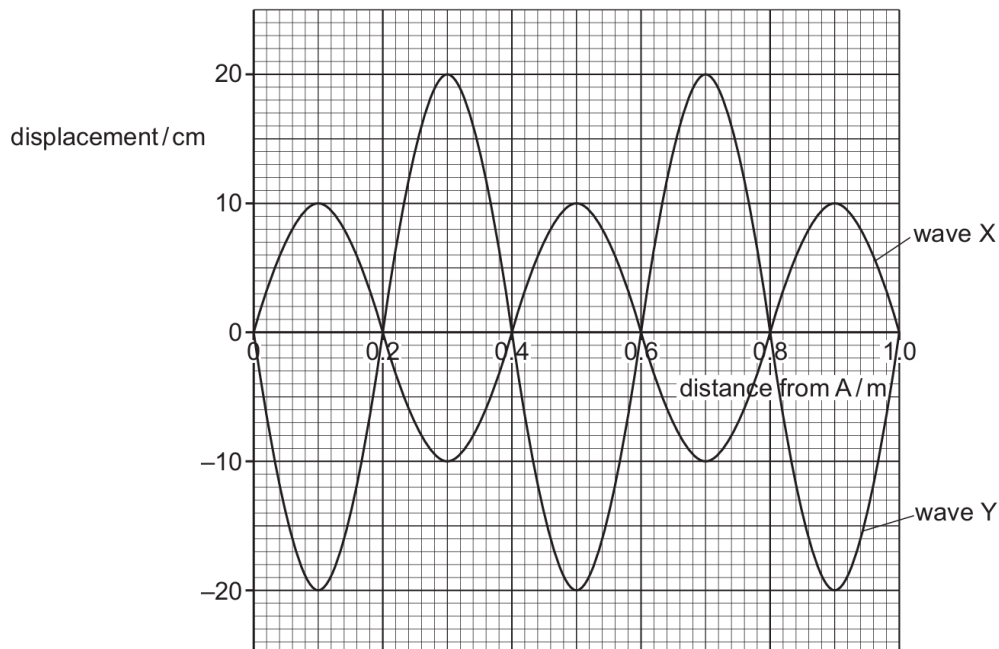


Fig. 7.1

- (a) State the following:

Amplitude of wave X:

Wavelength of wave Y:

[1]

- (b) State and explain which wave represents a louder sound.

.....

[1]

- (c) ChaiChai suggested that both waves X and Y are sound with same pitch. Do you agree? Explain your answer.

.....

.....

[2]

[total: 4 marks]

- 8 A battery of electromotive force (e.m.f.) 6.2 V is connected in a circuit to a uniform resistance wire (with 2 ends at position A and B), a voltmeter, a lamp R and a switch, as shown in Fig. 8.1.

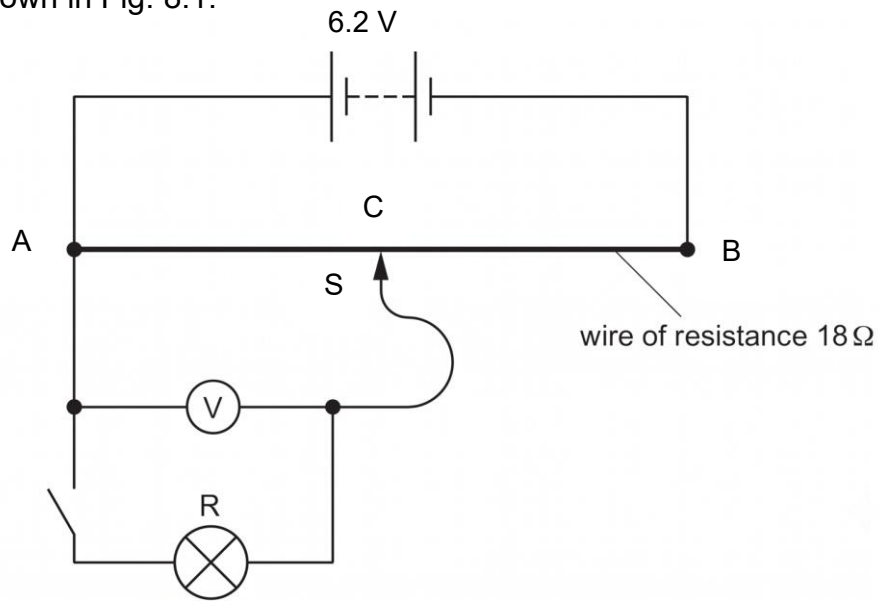


Fig. 8.1

The resistance wire has resistance $18\ \Omega$, length 0.94 m and cross-sectional area $7.2 \times 10^{-8}\ \text{m}^2$. The slider S is positioned half-way along the length of the wire at position C.

