SCOTTISH QUALIFICATIONS AUTHORITY

2005 Physics

Standard Grade Credit

Finalised Marking Instructions

These Marking Instructions have been prepared by Examination Teams for use by SQA Appointed Markers when marking External Course Assessments.

DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

1. A car driver listens to a radio station broadcasting on 1500 kHz.

(*a*) Calculate the wavelength of the radio broadcast.

Space for working and answer

$v = f\lambda \qquad \lambda = \frac{v}{f}$ (½)

$= \frac{3 \times 10^8}{1500 \times 10^3}$ (½)

$= 200\ m$ (1)

2

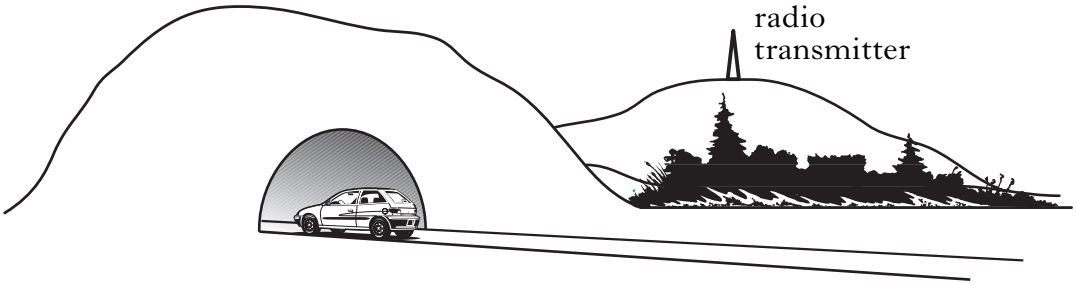
(*b*) The table shows the frequency range of the different wavebands on the radio receiver.

Waveband	*Frequency range*
long wave	30 kHz – 300 kHz
medium wave	300 kHz – 3 MHz
short wave	3 MHz – 30 MHz
FM	30 MHz – 300 MHz

From the table, write down the waveband of the radio station that the driver is listening to.

medium wave 1

(*c*) A passenger in the car listens to a personal CD player.
The car enters a tunnel.



As the car enters the tunnel, the sound from the radio fades, but the sound from the CD player can still be heard.

(i) Explain why the sound from the radio fades.

radio waves cannot <u>diffract</u> into the tunnel to reach the aerial of the car radio 1

(ii) Explain why the sound from the CD player can still be heard.

CD player receives its signal/data from the CD / no radio waves are used/does not need a { transmitter / wave } 1

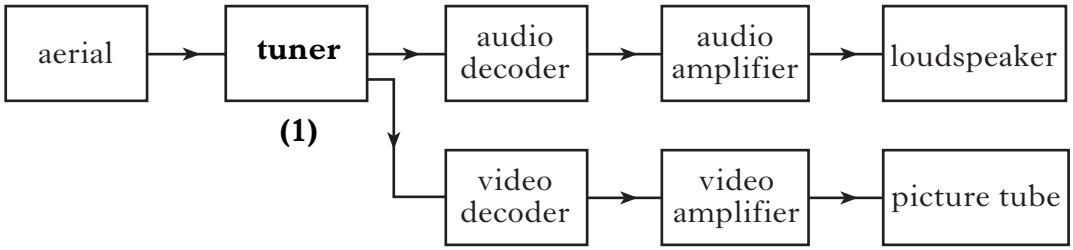
NOTES
missing × 10^3 → deduct (½) mark (unit/arith error) **anything other than 3×10^8 → (½) for formula only** **word "diffract" is necessary** **NOT "does not need a signal"**

DO NOT WRITE IN THIS MARGIN

	Marks	K&U	PS

2. A television receiver is used to pick up a signal from a television transmitter.

(*a*) The block diagram represents a television receiver.



(i) On the diagram, label the part of the receiver that has been left blank. **1**

(ii) State the purpose of the aerial.

picks up/detects/collect all radio waves (transmitted)

(within range) **1**

(iii) One other necessary part of the television receiver is not shown on the block diagram.

Name this part.

power supply/mains/battery/voltage supply **1**

(iv) Which part of the television receiver transforms electrical energy to light energy?

(picture) tube **1**

(*b*) In the transmitter, a video signal is combined with a carrier wave to produce a signal for transmission.

(i) Circle the correct phrase to complete this sentence.

The carrier wave has a frequency that is { **higher than** / the same as / lower than } the frequency of the video signal. **1**

(ii) Why is the carrier wave needed for transmission?

adds energy to the signal for transmission/allows single frequency transmission (of audio and video)/allows signal to be { detected at / transmitted to } greater distance **1**

(iii) Name the process of combining the waves for transmission.

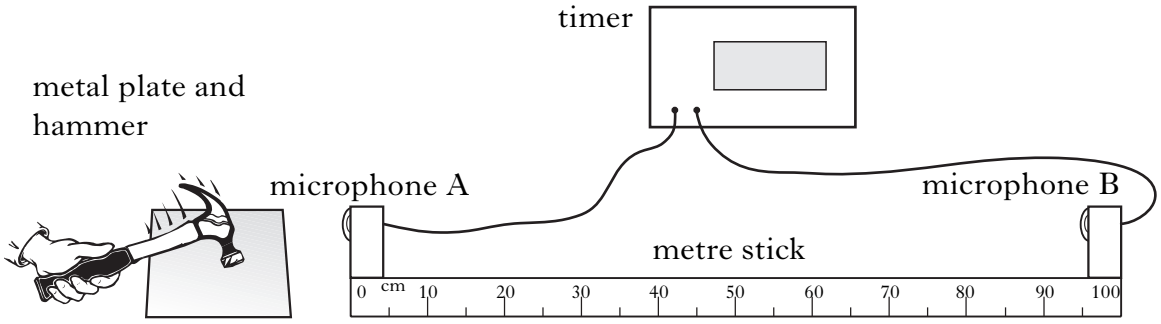
modulation/am/fm **1**

NOTES
TV waves **radio waves** **radio/TV signals** **broadcast channels** **stations** } **all acceptable** **NOT "screen"** **ignore amplitude/frequency if given**

DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

3. A student sets up the apparatus **exactly** as shown to measure the speed of sound in air.



Striking the metal plate with the hammer produces a sound. Timing starts when the sound reaches microphone A, and stops when the same sound reaches microphone B.

(*a*) The student carries out the experiment three times and records the results shown in the table.

trial	*distance between microphones* (m)	*time recorded on timer* (s)
1	1·00	0·00287
2	1·00	0·00282
3	1·00	0·00286

Use **all** of the student's results to calculate the value of the speed of sound.

