BEATTY SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2025
SECONDARY FOUR NORMAL (ACADEMIC) / G2

CANDIDATE NAME	
CLASS	
REGISTER NUMBER	

SCIENCE (PHYSICS) 5105/02

Paper 2 Structured (Physics) **4 August 2025**
Setter: Mr Jerrod Lo **Papers 1 and 2: 1 hour 15 minutes**

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

READ THESE INSTRUCTIONS FIRST

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

Answer **all** questions in Section A and any **one** question in Section B.
The use of an approved scientific calculator is expected, where appropriate.
In calculations, you should show all the steps in your working, giving your answer at each stage.
You are advised to spend no longer than 30 minutes on Paper 1.
You may proceed to answer Paper 2 as soon as you have completed Paper 1.

At the end of the examination, hand in your answers to Paper 1 and Paper 2 separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
A	22
B…..	8
Total	30

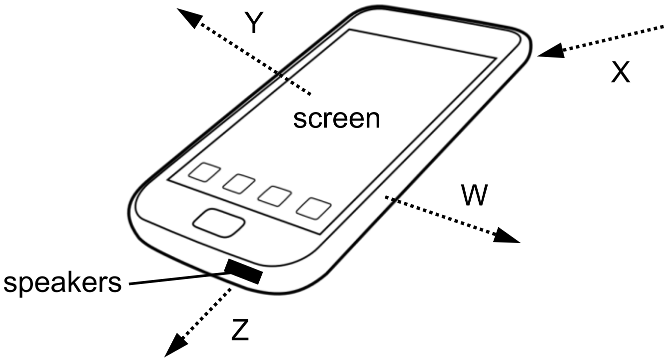
This document consists of **15** printed pages and **1** blank page.

[Turn over

Section A

Answer **all** the questions in the spaces provided.

1 A mobile phone emits and receives four different types of waves, W, X, Y and Z.



W, X and Y are electromagnetic waves. When the phone gets warm, it gives off W. The phone receives wireless signals using X, which has higher frequencies than television broadcast waves. The screen emits Y, which lets us see colours. The speakers produce Z, which are longitudinal waves that we can hear.

Based on the information, identify the waves W, X, Y and Z.

W is ......infra-red radiation......

X is ......microwave......

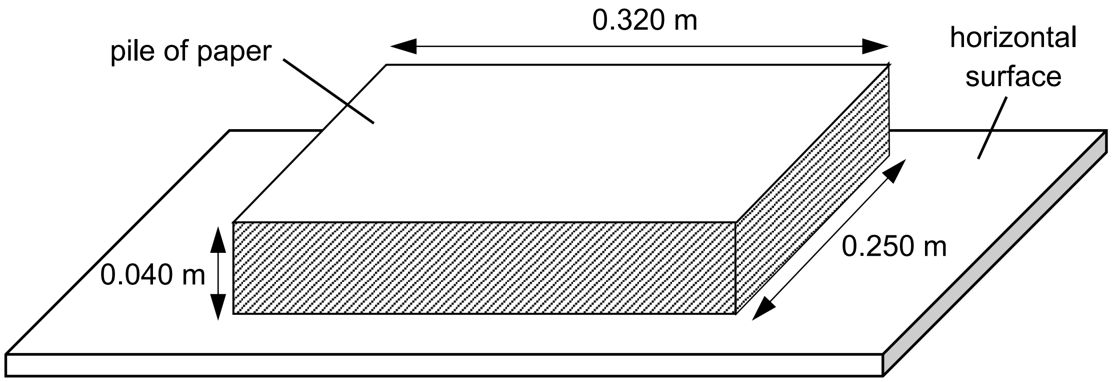
Y is ......visible light......

Any two correct – [1] Z is ......sound......

[2]

[Total: 2]

2 A pile of paper rests on a horizontal surface.



The weight of the pile of paper is 27.2 N.

(a) Calculate the density of the paper.

Use g = 10 N / kg in your calculations.

