XINMIN SECONDARY SCHOOL
新 民 中 學
SEKOLAH MENENGAH XINMIN

Preliminary Examination 2025

CANDIDATE NAME	
CLASS	INDEX NUMBER

PHYSICS 6091/02

Paper 2

Secondary 4 Express

22 Aug 2025

Setter: Mr. Koh Tat Siang
Vetter: Ms. Kris Chua

1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on 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.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces 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 all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for 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	Q …….	/10
Total		/80
Parent's Signature		

Section A [70 marks]
Answer **all** questions.
Write your answers in the spaces provided.

1 Fig. 1.1 shows a water gun that makes use of pressure exerted by piston to spray water out of a nozzle.

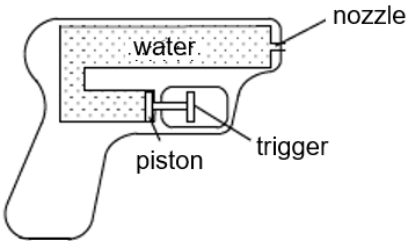


Fig. 1.1

(a) The cross-sectional areas of the piston and nozzle are 2.0 cm^2 and 0.080 cm^2 respectively.

If a force of 5.0 N is exerted on the trigger, calculate the force exerted on the water at the nozzle.

force = …….. [2]

(b) When the force of 5.0 N is applied, the piston moved a distance of 0.60 cm in 1.0 s.

(i) Calculate the volume of water displaced by the piston when it is pushed in.

volume = ……. [1]

(ii) Using your understanding of molecules, explain why the volume of water displaced by the piston is the same as the volume of water leaving the nozzle.

……...

……...

……... [2]

(iii) Hence or otherwise, determine the speed of the water leaving the nozzle.

speed = ……. [2]

[Total: 7]

2 Fig. 2.1 shows a rectangular stone block (ABCD) held stationary in position by a wire. The wire is in line with side DA and attached to a wall.

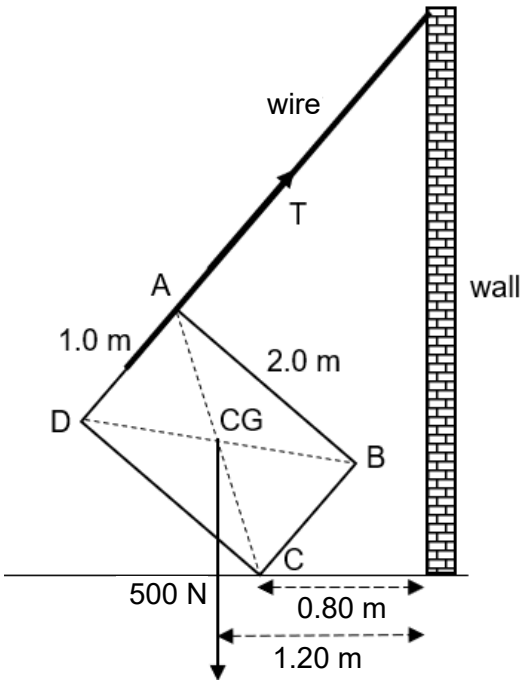


Fig. 2.1

The weight of the rectangular stone block is 500 N.
CG is the centre of gravity of the rectangular stone block.
T is the tension in the wire.

(a) Explain what is meant by the *centre of gravity*.

……..

…….. [1]

(b) Mark and label on Fig. 2.1 the pivot of the system should the wire be cut. [1]

(c) Calculate the moment due to the weight of the stone block about the pivot marked in part **(b)**.

moment = …….. [2]

(d) State the *principle of moments*.

……..

……..

…….. [1]

(e) Hence, or otherwise determine the magnitude of T.

T = …… [2]

(f) Describe one force acting on the stone block that is not shown on Fig. 2.1.

……..

…….. [1]

[Total: 8]

3 **(a)** Fig. 3.1 shows a container in which hot coffee is served for takeout at a cafe. It has a thin plastic lid. The container is made of two layers of cardboard, as shown in Fig. 3.2.

Fig. 3.1

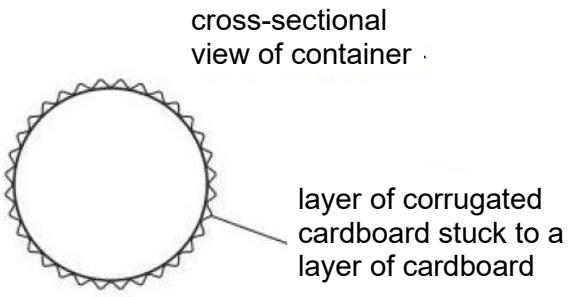


Fig. 3.2

Explain how the features of the container keeps the coffee hot for a longer period of time.

…….....

…….....

…….....

…….....

…….....

……..... [3]

(b) Fig. 3.3 shows a steam cleaner that produces steam to clean carpets.