Space for working and answer

average time = 0·00287
0·00282
0·00286
0·00855 /3 = 0·00285 s (1)

$\mathbf{v = \frac{s}{t}}$ **(½)**

$\mathbf{= \frac{1{\cdot}00}{0{\cdot}00285}}$ **(½)**

= 351 m/s (1)
350, 351, 350·9, 350·88

3

(*b*) Suggest a reason why the student's results do **not** give the value of 340 m/s for the speed of sound in air, as quoted in the data sheet.

distance used is not 1·00 m (as recorded)

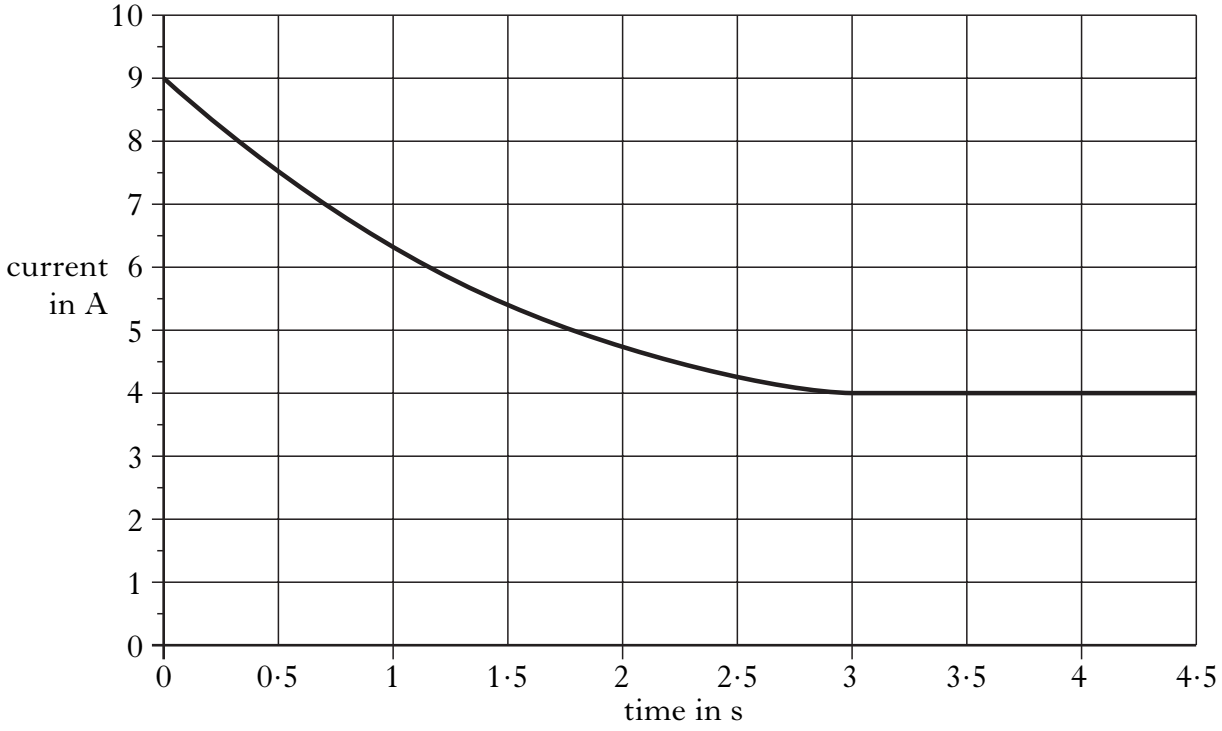
1

NOTES
accept 3 calculations of v, then averaging **no attempt at averaging → (½) mark for formula only** **no other answer possible**

DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

4. A mains vacuum cleaner contains a motor that takes 3·0 s to reach full speed after being switched on. The graph shows how the current in the motor varies from the time the motor is switched on.



(*a*) (i) State the current when the motor has reached full speed.

4·0 A

..... **1**

(ii) Calculate the power of the motor when it has reached full speed.

Space for working and answer

P = IV (½) (1) for 230(V)

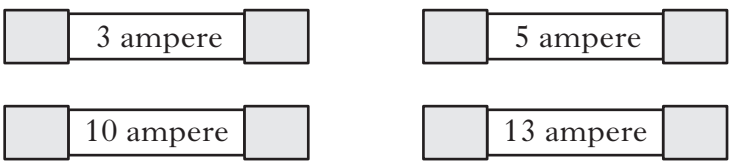
= 4 × 230 (½)

= 920 W (1)

3

(*b*) The vacuum cleaner is connected to the mains supply by a flex fitted with a fused plug.

(i) All the fuses shown are available.



Which one of these fuses is **most** suitable for fitting in the plug?

10 (ampere)

..... **1**

NOTES

1 or 0

only for 240 V

if 230 is given as <u>final</u> answer, it must have unit (V) to gain (1) mark max

if voltage → 240, max (2) marks

any other voltage → (½) for formula

DO NOT WRITE IN THIS MARGIN

	Marks	K&U	PS

4. (*b*) (continued)

(ii) State the purpose of the fuse fitted in the plug.

to protect the flex

..... **1**

(iii) Explain why the fuse must be connected in the live wire.

to {**isolate** / **disconnect**} **the appliance from the live wire/**

to disconnect the high voltage

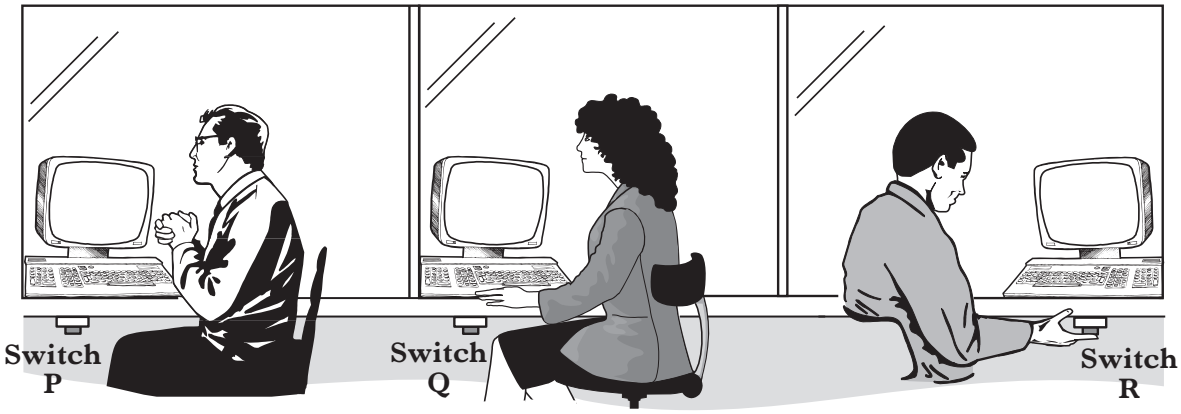
in the event of a fault **1**

NOTES
do <u>not</u> accept "appliance" **{fault / overload} is essential**

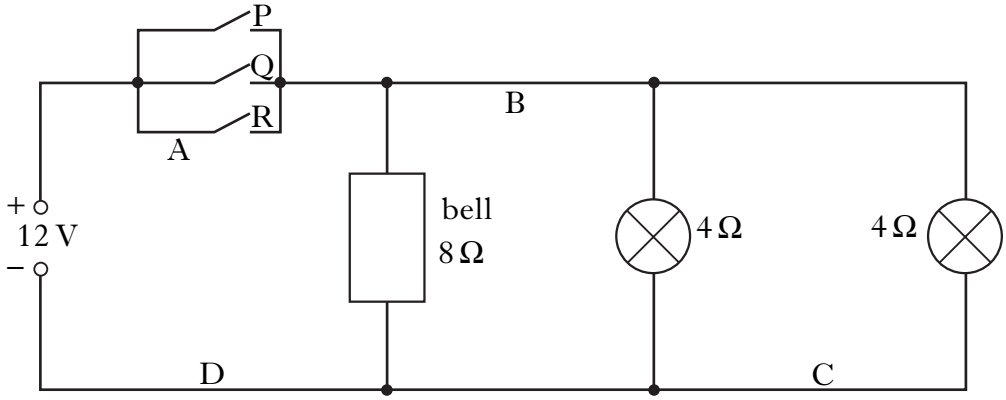
DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

5. A post office contains an emergency alarm circuit. Each of three cashiers has an alarm switch fitted as shown. Lamps come on and a bell sounds if an alarm switch is closed.



