Name: .... (   )

ASSUMPTION ENGLISH SCHOOL
PRELIMINARY EXAMINATION 2024

PHYSICS
6091 / 02

LEVEL: Sec 4 Express **DATE:** 23 August 2024

CLASS: Sec 4/1 **DURATION:** 1 hour 45 minutes

Additional Materials provided: -

INSTRUCTIONS TO CANDIDATES
Do not open this booklet until you are told to do so.

Write your NAME and INDEX NUMBER at the top of this page.

SECTION A (70 marks)
STRUCTURED QUESTIONS
Answer **all** questions. Write your answers in the spaces provided on the question paper.

SECTION B (10 marks)
FREE-RESPONSE QUESTIONS
Answer **one** question. Write your answers in the spaces provided on the question paper.

For Examiner's Use	
Paper 1	**40**
Paper 2 Section A	**70**
Paper 2 Section B	**10**
Paper 3	**40**
Total %	**100**

At the end of the examination, hand in this question booklet.

SECTION B – STRUCTURED QUESTIONS (70 marks)
Answer **all** the questions in the spaces provided.

1 Fig 1.1 shows the speed-time graph of the object moving across a surface in a straight line.

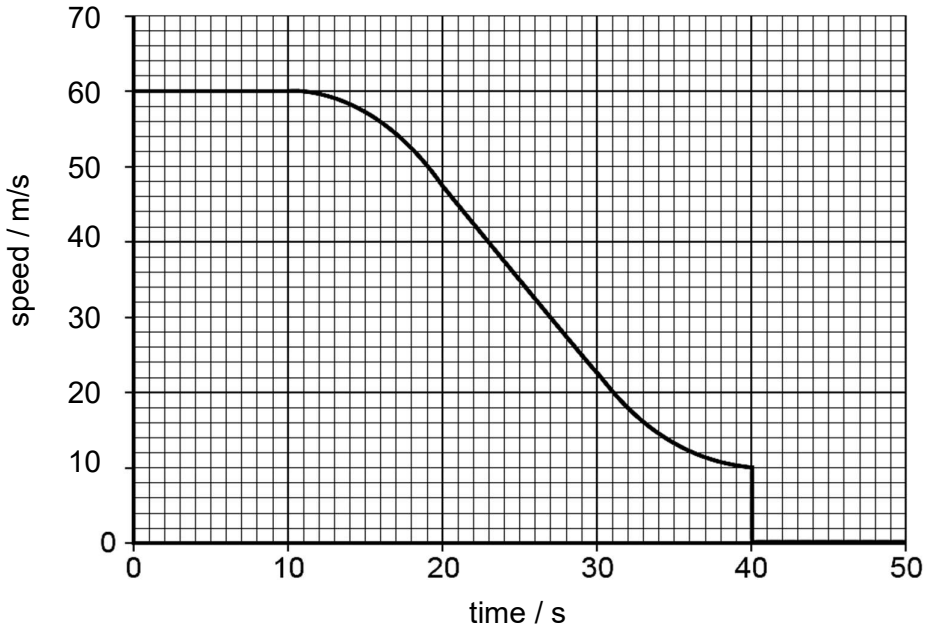


Fig 1.1

(a) **(i)** State a difference between speed and velocity.

……..

…….. [1]

(ii) Calculate the deceleration of the object at t = 25 s.

deceleration = …… [2]

(b) **(i)** On Fig. 1.1, mark a point **D** when the object has increasing deceleration. [1]