- (a) Calculate the resistance across AC.

resistance = [1]

- (b) (i) The switch is open.
Calculate the current in the resistance wire.

$I = \dots\dots\dots\text{A}$ [1]

- (ii) State the reading of the voltmeter when

• the slider S is at A: $V = \dots\dots\dots$

• the slider S is at B: $V = \dots\dots\dots$

[2]

- (c) The switch is now closed with lamp R clearly parallel to AC and slider S at point C. State if the reading of the voltmeter increases, decreases or stays the same. Explain your answer.

.....

.....

.....

.....

[2]

- (d) In another set-up, position AC is replaced with a rheostat and position CB is replaced with a fixed resistor. The set-up is shown in Fig. 8.2 below.

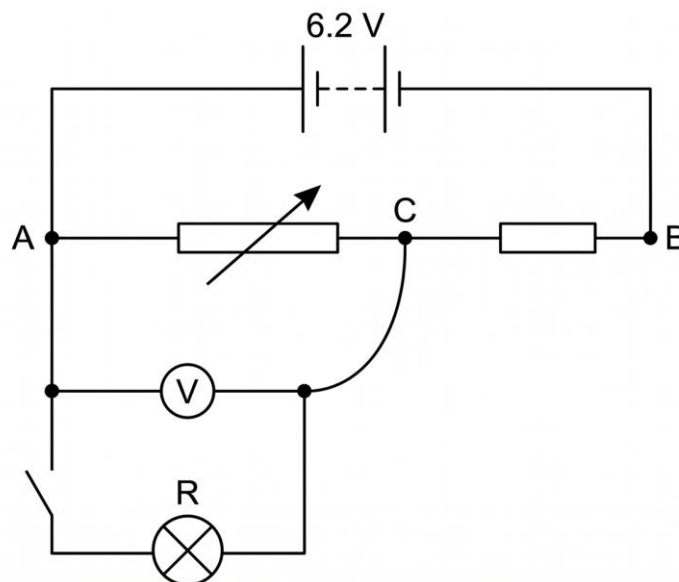


Fig. 8.2

Explain why the maximum brightness of the lamp in Fig. 8.2 is different from the maximum brightness of lamp in Fig. 8.1.

.....

.....

[1]

[total: 7 marks]

- 9 Fig. 9.1 shows an electrical wiring in a water heater. It consists of a heater coil rated 240 V, 2500 W and an exhaust fan rated 240 V, 300 W. The mains supply 240 V to the water heater.

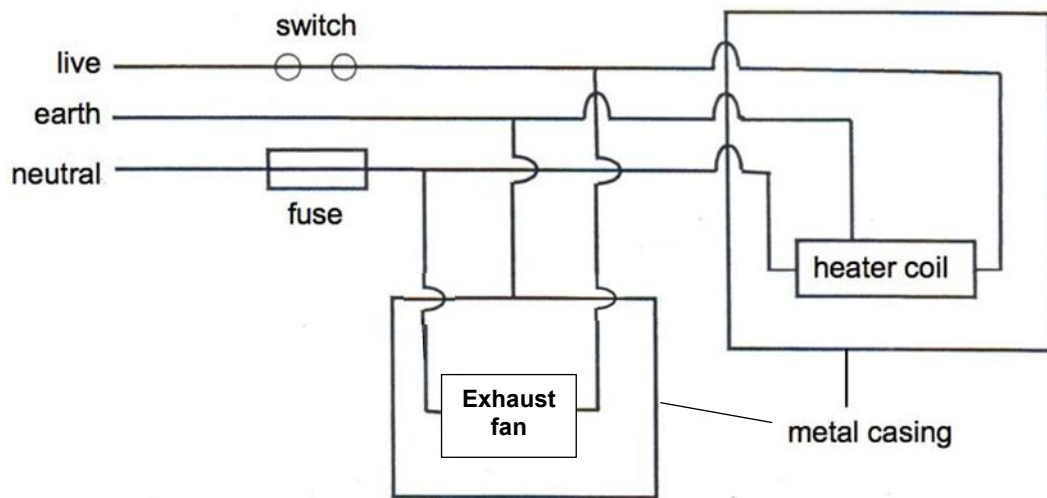


Fig. 9.1

- (a) The fuse rating in Fig. 9.1 is 11 A. Explain, with clear calculation, why the fuse rating is not suitable.