The circuit diagram for the alarm is shown.



(*a*) The alarm circuit is to be controlled by a master switch.

Which position, A, B, C or D, is most suitable for the master switch?

D — **1**

(*b*) Each lamp has a resistance of 4 Ω and the bell has a resistance of 8 Ω. The circuit uses a 12 V supply.

(i) Calculate the total resistance of the alarm circuit.

Space for working and answer

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ **(½)**

$= \frac{1}{8} + \frac{1}{4} + \frac{1}{4}$ **(½)**

$= \frac{5}{8}$

$\therefore$ **R = 1·6 Ω** **(1)** **accept** $1\frac{3}{5}\Omega$ — **2**

NOTES

$$\mathbf{R = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \Rightarrow (0)}$$

OR $\mathbf{R = \frac{R_1 R_2}{R_1 + R_2}}$ **applied twice**

$\mathbf{= \frac{5}{8}}$ $\mathbf{(=)}$ $\mathbf{\frac{8}{5} = 1{\cdot}6\,\Omega}$

ignore

DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

5. (*b*) (continued)

(ii) Calculate the current from the supply when the alarm is operating.

Space for working and answer

$\mathbf{V = IR} \qquad \therefore \mathbf{I} = \frac{\mathbf{V}}{\mathbf{R}}$ **(½)**

$= \frac{\mathbf{12}}{\mathbf{1{\cdot}6}}$ **(½)**

= 7·5 A **(1)**

2

(*c*) Brighter lamps are fitted in the alarm circuit.

Explain how this change affects the resistance of the circuit.

(brighter lamps) → more power

more power → more current **(1)**

more current → less resistance/lamp

less resistance/lamp → less resistance (in circuit) **(1)**

2

NOTES

minimum answer:

more current (1)

so less resistance (1)
(marks can be awarded independently)

DO NOT WRITE IN THIS MARGIN

	Marks	K&U	PS

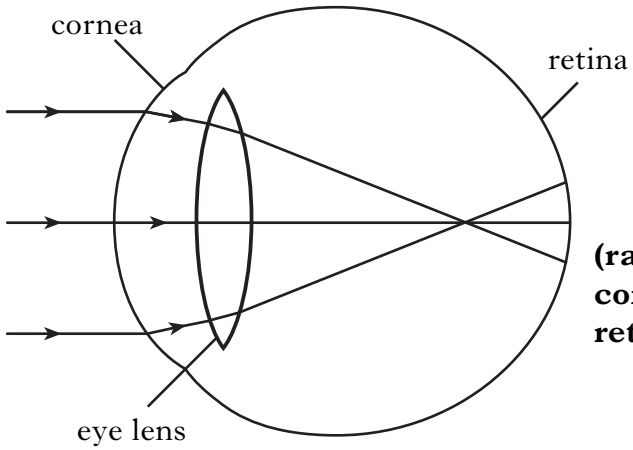
6. In the eye, refraction of light occurs at the cornea and at the eye lens.

(*a*) What is meant by refraction of light?

change of speed when travelling from one medium to another

..... **1**

(*b*) The diagram below shows light rays entering the eye of a short-sighted person.



(rays must continue to retina)

(i) Complete the diagram above to show how the light rays reach the retina of this short-sighted eye. **1**

(ii) A concave lens of focal length 400 mm is needed to correct the vision in this eye.

Calculate the power of this lens.

Space for working and answer

$$\mathbf{P = \frac{1}{f}} \quad (\tfrac{1}{2})$$

$$\mathbf{= \frac{1}{0{\cdot}4}} \quad (\tfrac{1}{2})$$

$$\mathbf{= 2{\cdot}5\,D} \quad (1)$$

2

NOTES
NOT "bending" **ignore any projection of rays beyond retina** **accept only 2 outside rays** **ignore any negative signs** **0·0025 D → (–½) unit error**

DO NOT WRITE IN THIS MARGIN

Marks | K&U | PS

6. (continued)

(*c*) Short-sight can be corrected using a laser to reshape the cornea.

(i) For this treatment a pulsed laser is used. Each pulse lasts for a time of 0·2 ms and transfers 5 mJ of energy.

Calculate the power rating of the laser.

Space for working and answer

$$P = \frac{E}{t} \quad (\tfrac{1}{2})$$

$$= \frac{5\times10^{-3}}{0{\cdot}2\times10^{-3}} \quad (\tfrac{1}{2})$$

$$= 25\ \text{W} \quad (1)$$

2

(ii) What effect does laser surgery have on the focal length of the cornea?

(f) increases

..... **1**

(iii) When a laser is in use, a warning sign similar to the one shown must be displayed.

Why must a warning sign be displayed?

laser { light / radiation } is harmful (to { tissue / eyes })

..... **1**

NOTES

accept $\frac{5}{0{\cdot}2}$ **as correct substitution**

accept focal length

NOT focal point

the
this
laser } **radiation is harmful → (1) mark**

but NOT **radiation is harmful → (0) mark**
(on its own)

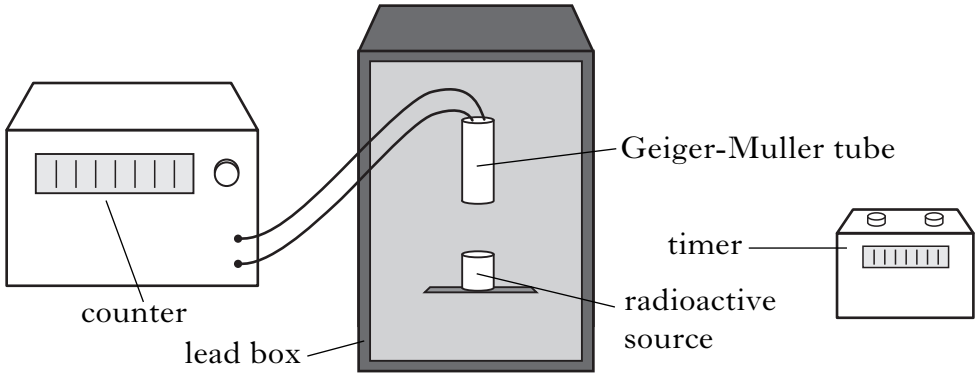
NOT it is <u>dangerous</u> (repeating stem given)

DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

7. Radioactive sources are used in medical investigations.

(*a*) A technician uses a Geiger-Muller tube, a counter and a timer to measure the half-life of a radioactive source. The source and the tube are placed in a lead box to exclude background radiation.