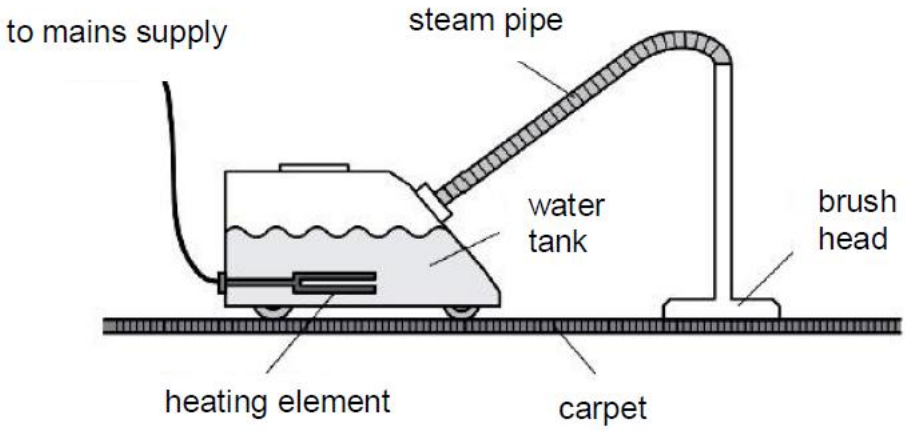


Fig. 3.3

The water tank is filled with 1.6 kg water at 25 °C. This water is heated until it boils and produces steam.

The specific heat capacity of water = 4200 J/ (kg °C)
The specific latent heat of vaporisation of water = 2.3×10^6 J/kg

Calculate the amount of energy needed to vapourise 0.90 kg of the water in the tank.

energy =…… [3]

[Total: 6]

4 Fig. 4.1 shows part of a page from a student's notebook. The student attempted to list out all the components of the electromagnetic spectrum.

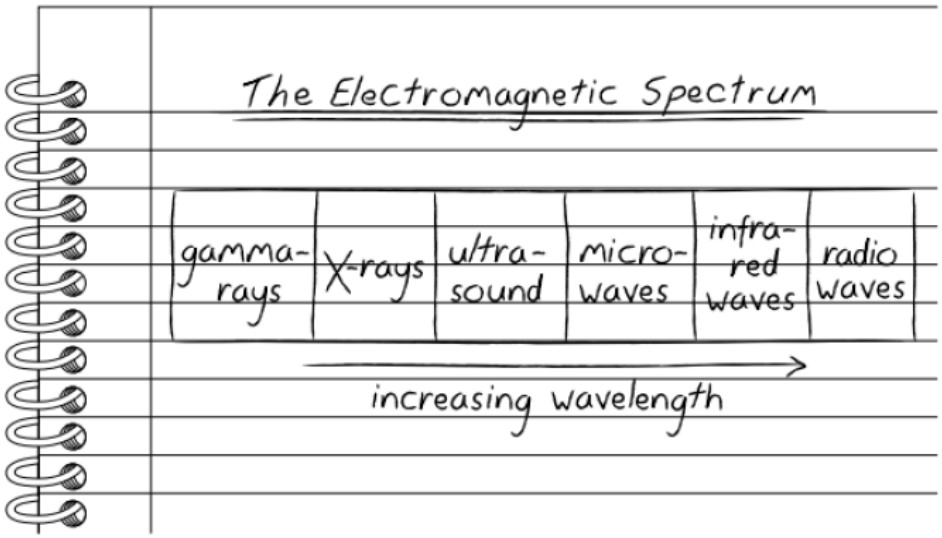


Fig. 4.1

(a) List three errors in the student's notes and state how it should be corrected.

1. ……...

2. ……...

3. ……... [3]

(b) X-rays is used in hospitals for the diagnosis of medical conditions such as fractures or tooth decay.

State one other application of X-rays.

……..

…….. [1]

[Total: 4]

5 Fig. 5.1 shows a lightning bolt striking a lightning rod.

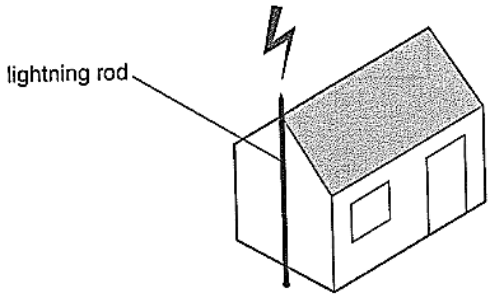


Fig. 5.1

The strike lasts for 0.25 s and 30 coulombs of charge passes through the lightning rod during this time. The average potential difference across the lighting rod is 7.5×10^8 V for the duration of the strike.

(a) Define *potential difference*.

……..

…….. [1]

(b) Calculate the power of the lightning rod during the strike.

power = ……. [2]

[Total: 3]

6 A small volume of liquid soap is dispensed when the soap dispenser detects a hand underneath the nozzle as shown in Fig. 6.1.