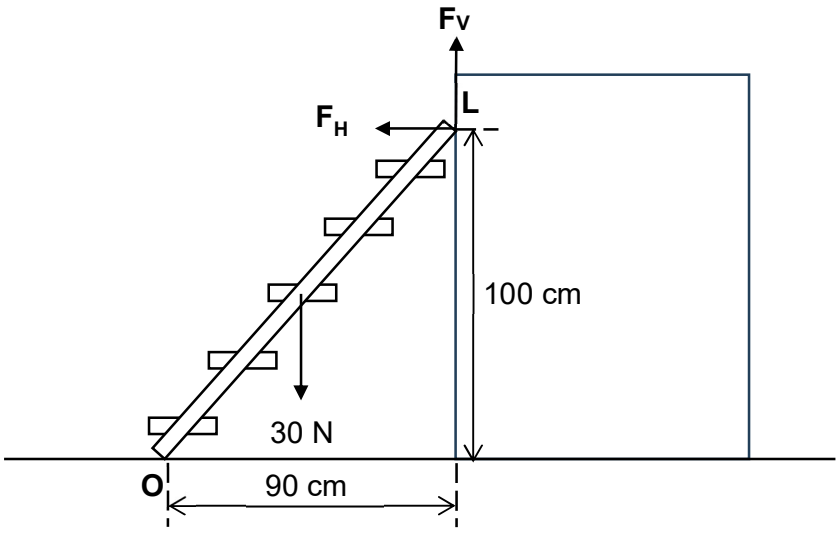
(ii) Using ideas about forces, explain why the object begins to slow down from 10 s.

……..

……..

…….. [2]

2 A ladder of weight 30 N is fixed to a wall at **L**. The weight of the ladder acts through the mid-point of the ladder. The wall exerts a horizontal force $\mathbf{F_H}$ and a vertical force $\mathbf{F_V}$ on the ladder at **L**.



(a) **(i)** State what is meant by the *moment of force*.

……..

…….. [1]

(ii) Calculate the clockwise moment about **O**.

clockwise moments = …… [2]

(b) A man on the ground begins to climb the ladder.

(i) State how the clockwise moments about point **O** change, if at all, as the man moves up the ramp. Explain your answer.

……..

……..

……..

…….. [2]

(ii) Suggest a point on the diagram, at which another force must act on the ramp.

…….. [1]

(iii) By considering moments about **L**, explain why this other force is necessary.

……..

……..

……..

…….. [2]

3 A syringe contains trapped air, as shown in Fig. 3.1. The piston inside the syringe is free to move up and down in the syringe. When the syringe is placed in hot water, the piston moves upwards as shown in Fig. 3.2.

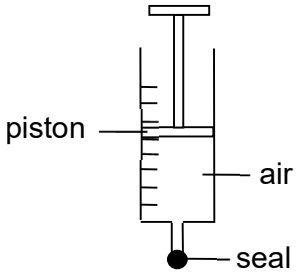


Fig. 3.1

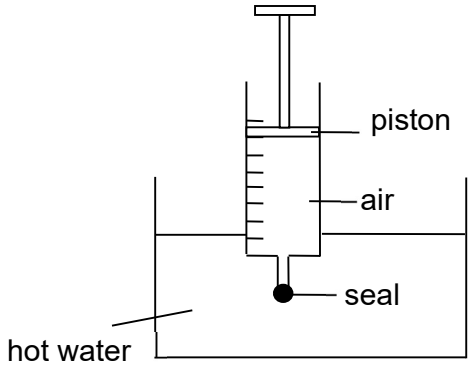


Fig. 3.2

(a) Explain, in terms of molecules,

(i) why the air inside the syringe exerts a pressure on the piston,

……..

……..

……..

…….. [2]

(ii) how pressure in the syringe change when it is placed in hot water.

……..

……..

……..

…….. [2]

(b) Explain why hot water evaporates faster than cool water.

……

……

……

…… [2]

(c) Some ice is added to the hot water. Describe the change in the internal stores of the ice during melting.

……

……

……

…… [2]

4 A rope is being displaced vertically at a frequency of 2.5 Hz. The displacement-distance wave of the rope is shown in Fig. 4.1. The wave is moving towards the right.