(i) Describe how the apparatus is used to measure the half-life of the radioactive source.

count measured for fixed time period (1);

several counts taken at intervals (1)

plot graph of count rate(-v-time) (1)

3

(ii) The half-life of the source is 10 minutes. The initial count rate is 1200 counts per minute.

Calculate the count rate after 40 minutes.

Space for working and answer

(½) for halving
(½) for correct number of ½ life periods

0 → 1200
10 → 600
20 → 300
30 → 150
40 → 75 (counts per minute) (1)

2

NOTES

if Bq (–½) (unit error)

DO NOT WRITE IN THIS MARGIN

7. (continued)

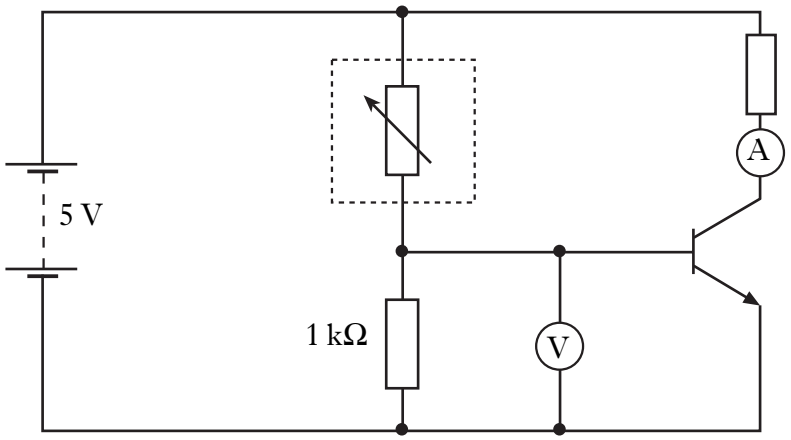
	Marks	K&U	PS
(*b*) Dose equivalent measures the biological effect of radiation.			
(i) What unit is used to measure dose equivalent?			
sievert or Sv	**1**		
(ii) State **two** factors that dose equivalent depends on.			
2 from type of radiation / type of tissue / weighting factor / quality factor / time (of exposure) / energy (absorbed) / absorbed dose / mass of tissue **(2 × 1)**	**2**		

NOTES

DO NOT WRITE IN THIS MARGIN

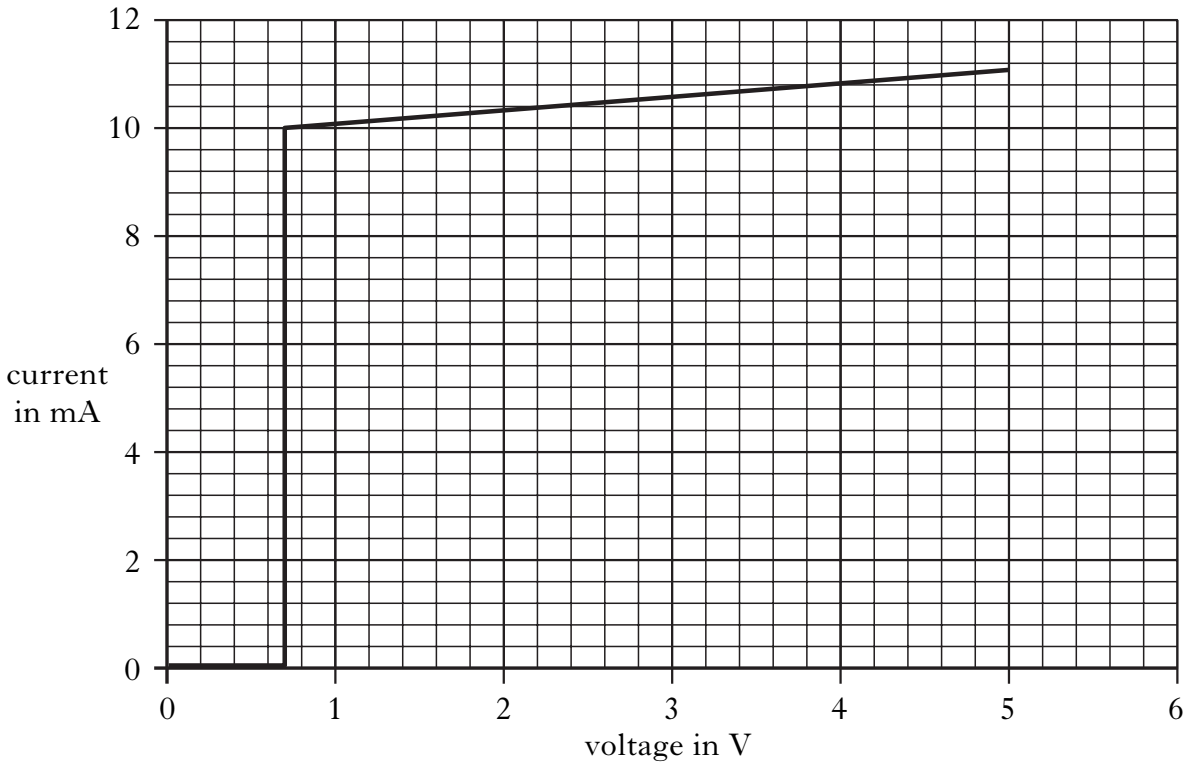
Marks	K&U	PS

8. The circuit shown is used to investigate the switching action of a transistor.



(*a*) Draw the symbol for a variable resistor in the dotted box in the above diagram. **1**

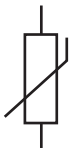
(*b*) The graph shows how the ammeter reading varies with the voltmeter reading when the resistance of the variable resistor is changed.



(i) State the voltage at which the transistor starts to conduct.

0·7 V **1**

NOTES

NOT 

1 or 0

Question No. 8 (*a*) *and* (*b*)(i)

DO NOT WRITE IN THIS MARGIN

	Marks	K&U	PS

8. (*b*) (continued)

(ii) Calculate the voltage across the variable resistor when the transistor starts to conduct.

Space for working and answer

$V_S = V_{VR} + V_R$ (½)

$5 = V_{VR} + 0{\cdot}7$

$\therefore V_{VR} = 4{\cdot}3\,V$ (½)

1

(iii) Calculate the resistance of the variable resistor when the transistor starts to conduct.