Fig. 6.2 shows the circuit that the LDR is connected to.

A light source and a light dependent resistor (LDR) placed beside the nozzle.

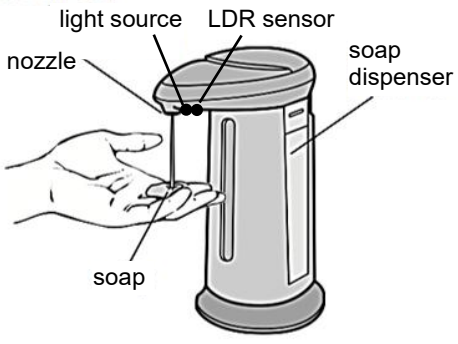


Fig. 6.1

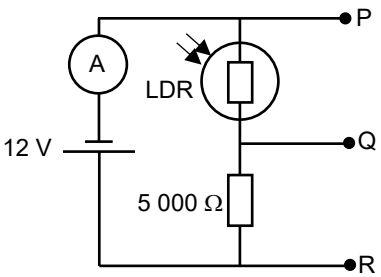


Fig. 6.2

(a) When no light shines on the LDR, the reading on the ammeter is 1.5 mA. Calculate

(i) the resistance of the LDR.

resistance = ……. [2]

(ii) the potential difference across the LDR.

potential difference = …….. [2]

(b) When a hand is placed beneath the nozzle, light from the light source is reflected into the LDR.

The resistance of the LDR when light shines on it is 1 000 Ω.

The electronic switch of the nozzle is activated to dispense soap when the potential difference across it is larger than 8.0 V.

State and explain how the electronic switch should be connected to the circuit shown in Fig. 6.2. Show all required working clearly.

……..…

……..…

……..…

……..… [3]

[Total: 7]

7 A student constructs a model of a relay switch using an unmagnetised steel core as shown in Fig. 7.1.

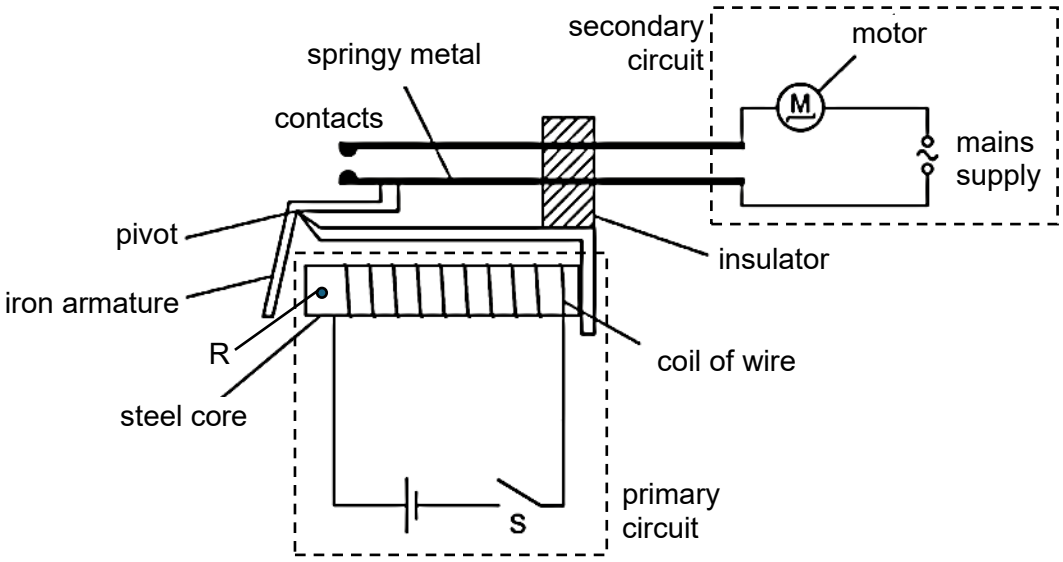


Fig. 7.1

(a) When switch S is closed, the motor in the secondary circuit is turned on.

(i) State the polarity at position R when switch S is closed.

…… [1]

(ii) Describe how the relay switch causes the motor to be turned on when switch S is closed.

……

……

……

…… [2]

(b) A relay switch should be able to turn on and turn off the devices in the secondary circuit by closing and opening switch S.

After switch S is closed and the motor is turned on once, the student found that when he opened switch S, the motor remained turned on.

Suggest and explain one reason why.