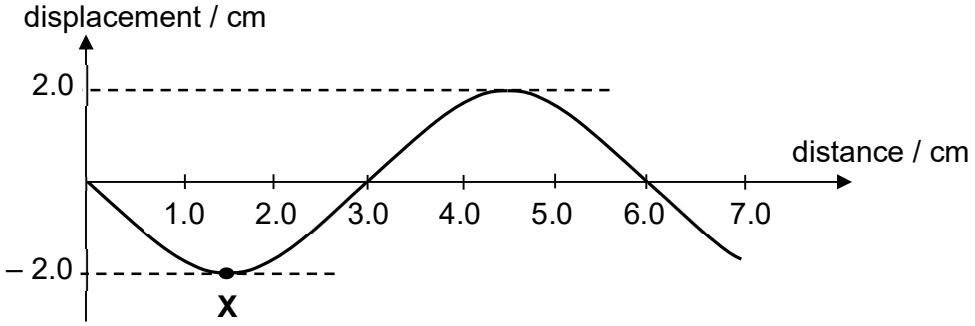


Fig. 4.1

(a) For each statement, write **T** for true or **F** for false.

	T or **F**
(i) The wave has an amplitude of 3.0 cm.	
(ii) The particle at **X** is moving upwards at the next instant.	
(iii) The speed of the wave is 15 m/s.	
(iv) Each wave takes 0.4 s to complete.	

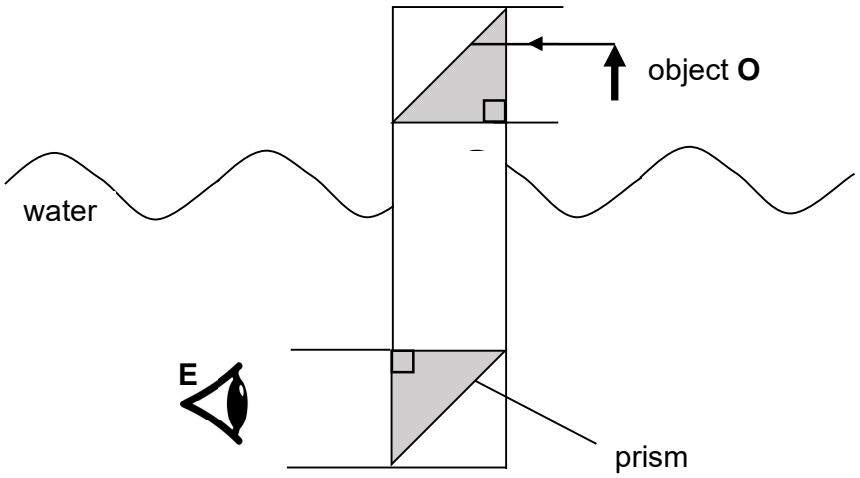
[2]

(b) State a difference between the wave formed by the rope and ultrasound.

……

…… [1]

5 A periscope is used in a submarine to view object **O** above the water surface. One type consists of two triangular prisms that are fixed at each end of the periscope.



Each prism has angles of 90° and 45°. The critical angle of light in the glass is 42°. The image of the object is viewed at **E**.

(a) A ray from the top of object **O** enters the top prism without bending. Explain.

……

…… [1]

(b) State **two** reasons why light is reflected inside each prism.

1:……

……

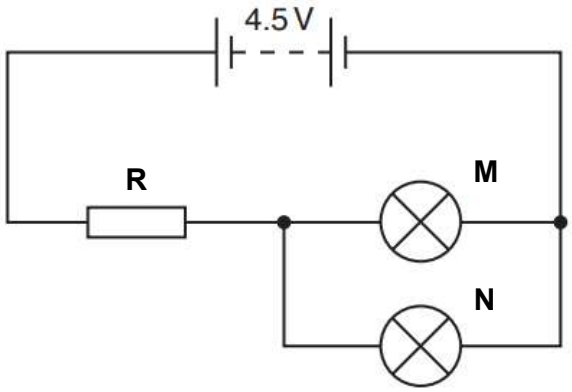
2:……

…… [2]

(c) Determine the refractive index of glass.

refractive index = …… [2]

6 A battery of electromotive force 4.5 V is connected to two filament lamps **M** and **N** and a resistor **R**.



The I-V characteristics of the filament lamps are shown in Fig. 6.1.