Space for working and answer

$$\frac{V_{VR}}{V_R} = \frac{R_{VR}}{R_R} \quad (½)$$

$$\therefore \quad \frac{4{\cdot}3}{0{\cdot}7} = \frac{R_{VR}}{1000} \quad (½)$$

$\therefore R_{VR} = 6143\,\Omega$ (1) (=6·1 kΩ)

2

6000, 6100, 6140, 6143

NOTES

OR: V = IR $\therefore\ 0{\cdot}7 = I \times 1000$

$\therefore\ I = \frac{0{\cdot}7}{1000}$

V = IR (½) $\therefore\ R = \frac{V}{I}$

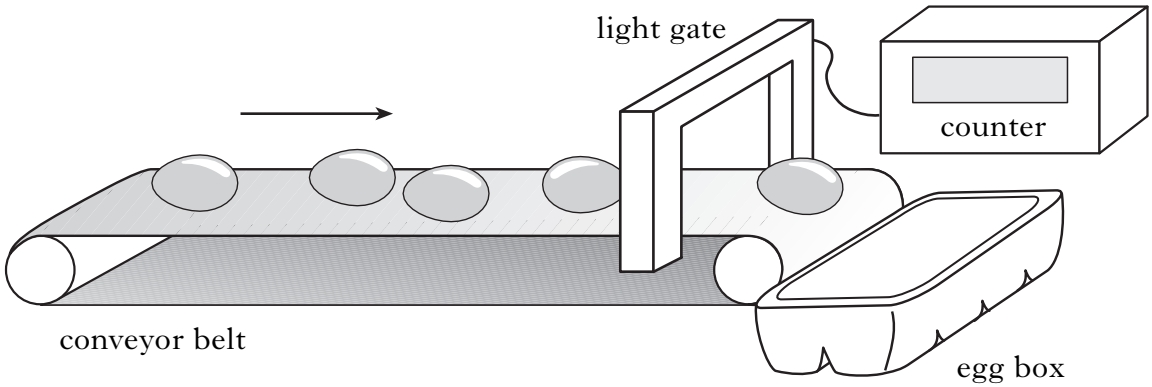
$= \frac{4{\cdot}3}{0{\cdot}7} \times 1000$ **(½)**

$= 6143\,\Omega$ **(1)**

DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

9. A machine packs eggs into boxes. The eggs travel along a conveyor belt and pass through a light gate that operates a counter. After the correct number of eggs has passed through the light gate, the counter resets and the box is exchanged for an empty one.

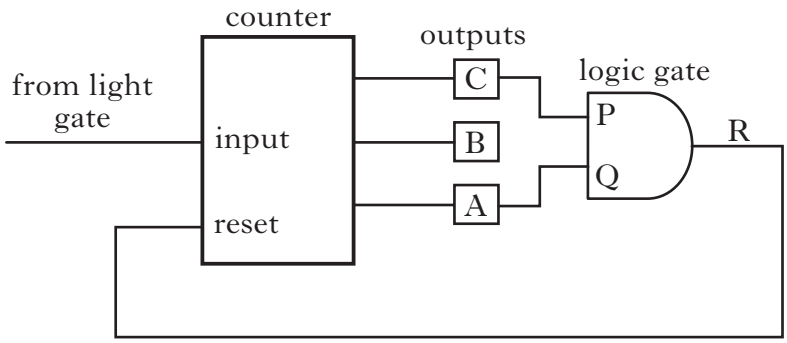


(*a*) The light gate consists of a light source and detector.

State a suitable component to be used as the detector.

LDR/solar cell/photodiode/phototransistor **1**

(*b*) Part of the counter circuit is shown.



The input to the counter goes to logic 1 every time an egg passes through the light gate. When the reset to the counter goes to logic 1, the outputs go to zero.

The table below shows the logic states of the three outputs A, B and C of the counter as eggs pass the detector.

Number of eggs	A	B	C
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1

NOTES

NOT light sensor

NOT solar panel

DO NOT WRITE IN THIS MARGIN

Marks | K&U | PS

9. (*b*) (continued)

(i) Complete the truth table for the logic gate shown.

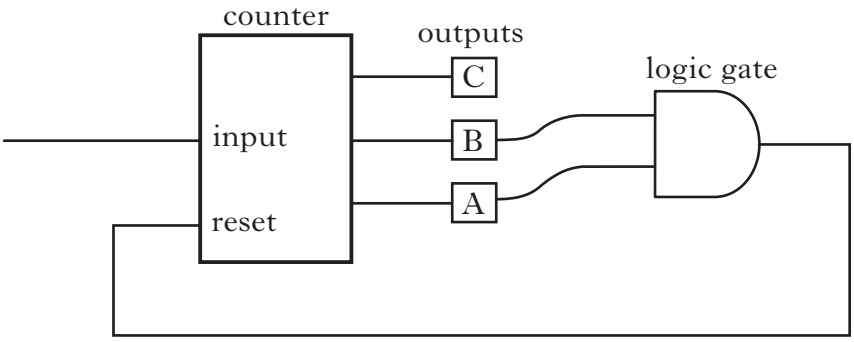
P	Q	R
0	0	**0**
0	1	**0**
1	0	**0**
1	1	**1**

(1 or 0) **1**

(ii) How many eggs are being packed into each box when the logic gate is connected to the counter outputs as shown?

5 ..... **1**

(iii) Complete the diagram below to show how the logic gate should be connected to the counter outputs so that six eggs can be packed in a box.



1

(1 or 0)

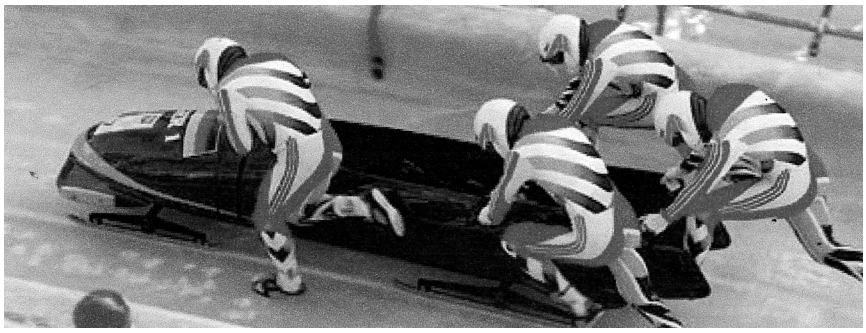
NOTES

Question No. 9 (*b*)

DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

10. A bobsleigh team competes in a race.



(*a*) Starting from rest, the bobsleigh reaches a speed of 11 m/s after a time of 3·2 s.

Calculate the acceleration of the bobsleigh.

Space for working and answer

$\mathbf{a = \frac{v - u}{t}}$ **(½)**

$\mathbf{= \frac{11(-0)}{3{\cdot}2}}$ **(½)**

$\mathbf{= 3{\cdot}4\ m/s^2}$ **(1)**

2

(*b*) The bobsleigh completes the 1200 m race in a time of 42·0 s.

Calculate the average speed of the bobsleigh.

Space for working and answer

$\mathbf{v = \frac{s}{t}}$ **(½)**

$\mathbf{= \frac{1200}{42}}$ **(½)**

= 28·6 m/s (1)

2

(*c*) Describe how the instantaneous speed of the bobsleigh could be measured as it crosses the finish line.

measure length of bobsleigh (½)

set up a light gate and timer (½)

speed = $\frac{\text{distance}}{\text{time}}$ (1) (dependant on previous 2 × (½) marks)

2

NOTES

if $a = \frac{v}{t}$ **→ (0) marks (wrong physics)**

3, 3·4, 3·44, 3·438

accept m/s/s, $m\,s^{-2}$, $m\,s^{-1}\,s^{-1}$

29, 28·6, 28·57, 28·571

$$\textbf{speed} = \frac{\textbf{length of bobsleigh}}{\textbf{time recorded} \begin{Bmatrix} \textbf{at light gate} \\ \textbf{on timer} \end{Bmatrix}} \Rightarrow \textbf{(2) marks}$$

DO NOT WRITE IN THIS MARGIN

	Marks	K&U	PS

10. (continued)

(*d*) To travel as quickly as possible, frictional forces must be minimised.