.....

.....

[2]

- (b) Identify two other faults in Fig. 9.1 and describe how they should be corrected.

.....

.....

.....

[2]

- (c) Fig. 9.2 shows the coil of a d.c. motor placed between the poles of a magnet. Current flows from the external circuit into the coil.

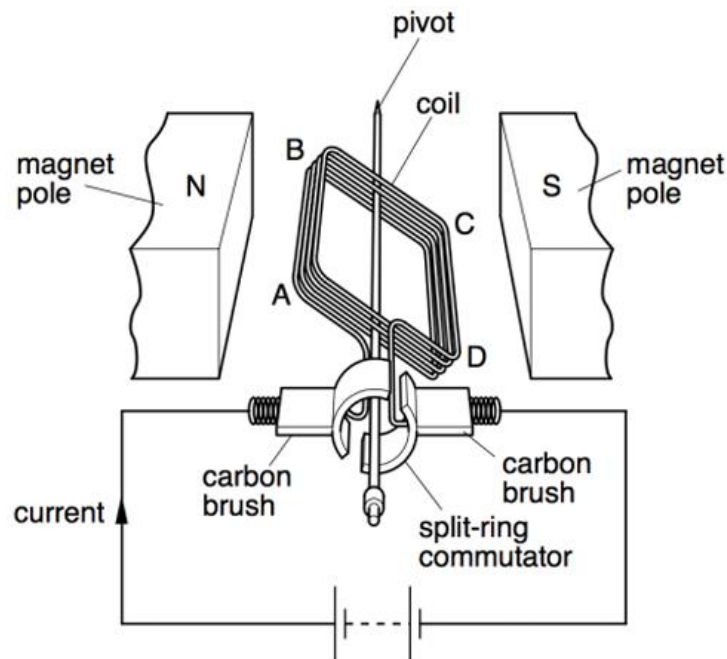


Fig. 9.2

- (i) On Fig. 9.2, draw the forces that act on side AB and CD of the coil. [1]

- (ii) Explain why there is a force acting on side AB.

.....

.....

..... [1]

- (iii) Explain the purpose of the split-ring commutator.

.....

..... [1]

- (iv) When the motor turns, there is an induced e.m.f. Explain why this induced e.m.f must be in a direction which reduces the current in the coil.

.....

.....

..... [1]

[total: 8 marks]

- 10** Wind turbines provide electrical energy by making use of wind to turn its turbine blades. As wind blows past the rotor blades, the blades will turn, which in turn spins a magnet placed between metal wires in a generator.

Fig. 10.1 shows a small wind turbine for domestic use.

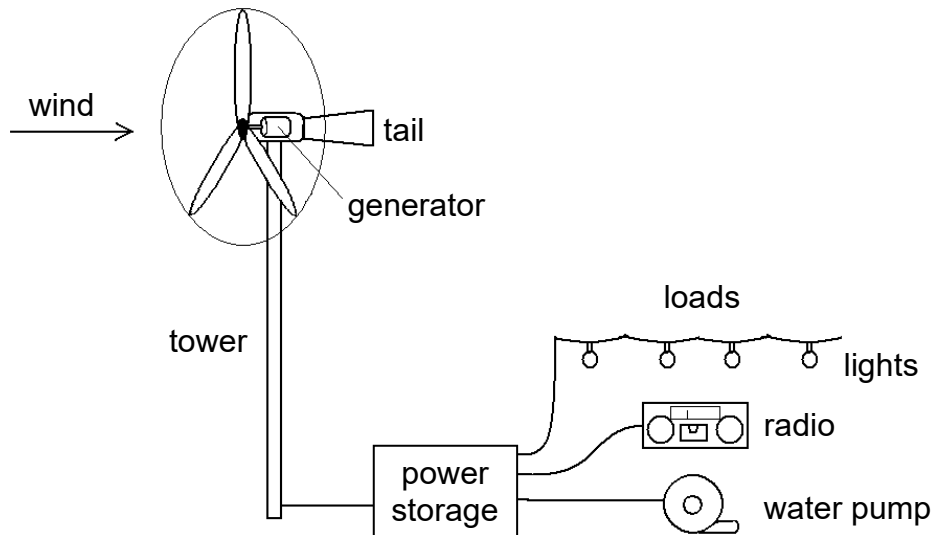


Fig. 10.1

- (a)** Table 10.1 below shows some specifications of the wind turbine.