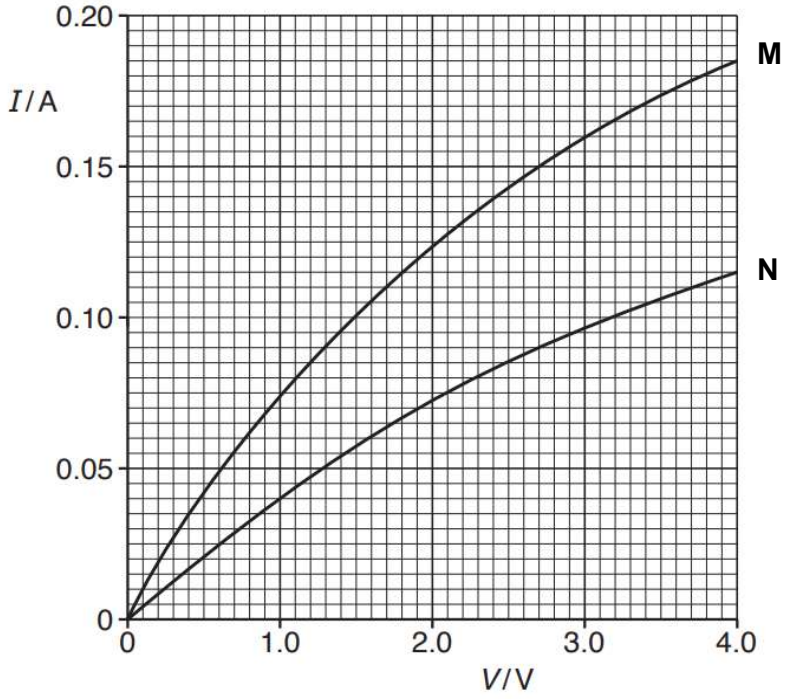


Fig. 6.1

(a) Using Fig. 6.1, explain which filament lamp has a greater resistance given that the potential difference across the two lamps is the same.

……

……

…… [2]

(b) The two filaments are made from the same type of metal. They both operate at the same temperature.

Suggest why one filament could have a resistance greater than that of the other filament.

……

…… [1]

(c) Given that current flowing in **M** is 0.15 A, calculate

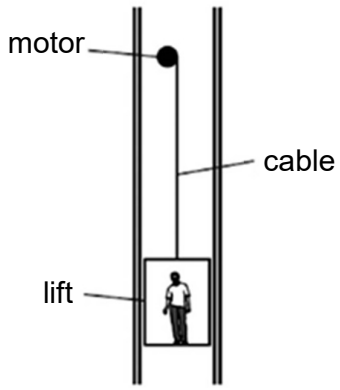
(i) the current flowing in the battery,

current = …… [1]

(ii) the charge flowing through the battery in 10 minutes.

charge = …… [2]

7 An electric motor is used to raise a lift which is carrying a passenger who has a mass of 70 kg. The mass of the empty lift is 610 kg and the lift has a rating of 40 kW, 240 V. The gravitational field strength of Earth is 10 N/kg.



(a) Calculate the current drawn by the lift during normal operation.

current = ... [2]

(b) The initial acceleration of the lift is 2.3 m/s^2. Calculate the tension in the cable.

tension = ... [2]

(c) The lift with its passenger took 4 s to move a vertical distance of 13 m from level 1 to level 5 and came to a stop. Calculate the efficiency of the lift system.

efficiency = ... [3]

(d) Explain why the lift must be earthed.

……

……

…… [2]

8 Fig. 8.1 is a model of a device that is used to show how a Ferris wheel works. When the switch is closed, the metal spoked wheel starts to rotate.