State **two** methods of reducing friction.

streamlining/lubrication

(2 × 1) **2**

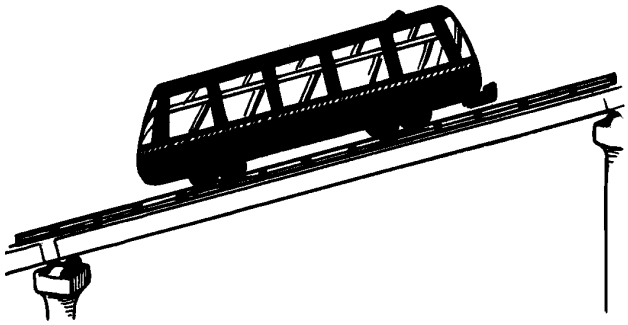
streamlining/aerodynamic shape
lubrication
less weight/less mass
smooth surfaces
using rollers

NOTES

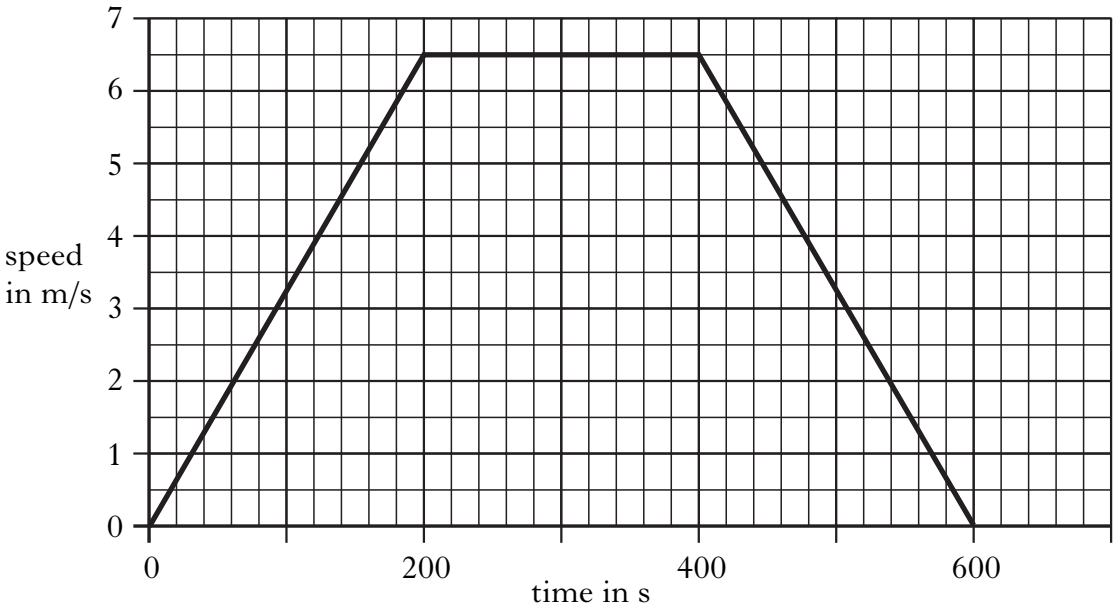
DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

11. A train travels up a mountain carrying skiers in winter and tourists in summer.



(*a*) The graph shows how the speed of the train varies with time for the journey in winter.



(i) Calculate the acceleration of the train during the first 200 s.

Space for working and answer

$\mathbf{a = \frac{v - u}{t}}$ **(½)**

$\mathbf{= \frac{6{\cdot}5(-0)}{200}}$ **(½)**

$\mathbf{= 0{\cdot}0325\ m/s^2}$ **(1)**

2

(ii) Calculate the length of the journey.

Space for working and answer

distance = area under graph (½)

= (½ × 200 × 6·5) + (200 × 6·5) + (½ × 200 × 6·5) (½)

= 650 + 1300 + 650

= 2600 m (1)

2

NOTES

$\mathbf{a = \frac{v}{t} \Rightarrow}$ **(0) marks (wrong physics)**

0·03, 0·033, 0·0325

DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

11. (continued)

(*b*) The mass of the train is 15 000 kg. During the journey the train travels through a height of 460 m.

Calculate the potential energy gained by the train.

Space for working and answer

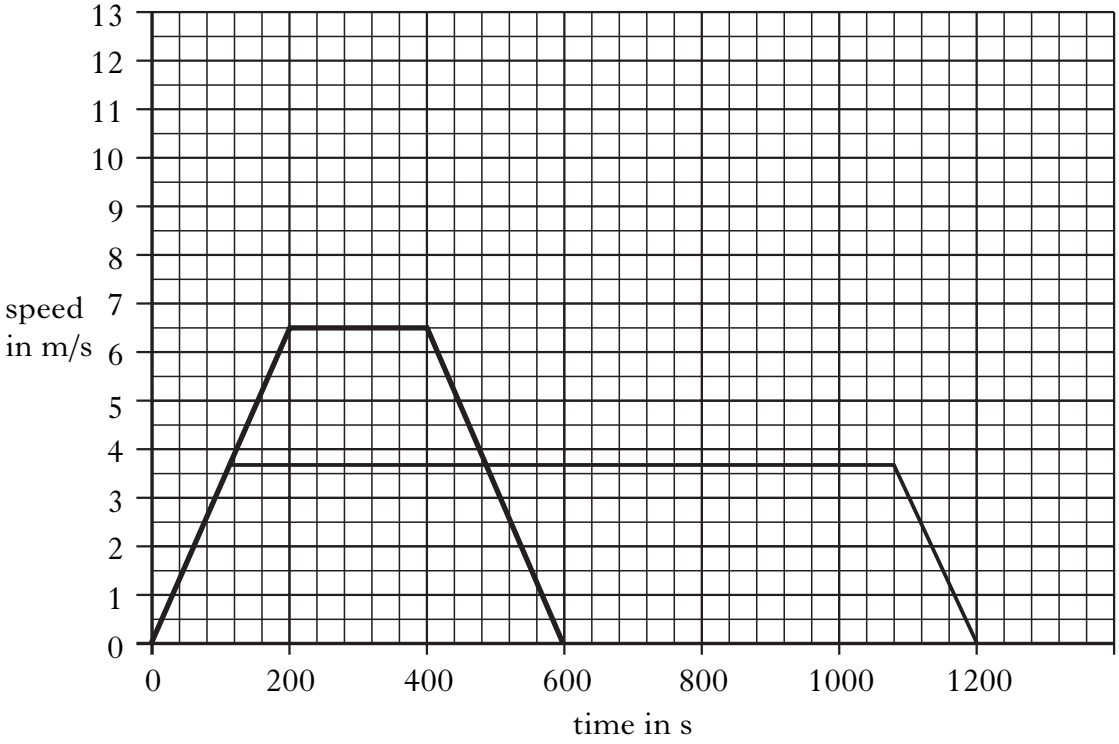
E_P = mgh (½)

= 15000 × 10 × 460 (½)

= $6{\cdot}9 \times 10^7$ J (1)

2

(*c*) In summer, the train takes a time of 1200 s to travel up the mountain so that tourists can enjoy the view. The acceleration and deceleration of the train remain the same as in winter. The graph below again shows the motion of the train in winter.