Table 10.1

blade diameter	2.7 m
cut-in wind speed	2.5 m/s
cut-out wind speed	15 m/s
rated wind speed	9.0 – 15 m/s
maximum output power	650 W
output voltage (constant)	48 V (d.c.)
average annual energy output	2000 kWh

The minimum wind speed at which the generator **starts to produce** electricity is referred to as the cut-in wind speed. The wind turbine starts to turn at this speed.

The cut-out wind speed is the speed at which the turbine blades are **brought to a rest by external braking system**.

At the rated wind speed, the turbine generates electricity at its maximum output power.

The output voltage is always a constant value of 48 V.

Fig. 10.2 shows the electrical power generated by the wind turbine at different wind speeds.

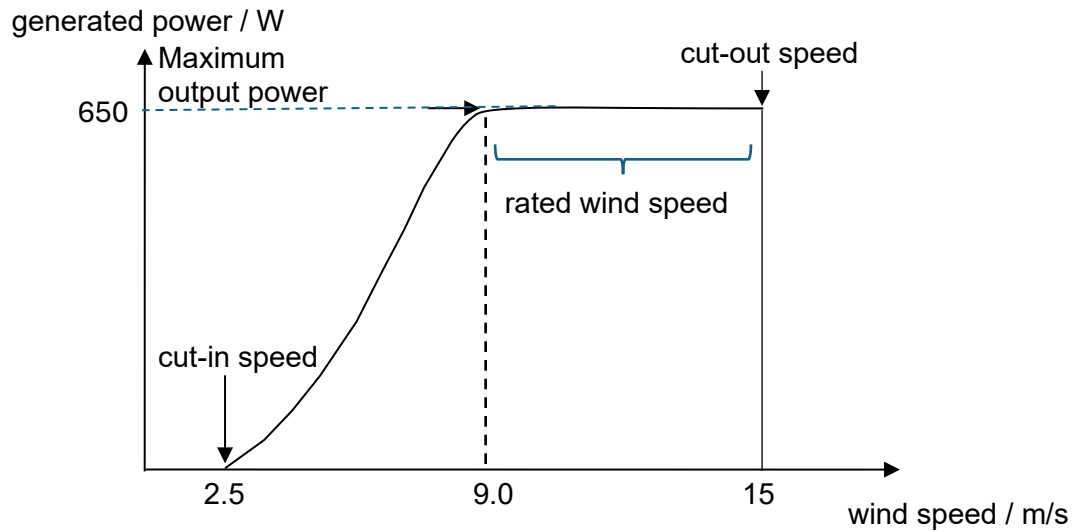


Fig. 10.2

- (i) With the idea of forces, suggest why the turbine blades could only start turning at the cut-in speed.

.....
 [1]

- (ii) Suggest what will happen to the turbine if it is not brought to rest at the cut-out speed.

.....
 [1]

- (b) On a particular day, the wind speed is 12 m/s.
 Determine the output current that is obtained from the turbine.

current = [2]

(c) A suggestion was made for a small home to be run solely on this wind turbine.

- (i) Assume 365 days in a year, calculate the average energy generated by the wind turbine in one day.

average energy per day =kWh [1]

- (ii) Assume that on an average day, the following are the electrical needs of the home.

lights	radio	water pump
600 W for 6 hours	20 W for 10 hours	750 W for 3 hours

Calculate the average energy used by the home in one day and hence explain whether this suggestion is suitable.

.....

.....

..... [2]

- (d) Fig. 10.3 shows the front view of the rotor blades of a wind turbine.

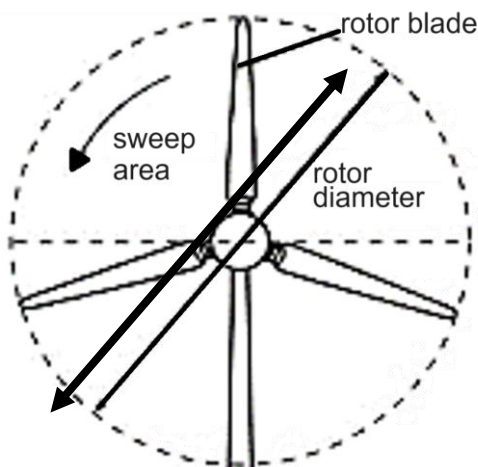


Fig. 10.3

- (i) When moving air particles move into the sweep area, a portion of the air particles hit onto the blades and leave the blades at slower speeds. The rest of the moving air particles that do not hit the blades pass through unaffected at original speeds.