W = mg
27.2 = m × 10
m = 2.72 kg [1]

d = m ÷ V
d = 2.72 ÷ (0.320 × 0.250 × 0.040)
d = 850 kg / m^3 [1]

density = ...850........ kg / m^3 [2]

(b) The sheets of paper are uniformly folded in half and restacked to form a new pile on the horizontal surface.

Calculate the minimum pressure on the horizontal surface due to the new pile of paper.

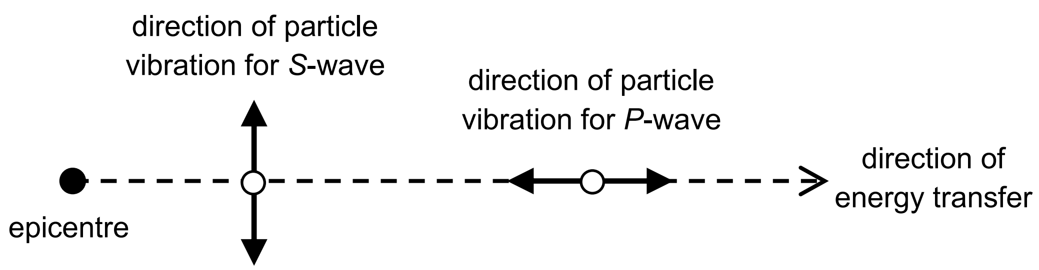
P = F ÷ A
P = 27.2 ÷ (0.5 × 0.320 × 0.250)
P = 680 N / m^2 [1]

pressure = ...680........ N / m^2 [1]

[Total: 3]

3 During an earthquake, two types of seismic waves, *P*-waves and *S*-waves are produced.

The diagram shows the directions of particle vibration in a *P*-wave and a *S*-wave as energy is transferred away from the earthquake's epicentre when viewed from above.



(a) State which seismic wave, *P*-wave or *S*-wave is a transverse wave.

S-wave [1]
.... [1]

(b) The foot of a hill is located 6.72 km away from the epicentre.

The time taken for a seismic wave to travel from the epicentre to the foot of the hill and reflected back is 3.2 s.

(i) Calculate the speed of the seismic wave in metres per second.

v = d ÷ t
v = (6.72 × 1000) ÷ (3.2 ÷ 2)
v = 4200 m/s [1]

speed = ...4200...... m / s [1]

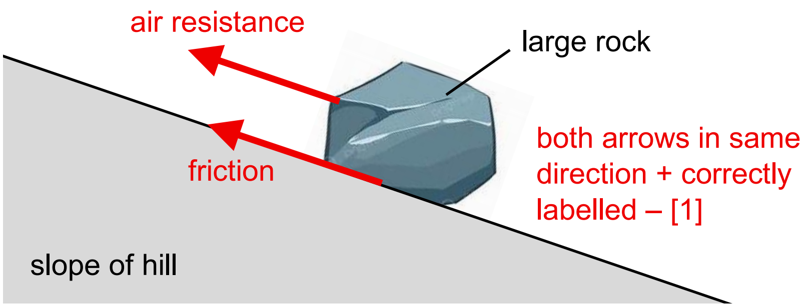
(ii) The wavelength of the seismic wave is 875 m.

Calculate the frequency of the seismic wave.

v = f × λ
<u>4200</u> = f × 875 (e.c.f.)
f = 4.8 Hz [1]

frequency = ...4.8......... Hz [1]

(c) During an earthquake, a large rock accelerates down the slope of the hill.



On the diagram, draw and label arrows to show the directions of the **two** forces acting on the rock that reduce its acceleration.

[1]

[Total: 4]

4 At a campfire, water in a ceramic pot is heated until it boils.

(a) Describe the change in motion of the particles in the ceramic pot during heating.