Using the axes given above, sketch a second graph showing the motion of the train in summer.
(Calculations are not required.)

maximum speed less (1)
time duration = 1200 s (1)

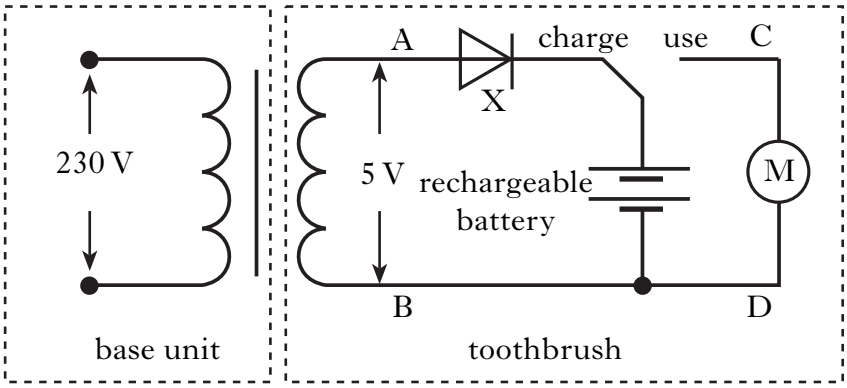
2

NOTES
accept 9·8 / 9·81 / 10 for g **$6{\cdot}762 \times 10^7$ $6{\cdot}768 \times 10^7$** **(2) independent marks**

DO NOT WRITE IN THIS MARGIN

	Marks	K&U	PS

12. An electric toothbrush contains a rechargeable battery. The battery is recharged using a transformer connected to a 230 V a.c. supply. The primary coil and the core of the transformer are sealed into the base unit. The 5 V secondary coil of the transformer is part of the toothbrush.



To charge the battery, the toothbrush is placed on the base unit, with the switch in the "charge" position.

(*a*) Identify the component labelled X.

diode

..... 1

(*b*) The primary coil of the transformer has 6440 turns.

(i) Assuming the transformer is 100% efficient, calculate the number of turns on the secondary coil.

Space for working and answer

$\frac{V_P}{V_S} = \frac{n_P}{n_S}$ **(½)** $\therefore n_S = 140$ **(1)**

$\frac{230}{5} = \frac{6440}{n_S}$ **(½)**

2

(ii) When the toothbrush is charging, the current in the secondary coil is 50 mA.

(A) Calculate the output power of the transformer.

Space for working and answer

P = IV (½)
= 50 × 10^{-3} × 5 (½)
= 0·25 W (1)

2

NOTES

NOT LED

Question No. 12 (*a*), (*b*)(i) *and* (ii)

DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

12. (*b*)(ii) (continued)

(B) In practice, the transformer is only 40% efficient.

Calculate the current in the primary coil.

Space for working and answer

Efficiency $= \frac{P_{out}}{P_{in}}$ (½)

$\therefore \frac{40}{100} = \frac{0{\cdot}25}{P_{in}}$ (½)

$\therefore P_{in} = \frac{0{\cdot}25 \times 100}{40}$

$= 0{\cdot}625$(W)

$P_{in} = I_P V_P$ (½)

$I_P = \frac{P_{in}}{V_P}$

$= \frac{0{\cdot}625}{230}$ (½)

$= 0{\cdot}0027$ A (1)

(= 2·7 mA)

3

(iii) State **one** reason why a transformer is less than 100% efficient.

heat in winding

loss + location (1) eg (eddy) currents in core

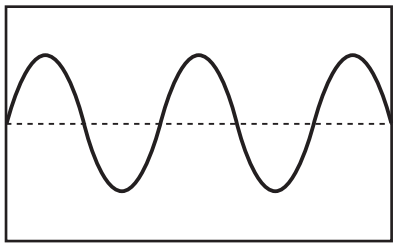
1

(*c*) Sketch the trace seen when an oscilloscope is connected across:

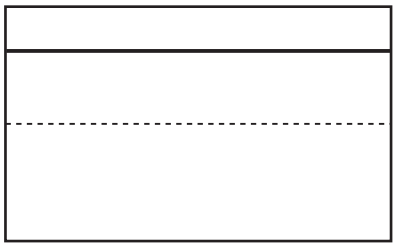
(i) AB when the battery is being charged;

(ii) CD when the toothbrush is removed from the base unit and the switch is in the "use" position.

Values need not be shown on either sketch.



AB



CD

2

(2 × 1)

NOTES

2 calculations (× 1) mark each

(1) mark for final answer

0·003, 0·0027, 0·00272, 0·002717

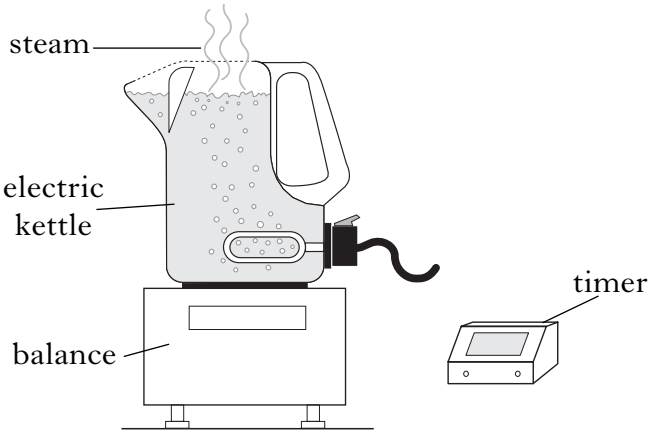
1 or 0 **accept** **heat in core**
magnetisation of core
sound in core
sound in windings
hysteresis
energy loss in wires

CD — above <u>or</u> below
independent marks

DO NOT WRITE IN THIS MARGIN

	Marks	K&U	PS

13. The apparatus shown is used to calculate the value of the specific latent heat of vaporisation of water.



The electric kettle is rated at 3·0 kW. The kettle containing water is placed on the balance. The lid of the kettle is removed and the kettle is switched on. Once the water starts to boil, the kettle is left switched on for a further 85·0 s before being switched off.

(*a*) Calculate how much electrical energy is supplied to the kettle in 85·0 s.

Space for working and answer

$\mathbf{E = Pt}$ **(½)**

$\mathbf{= 3 \times 10^3 \times 85}$ **(½)**

$\mathbf{= 2{\cdot}55 \times 10^5 J}$ **(1)**

2

(*b*) The reading on the balance decreases by 0·12 kg during the 85·0 s.

(i) Assuming all the electrical energy supplied is transferred to the water, calculate the value of the specific latent heat of vaporisation of water obtained in the experiment.

Space for working and answer

$\mathbf{E_h = m\ \ell}$ **(½)** $\mathbf{\therefore\ \ell = \frac{E_h}{m}}$

$\mathbf{= \frac{2{\cdot}55 \times 10^5}{0{\cdot}12}}$ **(½)**

$\mathbf{= 2{\cdot}13 \times 10^6\ J/kg}$ **(1)**

2

(ii) The accepted value for the specific latent heat of vaporisation of water is $22{\cdot}6 \times 10^5$ J/kg.