Using the appropriate Newton's laws of motion, explain how the air particles hitting onto the blades results in a force that turn the rotor blades.

.....

 [2]

- (ii) On a particular day, a mass of 9 000 kg of air travelling at a speed of 4.0 m/s moves past the swept area of the blades in **each minute**.

25% of this moving air hits onto the blades and leaves the blades at a slower speed of 1.0 m/s. The rest of the moving air passes through unaffected at their original speed.

1. Calculate m' , the mass of the air that hits onto the blades in each second.

$m' = \dots\dots\dots$ [1]

2. Hence, by considering the energy transferred to the kinetic store of the blades in each second, calculate the power developed in the turbine.

power = $\dots\dots\dots$ J/s [2]

[total: 12 marks]

Section B

Answer **one** question from this section.

- 11 (a)** An aircraft is flying horizontally at constant speed v through the vertical component of Earth's magnetic field, as shown in Fig. 11.1.

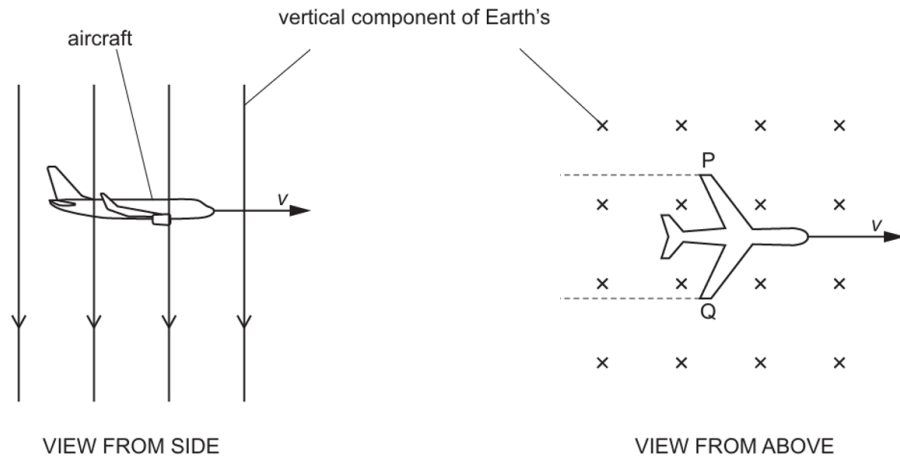


Fig. 11.1

At the location of the aircraft, the vertical component of the Earth's magnetic field pointing towards the ground. As the aircraft moves through the magnetic field, an electromotive force (e.m.f.) is induced between the wingtips P and Q. An induced current is produced.

- (i)** Explain why there is an induced e.m.f between PQ.

.....

 [1]

- (ii)** State the direction of induced current across the wingtips.

..... [1]

- (iii)** Which point P or Q is at a higher potential?

..... [1]

(b) Fig. 11.2 shows the cross-section of the wing of the plane.

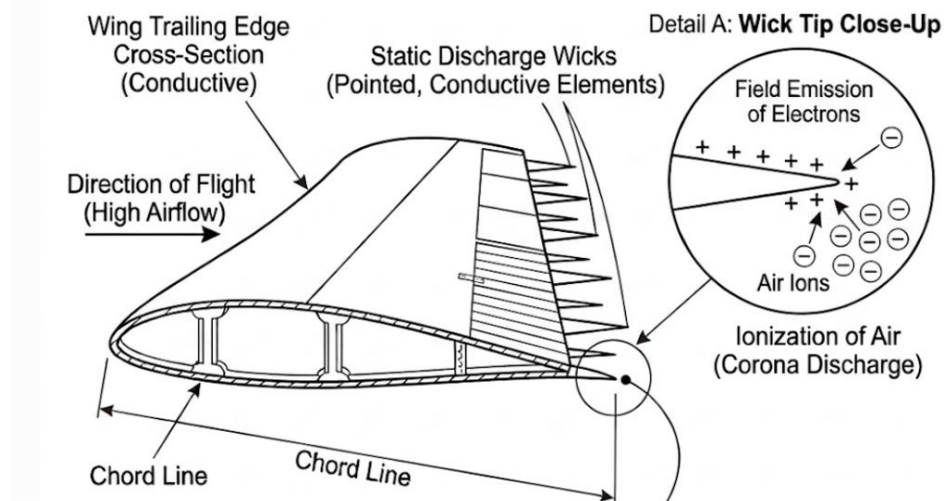


Fig. 11.2

The static discharge wicks are pointed edges installed at the rear of the wing as shown. Its purpose is to discharge any static electricity residing in the wings.