……

……

……

…… [2]

[Total: 5]

8 Fig. 8.1 shows the structure of an a.c. generator. The coil turns at a constant speed.

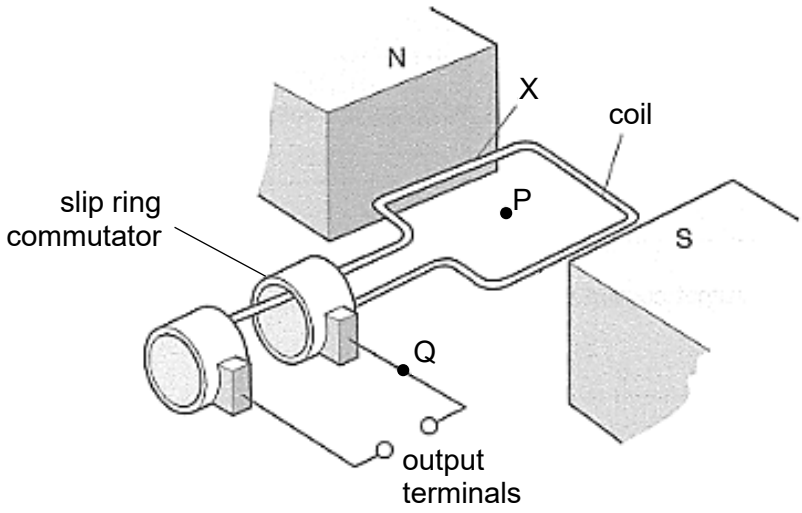


Fig. 8.1

(a) On Fig. 8.1, draw an arrow to show the direction of the magnetic field at point P caused by the poles of magnet. [1]

(b) When the coil of the a.c. generator is in the position shown in Fig. 8.1, a force acts upwards at X.

(i) On Fig. 8.1, draw an arrow to show the direction of the current at point Q. [1]

(ii) Describe how the answer in part **(b)(i)** was obtained.

……

……

…… [1]

(c) State the function of the slip ring commutator.

……

…… [1]

[Total: 4]

9 A sample of radioactive nuclei X is placed in a laboratory.

(a) The radioactive nuclei X decays to a stable nuclei Y by emitting a beta particle and gamma rays.

Complete the nuclide equation of nuclei X's decay:

$$^{149}_{64}\mathrm{X} \rightarrow {}^{\ldots\ldots}_{\ldots\ldots}\mathrm{Y} + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$ [2]

(b) A Geiger-Muller counter is placed beside the sample of X to measure the count-rate.

Fig. 9.1 shows how the count-rate changed over time.