Suggest why there is a difference between this value and the value obtained in (*b*)(i).

water splashing out

1

NOTES

no conversion to watts (–½) mark (unit error)

2×10^6, $2{\cdot}1 \times 10^6$, $2{\cdot}13 \times 10^6$, $2{\cdot}125 \times 10^6$

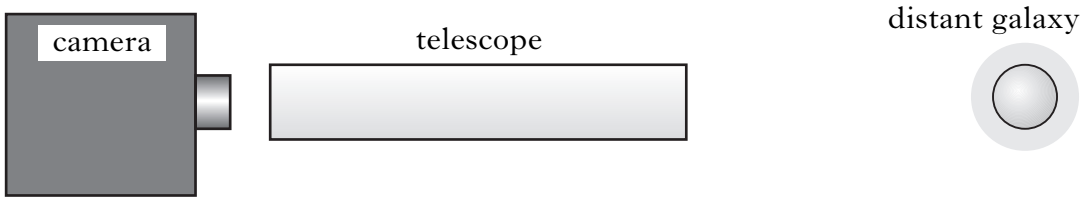
(*b*)(i) <u>answer smaller</u>
water splashing out

(*b*)(i) <u>answer bigger</u>
condensation
heat transferred to surroundings

DO NOT WRITE IN THIS MARGIN

Marks | K&U | PS

14. An astronomer uses a telescope and a camera to take a photograph of a distant galaxy.



(*a*) The table shows a number of lenses that are available for use in the telescope.

lens	*type*	*focal length* (mm)	*diameter* (mm)
P	concave	15	10
Q	convex	15	10
R	convex	1000	10
S	convex	1000	100
T	concave	1000	100

From the table, select the most suitable lenses for use as the eyepiece and the objective of the telescope.

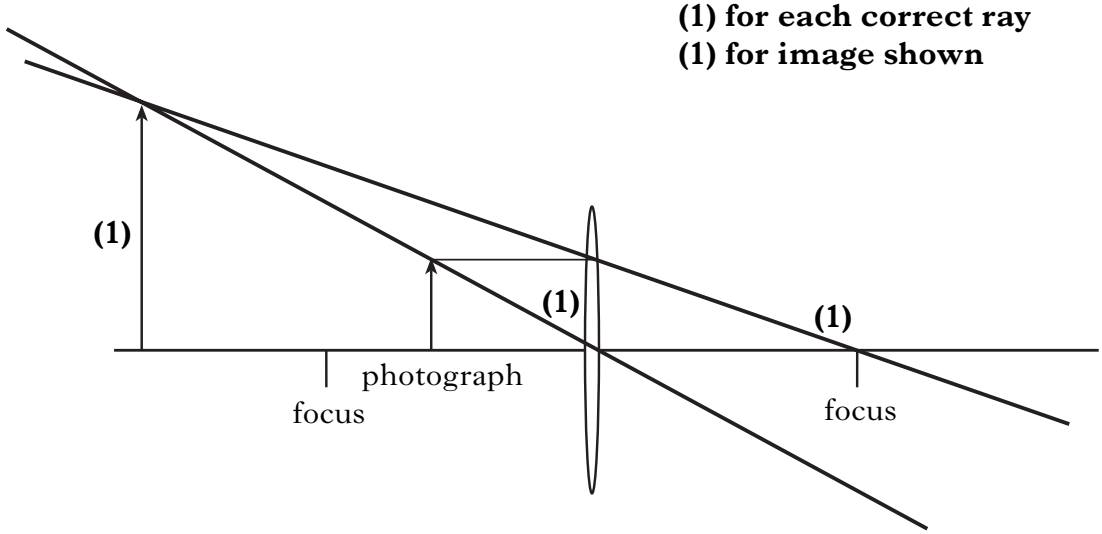
Eyepiece **Q** Objective **S** **(2 × 1)** 2

(*b*) The astronomer examines the photograph using a magnifying glass.

Complete the ray diagram to show how the magnifying glass can be used to form an image of the photograph.

Your diagram must show the position of the image.

(1) for each correct ray
(1) for image shown



3

NOTES

independent marks

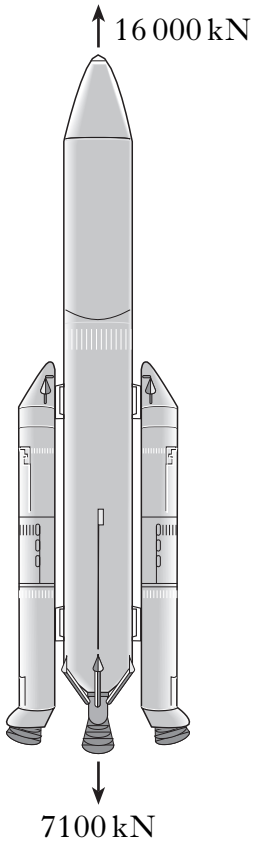
(1) for image is dependent on 2 rays

DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

15. A spacecraft consisting of a rocket and a lunar probe is launched from the Earth to the Moon.

(*a*) At lift-off from the Earth, the spacecraft has a weight of 7100 kN. The thrust from the engines is 16 000 kN.



(i) Calculate the unbalanced force acting on the spacecraft.

Space for working and answer

F = 16000 – 7100
= 8900 kN (1)

1

(ii) Calculate the mass of the spacecraft.

Space for working and answer

$$\mathbf{W = mg}$$
$$\mathbf{\therefore m = \frac{W}{g}}$$
$$\mathbf{= \frac{7100 \times 10^3}{10}}$$
= 710,000 kg (= 7·1 × 10^5 kg) (1)

1

NOTES
accept 9·8 / 9·81 / 10 for g

DO NOT WRITE IN THIS MARGIN

	Marks	K&U	PS

15. (*a*) (continued)

(iii) Calculate the initial acceleration of the spacecraft.

Space for working and answer

$\mathbf{F = ma}$ (½) $\therefore \quad \mathbf{a = \frac{F}{m}}$

$= \frac{8900 \times 10^3}{7{\cdot}1 \times 10^5}$ (½)

$= 12{\cdot}5 \text{ m/s}^2$ (1)

2

(*b*) As it approaches the Moon, the probe is detached from the rocket and goes into lunar orbit.

(i) While orbiting the Moon, the probe takes images of the Moon's surface. This data is sent to Earth using radio waves. The distance between the probe and Earth is 384 000 km.

Calculate the time taken for the data to reach Earth.

Space for working and answer

$\mathbf{v = \frac{s}{t}}$ (½) $\therefore \quad \mathbf{t = \frac{s}{v}}$

$= \frac{384000 \times 10^3}{3 \times 10^8}$ (½)

$= 1{\cdot}28 \text{ s}$ (1)

2

(ii) The Moon is a natural satellite and the probe is an artificial satellite.

Explain what a satellite is.

an object that orbits another object

1

(iii) The probe orbits the Moon because of the Moon's gravitational field.

Explain why the probe does not crash into the Moon.

forward speed means it continually misses the Moon

while falling/it is in projectile motion

1

[*END OF MARKING INSTRUCTIONS*]

NOTES

13, 12·5, 12·54, 12·535

accept: an object that orbits { **Earth** / **a planet** / **a star**