Other than the induced current stated in (a), explain another mechanism where the wing can become electrically charged with the idea of atoms/molecules.

.....
 [1]

(c) Fig. 11.3 shows a simple electricity transmission system.

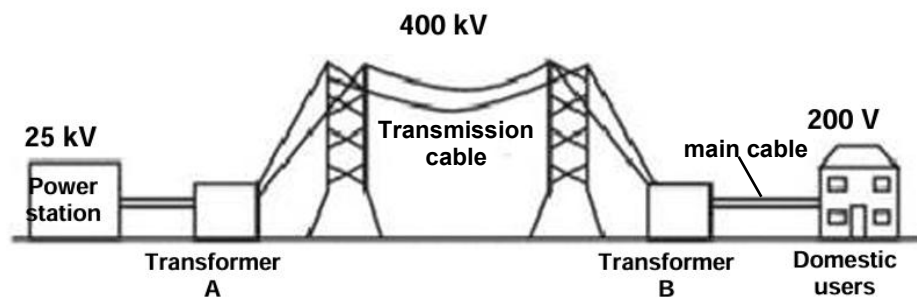


Fig. 11.3

The current in the main cable supplying electricity to the domestic users is 12.5 A. Both transformers are 100% efficient.

(i) Calculate the current in the transmission cable.

current = [2]

- (ii) Explain why the voltage across transmission cable is step up to a very high value from 25 kV at the power station.

.....

..... [1]

- (d) Nucleus P undergoes α -decay to form nucleus Q. Nucleus Q then undergoes a further decay to form nucleus R. The proton and nucleon numbers of P and R are shown in Fig. 11.4.

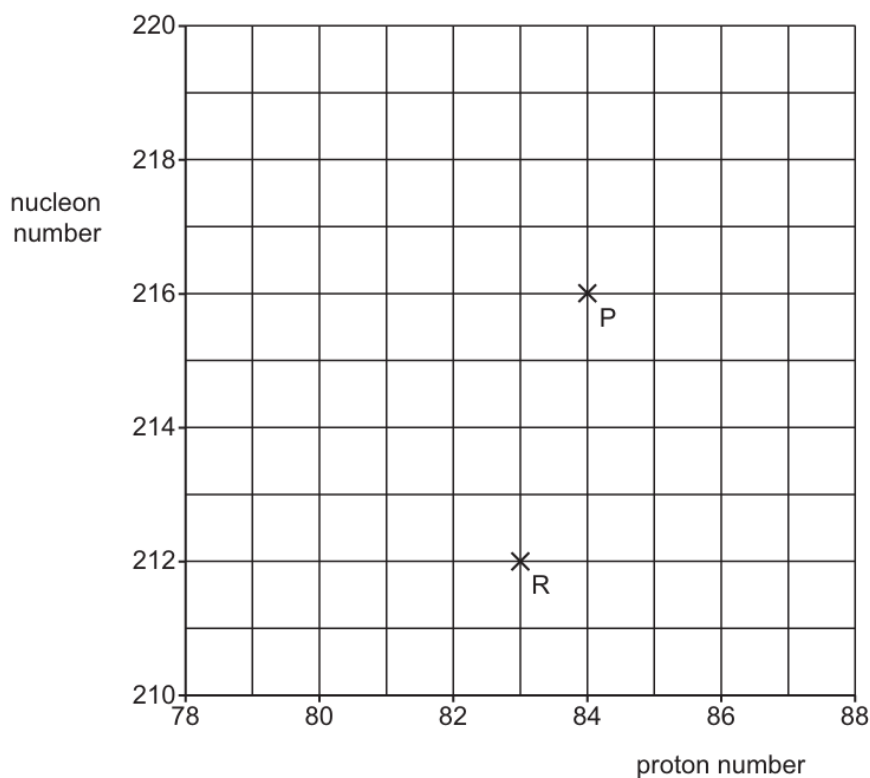


Fig. 11.4

- (i) For nucleus Q, state its

nucleon number =

proton number =

[2]

- (ii) Circle the correct process where nucleus Q decays to form nucleus R.

alpha decay

beta decay

gamma decay

[1]

[total: 10 marks]

- 12 (a) Fig 12.1 shows a ray of light passing through a plastic converging lens.