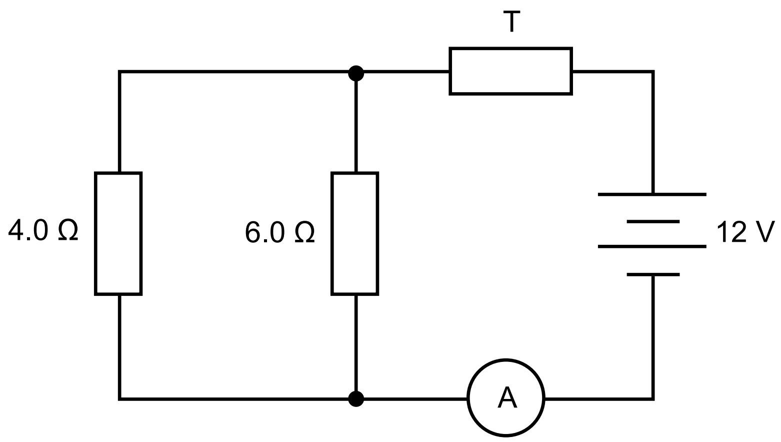
Particles in the ceramic pot vibrate about their fixed positions more vigorously (or faster). [1] [1]

(b) Explain the change in arrangement of the water particles during boiling.

Water particles move further apart due to weaker forces of attraction between particles. [1] [1]

[Total: 2]

5 A circuit is made up of a 12 V battery, an ammeter, a 4.0 Ω resistor, a 6.0 Ω resistor and an unknown resistor T.



The ammeter shows a reading of 1.6 A.

(a) Calculate the total resistance of the circuit.

V = R × I
12 = R × 1.6
R = 7.5 Ω [1]

total resistance = ...7.5........ Ω [1]

(b) Using your answer in **(a)**, calculate the resistance of resistor T.

Combined R = $\frac{1}{\frac{1}{4.0}+\frac{1}{6.0}}$

R = 2.4 Ω [1] (e.c.f.)

T + 2.4 = 7.5

T = 5.1 Ω [1]

resistance of resistor T = ...5.1........ Ω [2]

[Total:3]

6 R is a radioactive material found in a laboratory.

The count rate from R is measured by a Geiger-Muller (GM) counter for 24 hours.