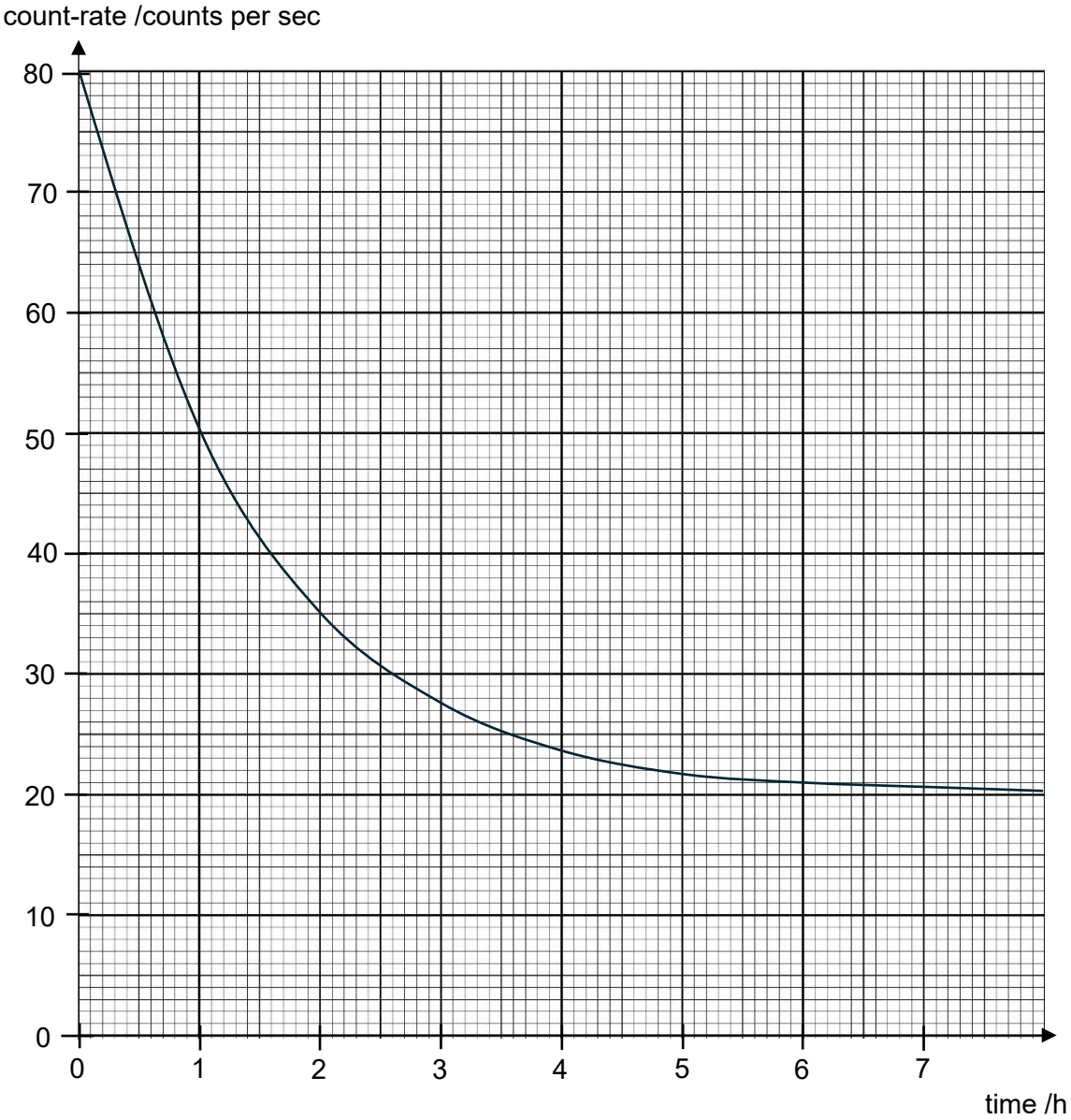


Fig. 9.1

(i) State the background radiation of the laboratory.

background radiation = …….. [1]

(ii) Suggest a source of the background radiation of the laboratory.

……..

……...

……... [1]

(iii) Determine the half-life of X using the information in Fig. 9.1.

half-life = …….. [2]

[Total: 6]

10 Fig. 10.1 shows a woman of mass 65 kg standing in an elevator.

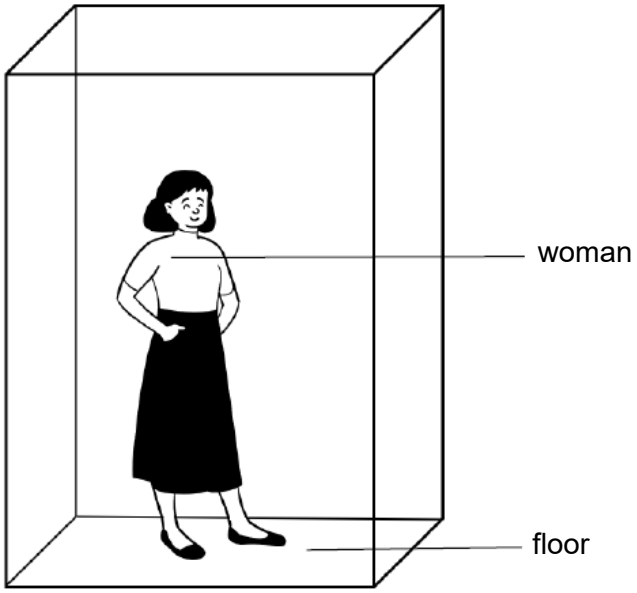


Fig. 10.1

The gravitational field strength, g is 10 N/kg.

(a) Calculate the weight of the woman.

weight = …… [1]

(b) The elevator accelerates upwards uniformly at 0.50 m/s^2.

(i) Calculate the resultant upward force on the woman.

resultant force = ……. [2]

(ii) Draw and label on Fig. 10.1, all the forces acting on the woman. [1]

(iii) Determine the force exerted on the woman by the floor of the elevator.

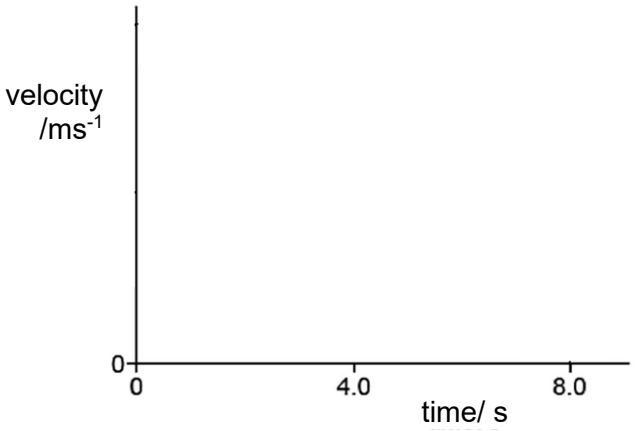
force = …….. [1]

(c) The elevator accelerates upwards uniformly at 0.50 m/s^2 from rest for 4.0 s and then at uniform velocity for another 4.0 s.