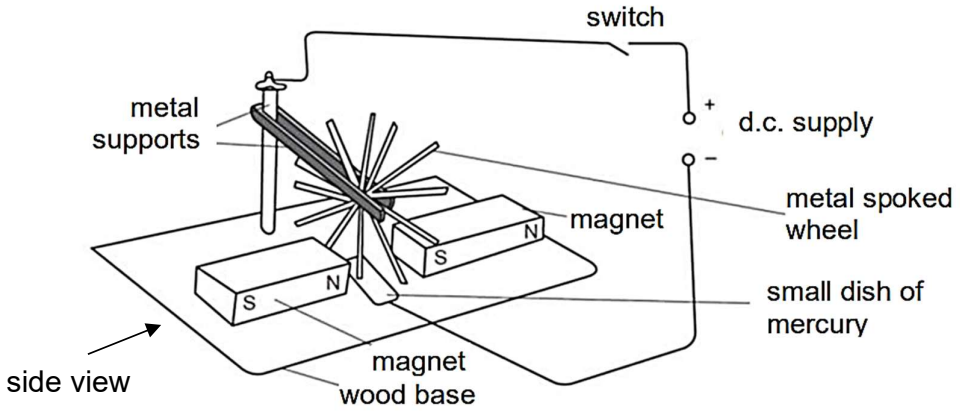


Fig. 8.1

The current flowing in a particular metal spoke causes a force to act on it.

(a) On Fig 8.1, draw the current that flows in the metal spoke. Label it as **I**. [1]

(b) Explain why the wheel starts to rotate.

……

……

…… [2]

(c) **(i)** State the direction that the wheel rotates when viewed from the side.

…….. [1]

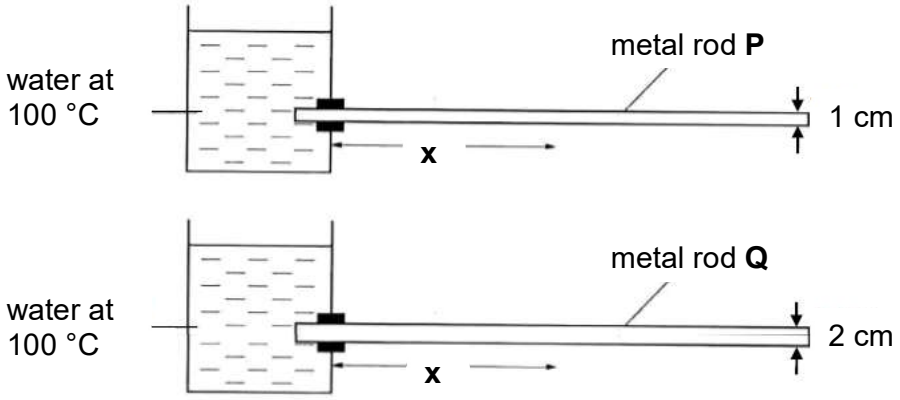
(ii) Describe how you determined the direction of the force on the spoke.

……..

……..

…….. [1]

9 Two aluminium rods of equal length, **P** and **Q**, have the same initial temperature but different diameters. They are each clamped at one end to an identical water bath maintained at a temperature of 100 °C.



The apparatus is left for 5 minutes until the temperature at any point along each rod remains constant.

The temperature of the rods is then measured at various distances, **x**, using an infra-red thermometer. Table 9.1 shows the readings recorded.

Table 9.1

	rod **P**	rod **Q**
x / cm	temperature / °C	temperature / °C
0.0	100	100
2.5	92	88
5.0	84	76
7.5	78	68
10.0	73	61
12.5	68	55
15.0	63	50
17.5	59	46
20.0	56	42
22.5	54	38
25.0	53	36
27.5	52	35
30.0	51	34

(a) Using data from Table 9.1, state the relationship between distance **x** and temperature in rod **P**.

1. for smaller **x** ……

……

……

2. for larger **x** ……..

……

…… [2]

(b) At the same distance away from the water bath, the temperature of rod **P** and rod **Q** is different. Suggest why.

……

……

…… [2]

(c) Explain how thermal energy is transferred from the water bath to the end of the rod.

……

……

…… [2]

(d) Describe two ways in which thermal energy is transferred away from the rod.

……

……

…… [2]

(e) The experiment is repeated using iron rods.

Table 9.2 shows the specific heat capacities of aluminium and iron.

Table 9.2

aluminium	iron
920 J/kg K	460 J/kg K

Suggest how the values of the temperature might be different.