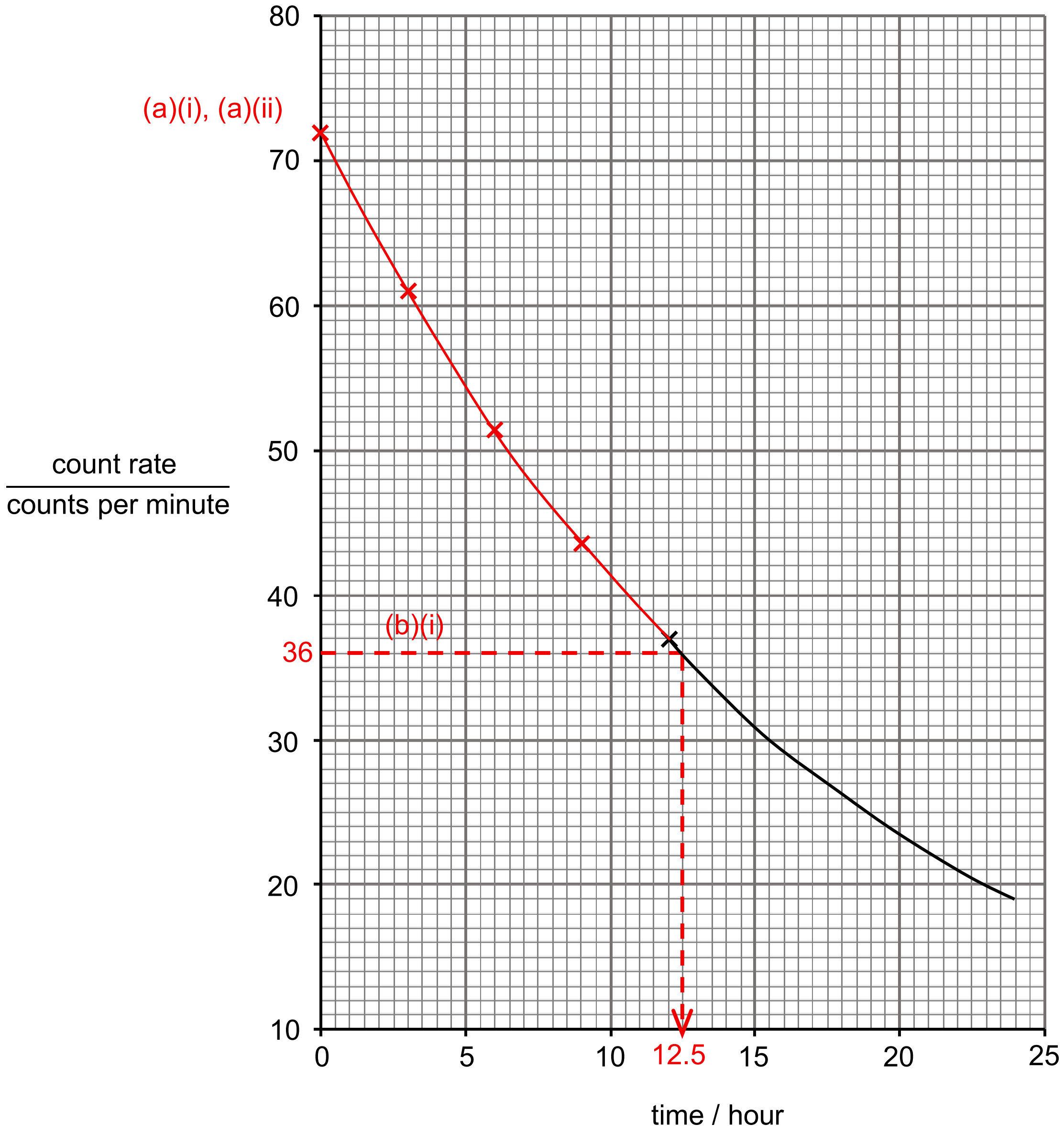
The table shows the measured count rates every 3 hours for the first 12 hours of the day.
The measured count rates do **not** include background radiation in the laboratory.

time / hour	0	3	6	9	12
count rate / counts per minute	72.0	61.0	51.5	43.5	37.0

(a) Using the data in the table, complete the decay curve on the grid to show how the count rate from radioactive material R varies with time.

(i) Mark each point between 0 hours and 12 hours with a cross (x). [1]

(ii) Draw a best-fit curve that takes into account all plotted points. [1]



(b) **(i)** Using your graph, determine the half-life of R.

Show on the graph how you obtain your answer.

Time to decay from 72 to 36 count / min
= 12.5 hours [1]

half-life = ...12.5...... hours [1]

(ii) Using your answer in **(b)(i)**, calculate the time required for R to decay to 12.5% of its original amount.

Show your working.

100% → 50% → 25% → 12.5% (3 half-lives)

Time required
= 12.5 hours × 3 half-lives (e.c.f.)
= 37.5 hours [1]

OR
12.5 ÷100 × 72 = 9
72 → 36 → 18 → 9 (3 half-lives)

time required = ...37.5...... hours [2]

(c) R is unstable and undergoes beta-decay.

In beta-decay, each nucleus of R ($^{64}_{29}R$) gives off one electron ($^{0}_{-1}e$) and changes into a stable element Q.

(i) Indicate the number of protons and neutrons in a nucleus of Q.