(i) Calculate the velocity of the elevator after the first 4.0 s.

velocity = ……. [1]

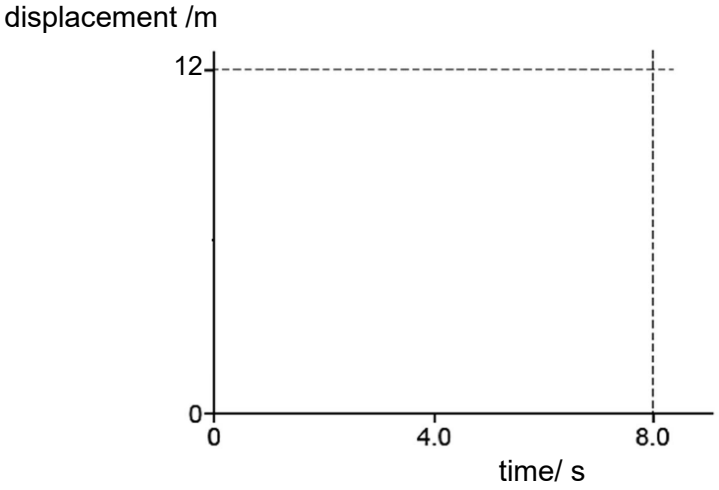
(ii) On Fig. 10.2, sketch the velocity-time graph of the elevator.



[2]

Fig. 10.2

(iii) The displacement of the elevator after 8.0 s is 12 m.
On Fig. 10.3, sketch the displacement-time graph of the elevator.



[2]

Fig. 10.3

[Total: 10]

11 Fig 11.1 shows a solar panel using solar power as a renewable energy resource to generate electricity and power a cooling unit inside a cold storage box.

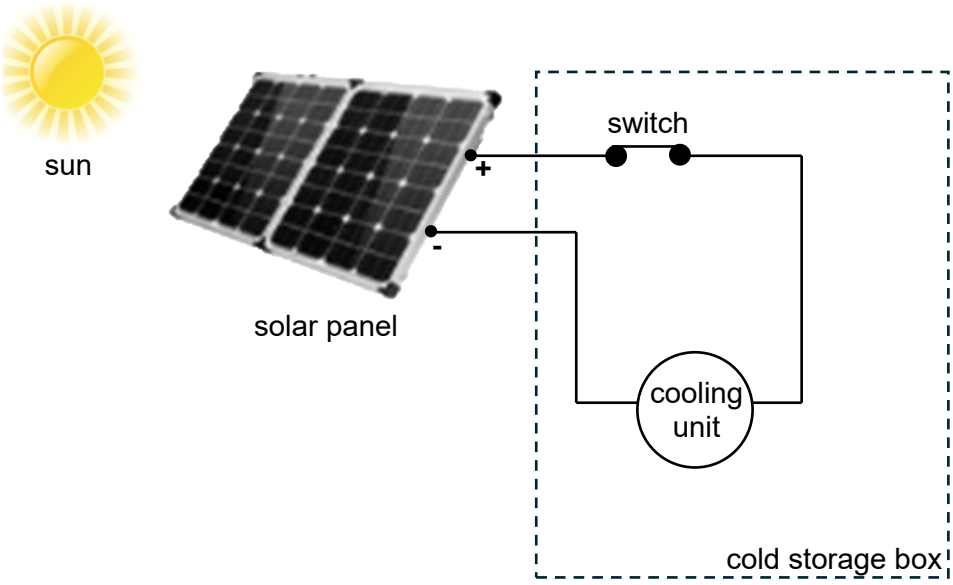


Fig. 11.1

When sunlight shines on the solar panel, its temperature increases and a potential difference across the solar panel is produced. When the switch is closed, a current passes through the circuit and powers the cooling unit.

(a) Using your knowledge of energy stores and transfers, describe the energy changes of the solar panel when sunlight is shining on the panel and the switch is closed.

……

……

……

…… [2]

(b) State one disadvantage of using solar panels to produce a high proportion of the electricity in Singapore.

……

…… [1]

(c) Fig. 11.2 shows how the power output of the solar panel varies with the intensity of sunlight shining on the solar panel measured in watts per metre squared.