……

……

…… [2]

10 **(a)** Fig. 10.1 illustrates a nuclear reaction of uranium-235 in a nuclear reactor.

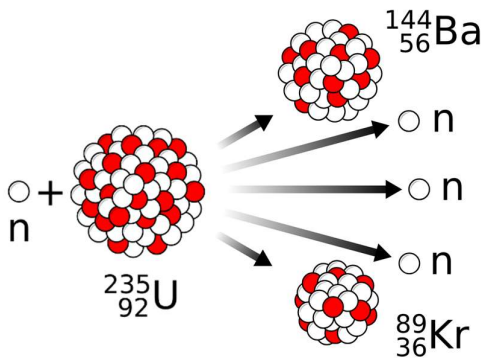


Fig. 10.1

(i) Identify the type of nuclear reaction in Fig. 10.1.

…… [1]

(ii) Explain your answer in part **(a)(i)**.

……

……

……

…… [2]

(iii) In nuclide notation, uranium-235 is written as $^{235}_{92}U$.

Write down the nuclide equation of this reaction.

…… [1]

(b) Describe the principal energy transfer in the nuclear reactor.

……

……

……

…… [2]

(c) Krypton-89 is an isotope used in the radioactive source in Fig. 10.2. A nucleus of krypton-89 emits a beta-particle as it decays.

In a factory, rollers press aluminium metal to make thin foil sheets. An automatic system changes the gap between the top and bottom rollers to control the thickness of the foil.

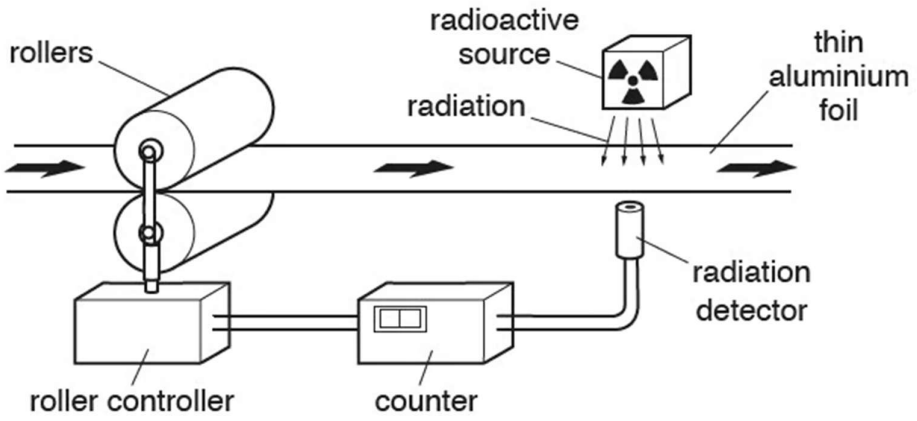


Fig. 10.2

(i) State a reason why beta-particle is used to check the thickness of aluminium.

……..

…….. [1]

(ii) The aluminium foil passing the radiation detector is too thin. Describe how this fault affects the reading on the counter.

……..

…….. [1]

(iii) Explain how beta-particles can be harmful to humans.

……..

……..

……..

…….. [2]

SECTION B – FREE RESPONSE QUESTIONS (10 marks)
Answer **one** question from this section.

11 In Fig. 11.1, an electrical device **X** is connected to a fixed resistor that has a resistance of 5.0 kΩ.

The output voltage, V_{out}, is connected to a lamp (not shown in diagram). The lamp will be switched off when V_{out} is less than 5.0 V.

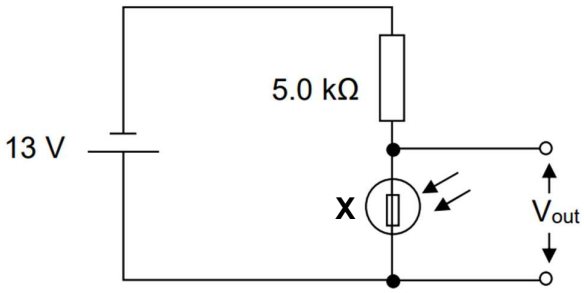


Fig. 11.1

(a) **(i)** State the name of device **X**.