$^{64}_{29}R \rightarrow {}^{0}_{-1}e + {}^{64}_{30}Q$ (optional)

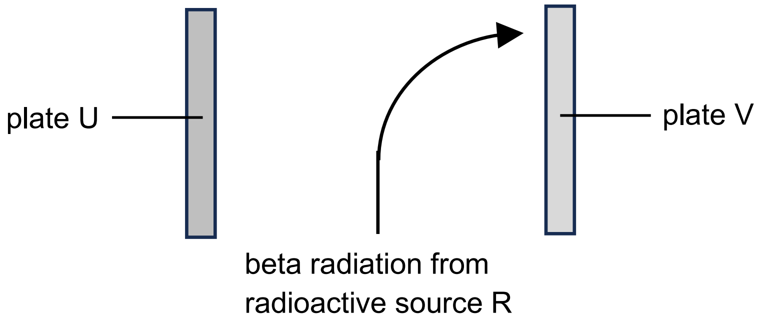
protons = 29 + 1 = 30

neutrons = 64 – 30 = 34 [1]

number of protons = ...30......

number of neutrons = ...34...... [1]

(ii) The beta radiation from radioactive material R passes through two charged plates, U and V. It travels in the path as shown.



Explain how the path of beta radiation show that plates U and V have opposite charges.

Since unlike charges attract and like charges repel, beta radiation (which is negatively charged) is attracted by V and repelled by U, so U and V have opposite charges. [1] [1]

(d) During the radioactive decay of R, gamma rays are also emitted.

State **one** property of gamma rays that makes them responsible for causing damage to cells.

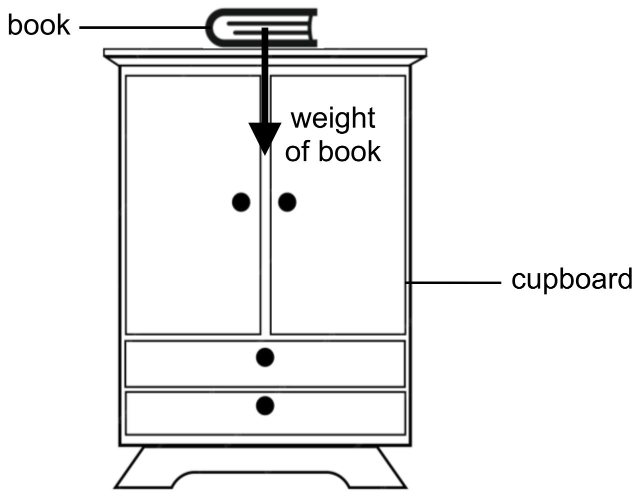
(high) penetrating ability / (high) ionising effect [1] [1]

[Total: 8]

Section B

Answer any **one** question from this section in the spaces provided.

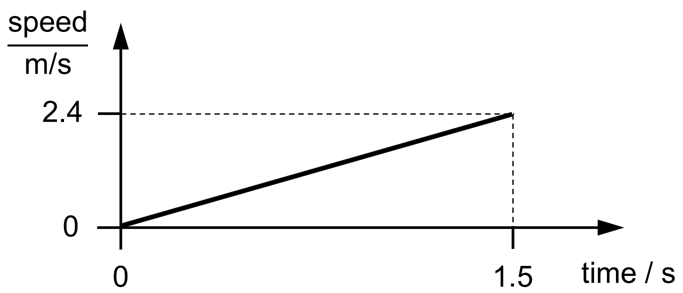
7 A book is resting on top of a cupboard on the Moon's surface. The diagram shows the force of weight acting on the book.



(a) Explain, in terms of upward and downward forces, why the resultant force acting on the book is zero.

Contact (normal reaction) force on the book acts upwards and balances (or has equal magnitude as) its weight (or contact force is equal and opposite of weight). [1]

(b) The book falls downward after the cupboard is removed. The book takes 1.5 s to reach the ground on the Moon. The diagram shows the speed-time graph of the book's motion as it falls.



The mass of the book is 0.75 kg.

(i) Describe the motion of the book as it falls from time 0 s to 1.5 s on the Moon.

speed increases uniformly / acceleration is constant [1]

[1]

(ii) Calculate the acceleration of the book as it falls during the 1.5 seconds on the Moon.

$a = (v – u) \div t$ or gradient under speed-time graph
$a = (2.4 – 0) \div 1.5$
$a = 1.6\ m/s^2$ [1]

acceleration = ……1.6…… m / s^2 [1]

(iii) Using your answer in **(b)(ii)**, calculate the resultant force acting on the book during its fall on the Moon.