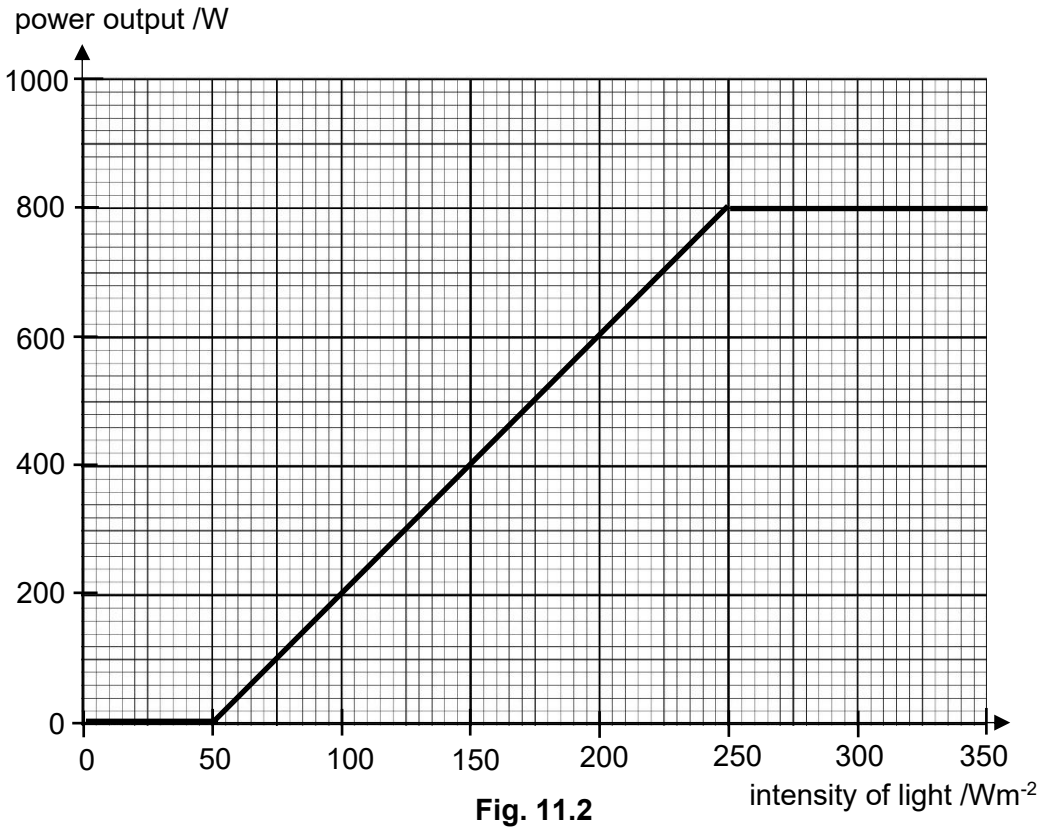


Fig. 11.2

The intensity of sunlight shining on the solar panel is recorded at 1 min intervals for 10 min as shown in Table 11.3.

Table 11.3

time / min	intensity of sunlight / Wm^{-2}
0	100
1	100
2	23
3	23
4	0
5	0
6	320
7	320
8	200
9	200

(i) State the power output of the solar panel when time = 1 min.

power output = …… [1]

(ii) Define *power*.

…… [1]

(iii) Hence, or otherwise using the data in Fig. 11.2 and Table. 11.3, estimate the total energy produced by the solar panel in the ten minute interval. Give your answer in joules.

energy = …… [2]

(iv) Explain why your answer to part **(iii)** is only an estimate.

……

……

…… [1]

(v) The efficiency of the solar panel is 30% when the intensity of light on the panel is 200 Wm^{-2}.

Using the power output data in Fig. 11.2, and the efficiency, calculate:

1. the number of joules of energy per second falling on the solar panel.

energy per second = …… [1]

2. the surface area of the cell.

area = …… [1]

[Total: 10]

Section B [10 marks]
Answer **one** question from this section.
Write your answers in the spaces provided.

12 In an art installation, a light emitting diode (LED) that emits red light is placed at the back of a clear, vertical plastic panel.

Fig. 12.1 shows the path of two red light rays, ray P and ray Q, emitted from the LED.

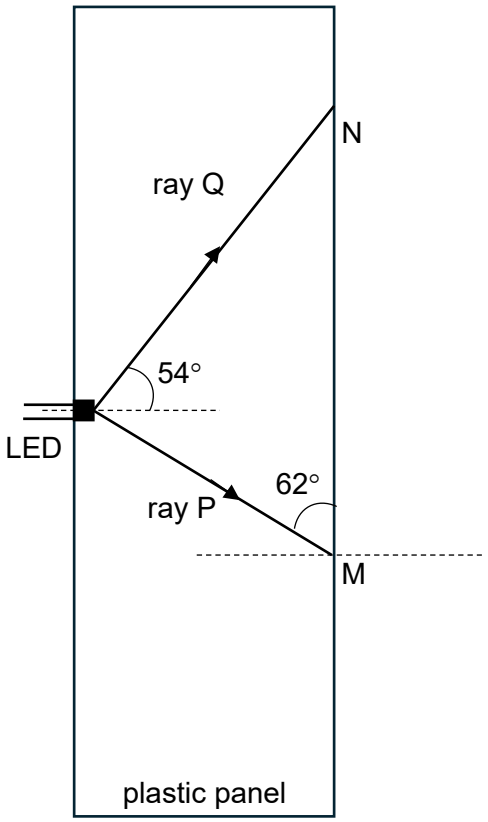


Fig. 12.1 (not to scale)

The refractive index of the plastic panel for red light is 1.3.

(a) Calculate the critical angle of the plastic panel.

critical angle = ... [1]

(b) Sketch, on Fig. 12.1, the path of ray P after it is incident on point M. Label all significant angles.

Show any working in the space below.

[3]

(c) State and explain the path of ray Q after it is incident at point N.