…….. [1]

(ii) Describe how **X** can be used to switch off the lamp.

……..

……..

……..

…….. [2]

(b) At a particular time of a day, V_{out} is 8.0 V and the current flowing in the lamp is 0.50 mA.

(i) Define *current*.

……..

…….. [1]

Calculate

(ii) the current flowing in the fixed resistor,

current = …… [2]

(iii) the resistance of **X**.

resistance = …… [2]

(c) State a way to increase the lifetime of the dry cell.

……

…… [1]

(d) Suggest why device **X** is preferred over switching off the lamp at a fixed timing every day.

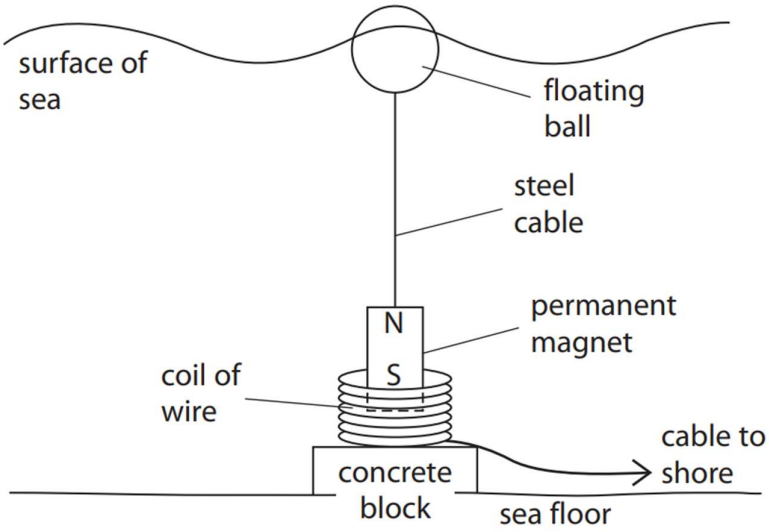
……

……

…… [1]

12 Scientists are looking for new ways to produce electricity from renewable resources.

The diagram shows a model of a device to generate electricity from tidal waves. A ball, which is made to float on the surface of the sea, is attached to a permanent magnet. A coil is fixed to the concrete block and the magnet can move freely inside the coil.



(a) Describe how this device produces an alternating electric current.

.....

.....

.....

.....

.....

..... [4]

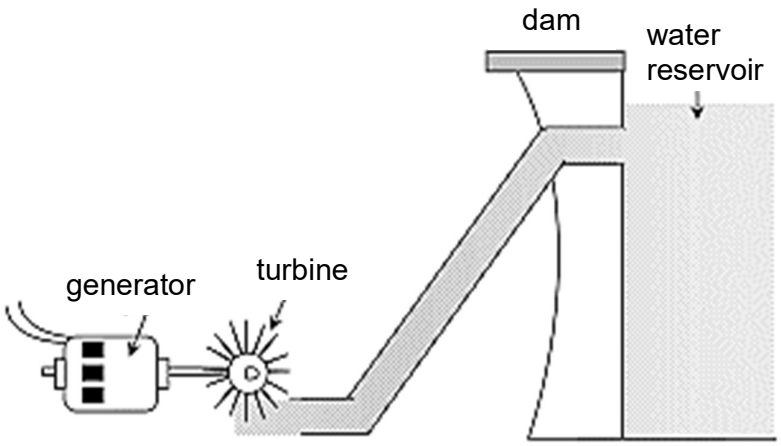
(b) Explain the effect of the speed of the tidal waves on the electric current produced.

.....

.....

..... [2]

(c) Another way of producing electricity from a renewable source is hydropower. Water flowing down a dam turns the turbine which in turn generates electricity.



(i) Explain why the efficiency of hydropower is never 100%.

……..

……..

……..

…….. [2]

(ii) Explain why using tidal waves in part **(a)** could be recommended to be used in Singapore to generate electricity compared to hydropower.

……..

……..

…….. [2]

- End of Paper -