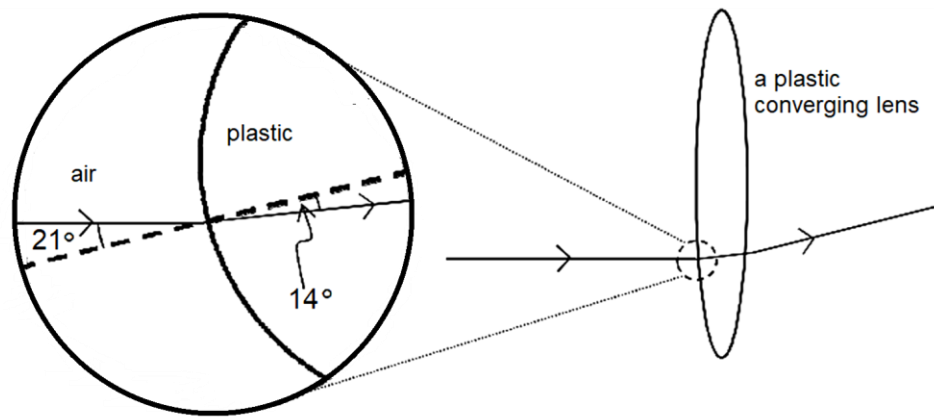


Fig. 12.1

- (i) State one physical quantity of the light wave that does **not** change as it enters from air into the plastic lens.

..... [1]

- (ii) Using information given in Fig. 12.1, calculate the speed of light inside the plastic lens.

speed = [2]

- (b) Fig 12.2 shows three light rays from an object incident on the converging lens.

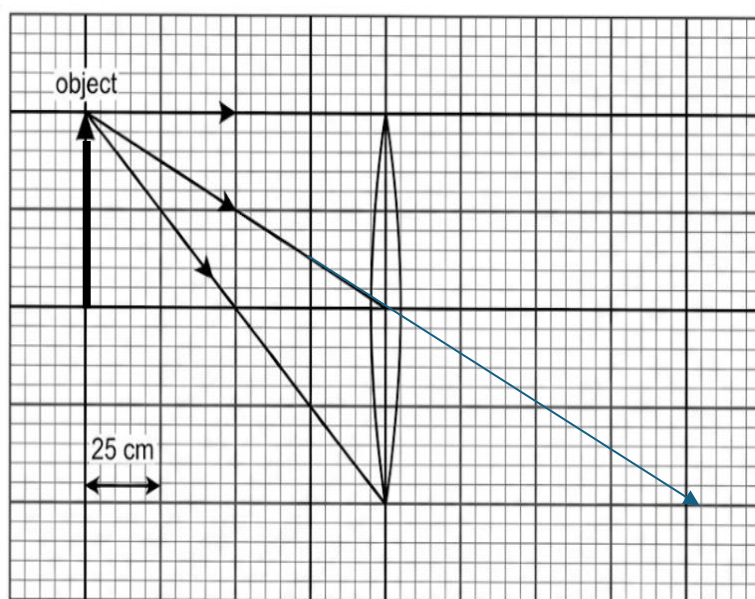


Fig. 12.2

Linear magnification is defined as

$$\frac{\text{image height}}{\text{object height}}$$

The linear magnification of the lens is 0.70.

- (i) On Fig. 12.2, locate and draw the image of the object. [Hint: you need to draw additional light rays and make use of the linear magnification.] [2]
- (ii) On Fig. 12.2, locate the focal point of the lens. Label it as F. [Hint: you need to draw additional light rays] [1]
- (c) Fig. 12.3 shows the count rate of a detector placed near a radioactive source. The radioactive source has a short half-life.