……

……

……

…… [2]

(d) When viewed from the right, the red light from the LED emerges only from a circular area on the plastic panel.

(i) Explain why this happens.

……..

……..

…….. [2]

(ii) The LED is replaced with a LED that emits blue light. The speed of blue light in the plastic panel is slower than the speed of red light in the plastic panel.

It is observed that the circular area on the plastic panel that the blue light emerges from is smaller than the circular area that the red light emerges from.

Explain why this happens.

……..

……..

……..

…….. [2]

[Total: 10]

13 Fig. 13.1 shows the sound wave produced by a blown whistle reaching a microphone and a simplified diagram of that microphone.

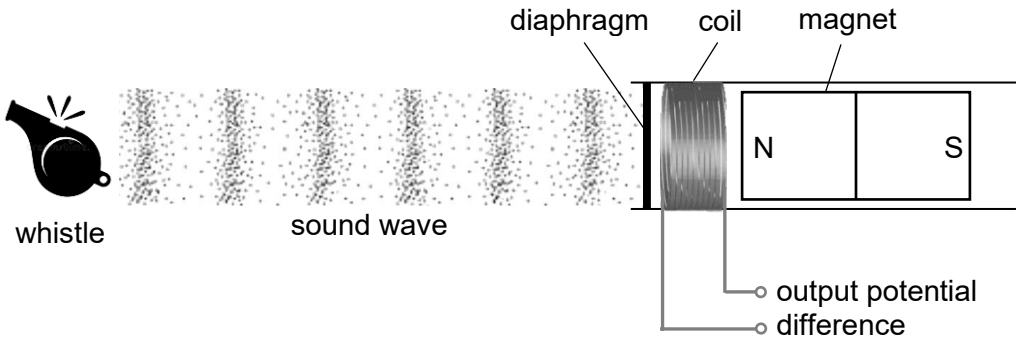


Fig. 13.1

The diaphragm and coil are physically attached and would slide left and right together when pulled and pushed.

(a) Describe how energy is transferred from whistle to the diaphragm.

……

……

……

……

…… [2]

(b) Explain why an output potential difference is produced by the coil.

……

……

……

……

…… [2]

(c) Fig. 13.2 shows how the output potential difference of the coil varies with time.

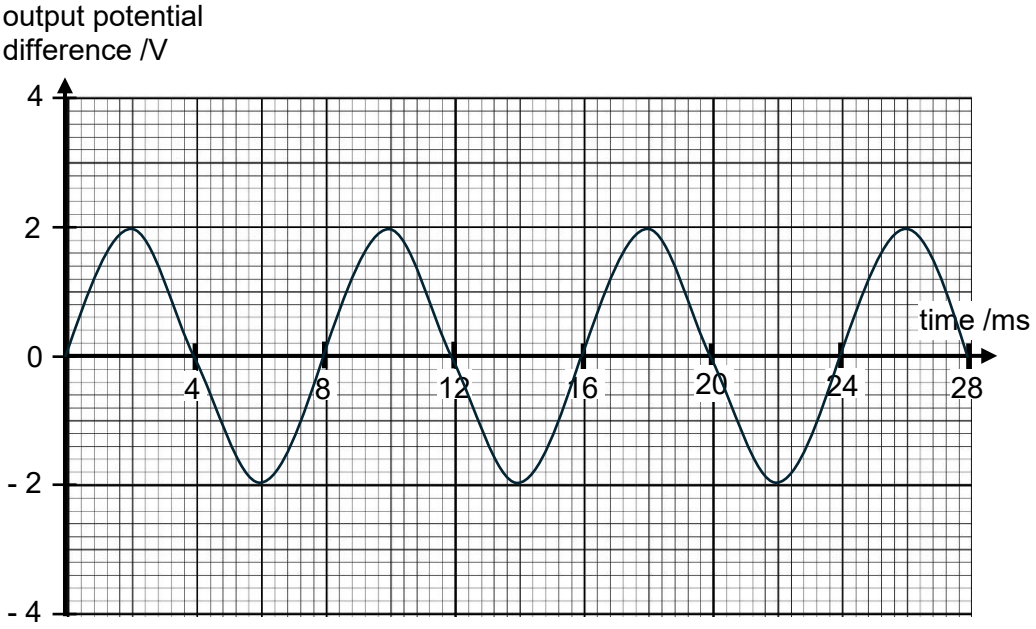


Fig. 13.2

(i) Define *frequency*.

……. [1]

(ii) Determine the frequency of the sound wave.

frequency = …….. [2]

(iii) State and explain how the output potential difference of the coil as shown in Fig. 13.2 with time would change if the sound reaching the microphone is higher in pitch and of the same loudness.

…….

…….

…….

……. [2]

(iv) Draw, on Fig. 13.2, how the output potential difference of the coil would vary with time if the position of the magnet was reversed. [1]

[Total: 10]

End of paper

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