$F_r = ma$
$F_r = 0.75 \times 1.6$ (e.c.f.)
$F_r = 1.2\ N$ [1]

resultant force = ……1.2…… N [1]

(iv) Calculate the energy in the book's kinetic store just before it reaches the ground at time 1.5 s on the Moon.

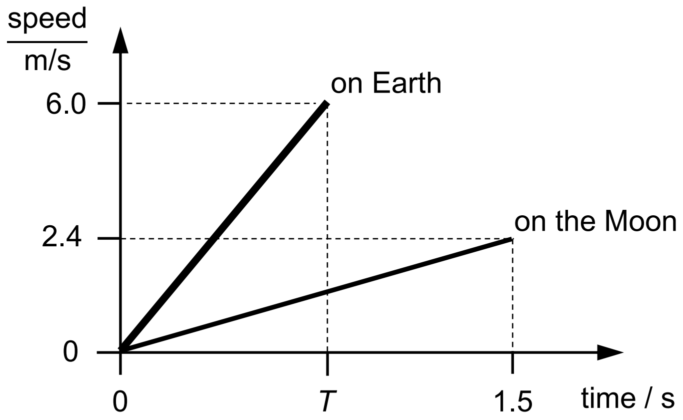
$E_k = ½mv^2$
$E_k = ½ \times 0.75 \times (2.4)^2$
$E_k = 2.16\ J$ [1]

energy in kinetic store = ……2.16…… J [1]

(c) The same book is now placed on the same cupboard on the Earth's surface.

The book takes a time T to reach the ground after the cupboard is removed.

The speed-time graph of the book's motion as it falls on the Moon and on Earth is shown below.



(i) The book falls from the same height on the Moon and on Earth.

Calculate the time T taken by the book to reach the ground on Earth.

distance = area under the speed-time graph
distance = ½ × base × height of triangle
$\frac{1}{2} \times T \times 6.0 = \frac{1}{2} \times 1.5 \times 2.4$
$T = 0.60$ s [1]

time T = ...0.60.......... s [1]

(ii) Explain why the energy in the book's gravitational potential store is greater on Earth than on the Moon.

The gravitational field strength g (or acceleration due to freefall or weight W) is greater on Earth than on the Moon. [1] [1]

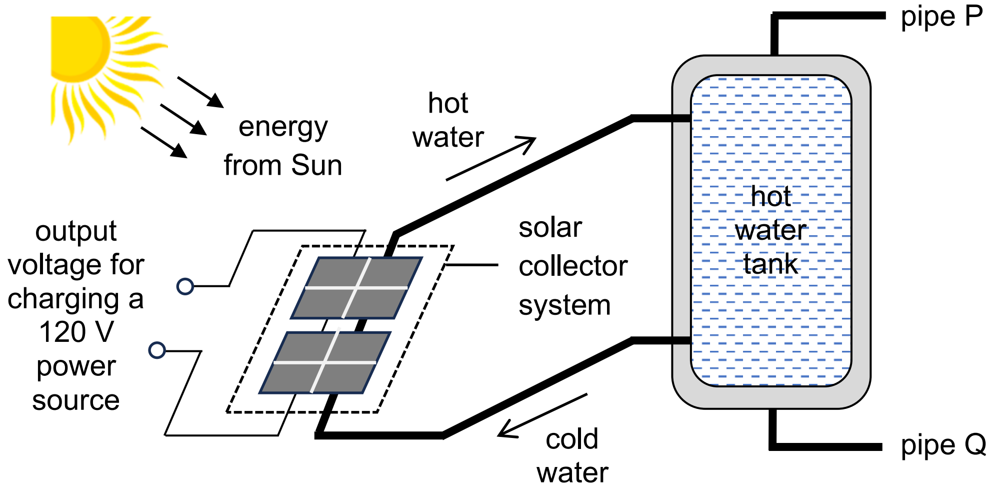
(d) The effects of air resistance on the book's motion can be ignored at both locations.