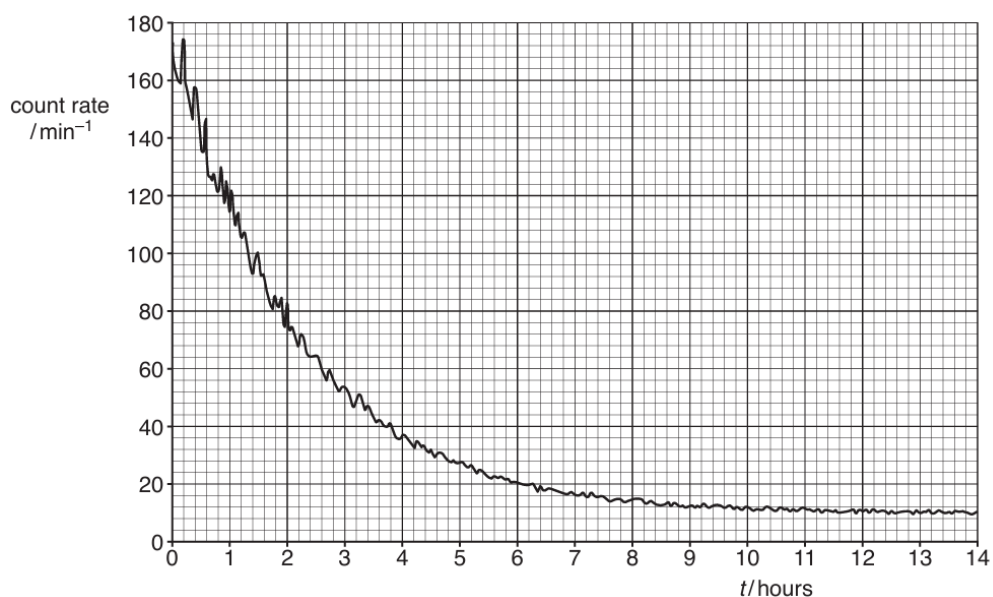


Fig. 12.3

- (i) From Fig. 12.3, estimate the count rate due to background radiation.

Count rate =min⁻¹ [1]

- (ii) State the feature of Fig. 12.3 that indicates the random nature of radioactive decay.

..... [1]

- (iii) A software is used to “smoothen” the curve in Fig. 12.3. Fig. 12.4 shows the smooth curve model.

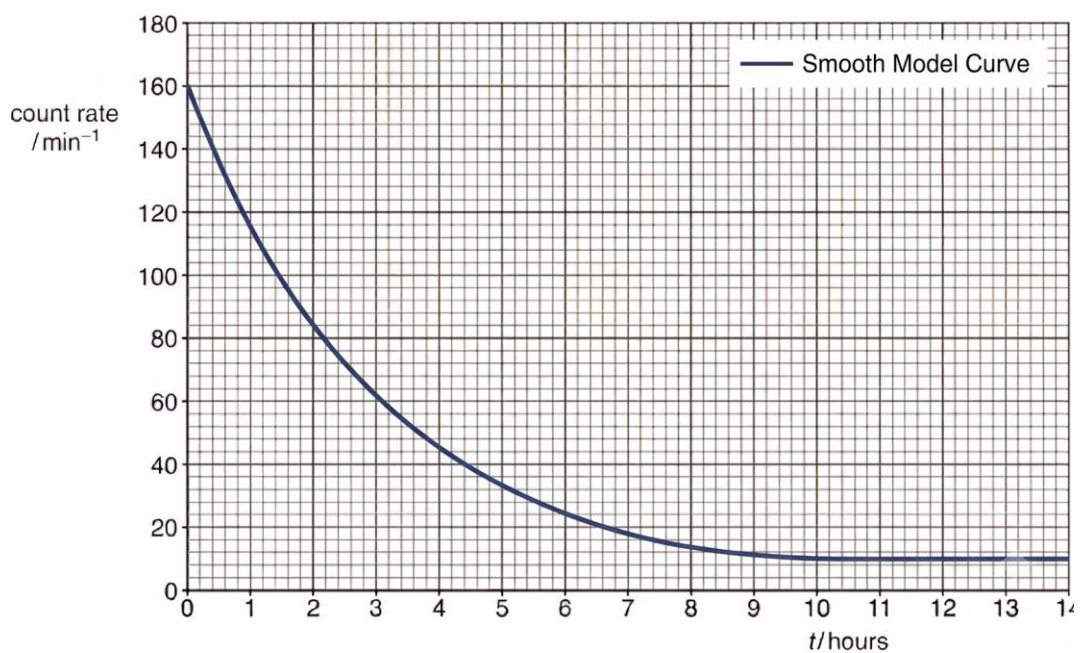


Fig. 12.4

From Fig. 12.4, determine the half-life of the radioactive isotope. Show your working on Fig. 12.4.

half-life = [2]

[total: 10 marks]

End of paper