State one energy store that stays constant during the book's motion.

..........internal.......... energy store [1]

[Total: 8]

8 The diagram shows a solar collector system, which uses energy from the Sun to heat water and charge a 120 V power source.



(a) Water flows through the solar collectors, where it is heated and directed into a hot water tank.

(i) Explain why hot water flows out of the hot water tank from pipe P and not from pipe Q.

Hot water in tank expands, becomes less dense and rises to the top.

At the bottom, cooler denser water sinks. [1] [1]

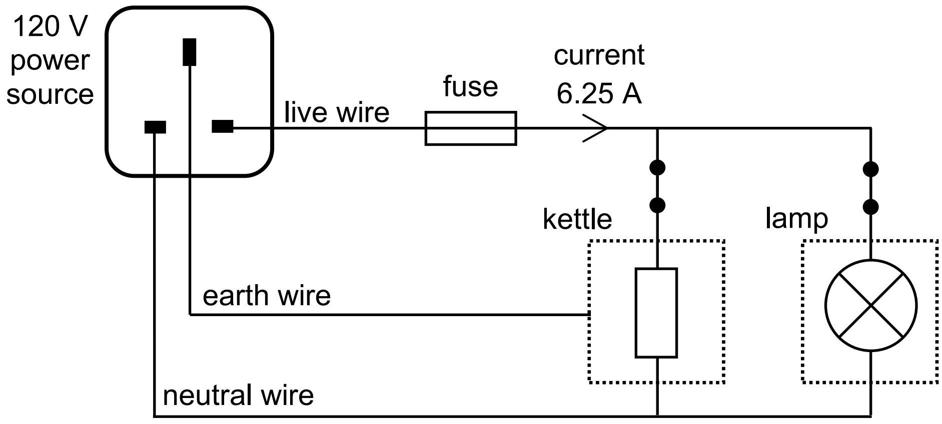
(ii) The outer surfaces of the solar collectors are coated with white paint.

Explain how white painted surfaces make the solar collectors less efficient in heating the water.

White surfaces are poor absorbers of infra-red radiation (or heat). [1]

.... [1]

(b) A kettle and a lamp are connected to the 120 V power source after it is charged.



(i) The current in the fuse is 6.25 A when the kettle and the lamp are both switched on.

Two fuse ratings, 5 A and 10 A are available.

Identify a suitable fuse rating to use when both the kettle and the lamp are switched on.

fuse rating = ...10........ A [1]

(ii) The kettle is connected to the earth wire but not the lamp.

Describe a safety feature of the lamp, which allows it to be used safely without an earth wire.

The lamp is double insulated, but not the kettle. [1]

.... [1]

(iii) The earth wire is thicker than the live and neutral wires.

Explain, in terms of resistance and current, how using a thicker earth wire ensures the fuse blow quickly in the event of an electrical fault.

A thicker earth wire lowers the resistance of the wire and the circuit, thus increases current in circuit allowing it to exceed fuse rating quickly. [1] [1]

(c) The kettle and the lamp are both switched on at the same time for 1 hour.

(i) Calculate the total number of charges flowing through the kettle and the lamp for 1 hour.

$Q = I \times t$
$Q = 6.25 \times (1 \times 60 \times 60)$
$Q = 22500$ C [1]

charge = ……22500…… C [1]

(ii) Calculate the total power used by the kettle and the lamp in kilowatts (kW).

P (kW) = IV ÷ 1000
P (kW) = (6.25 × 120) ÷ 1000
P (kW) = 0.75 kW [1]

power = ……0.75…… kW [1]

(iii) The cost of 1 kW h of energy is 22 cents.

Using your answer in **(c)(ii)**, calculate the total cost of energy used by the kettle and the lamp for 1 hour.

Total cost = P (kW) × t (h) × unit cost
Total cost = 0.75 × 1 × 22 (e.c.f.)
Total cost = 16.5 cents [1]

total cost = ……16.5…… cents [1]

[Total: 8]