2007 Physics

Standard Grade − Credit

Finalised Marking Instructions

Physics – Marking Issues

The current in a resistor is 1·5 amperes when the potential difference across it is 7·5 volts. Calculate the resistance of the resistor.

	Answers	Mark + Comment	Issue
1.	V=IR 7·5=1·5R R=5·0 Ω	(½) (½) (1)	Ideal answer
2.	5·0 Ω	(2) Correct answer	GMI 1
3.	5·0	(1½) Unit missing	GMI 2 (a)
4.	4·0 Ω	(0) No evidence/wrong answer	GMI 1
5.	_____ Ω	(0) No final answer	GMI 1
6.	$R = \frac{V}{I} = \frac{7 \cdot 5}{1 \cdot 5} = 4 \cdot 0\,\Omega$	(1½) Arithmetic error	GMI 7
7.	$R = \frac{V}{I} = 4 \cdot 0\,\Omega$	(½) Formula only	GMI 4 and 1
8.	$R = \frac{V}{I} =$ _____Ω	(½) Formula only	GMI 4 and 1
9.	$R = \frac{V}{I} = \frac{7 \cdot 5}{1 \cdot 5} =$ _____Ω	(1) Formula + subs/No final answer	GMI 4 and 1
10.	$R = \frac{V}{I} = \frac{7 \cdot 5}{1 \cdot 5} = 4 \cdot 0$	(1) Formula + substitution	GMI 2 (a) and 7
11.	$R = \frac{V}{I} = \frac{1 \cdot 5}{7 \cdot 5} = 5 \cdot 0\,\Omega$	(½) Formula but wrong substitution	GMI 5
12.	$R = \frac{V}{I} = \frac{75}{1 \cdot 5} = 5 \cdot 0\,\Omega$	(½) Formula but wrong substitution	GMI 5
13.	$R = \frac{I}{V} = \frac{7 \cdot 5}{1 \cdot 5} = 5 \cdot 0\,\Omega$	(0) Wrong formula	GMI 5
14.	V = IR 7·5 = 1·5 × R R = 0·2 Ω	(1½) Arithmetic error	GMI 7
15.	V = IR $R = \frac{I}{V} = \frac{1 \cdot 5}{7 \cdot 5} = 0 \cdot 2\,\Omega$	(½) Formula only	GMI 20

DATA SHEET

Speed of light in materials

Material	*Speed in m/s*
Air	$3{\cdot}0 \times 10^8$
Carbon dioxide	$3{\cdot}0 \times 10^8$
Diamond	$1{\cdot}2 \times 10^8$
Glass	$2{\cdot}0 \times 10^8$
Glycerol	$2{\cdot}1 \times 10^8$
Water	$2{\cdot}3 \times 10^8$

Speed of sound in materials

Material	*Speed in m/s*
Aluminium	5200
Air	340
Bone	4100
Carbon dioxide	270
Glycerol	1900
Muscle	1600
Steel	5200
Tissue	1500
Water	1500

Gravitational field strengths

	Gravitational field strength on the surface in N/kg
Earth	10
Jupiter	26
Mars	4
Mercury	4
Moon	1·6
Neptune	12
Saturn	11
Sun	270
Venus	9

Specific heat capacity of materials

Material	*Specific heat capacity in J/kg °C*
Alcohol	2350
Aluminium	902
Copper	386
Diamond	530
Glass	500
Glycerol	2400
Ice	2100
Lead	128
Water	4180

Specific latent heat of fusion of materials

Material	*Specific latent heat of fusion in J/kg*
Alcohol	$0{\cdot}99 \times 10^5$
Aluminium	$3{\cdot}95 \times 10^5$
Carbon dioxide	$1{\cdot}80 \times 10^5$
Copper	$2{\cdot}05 \times 10^5$
Glycerol	$1{\cdot}81 \times 10^5$
Lead	$0{\cdot}25 \times 10^5$
Water	$3{\cdot}34 \times 10^5$

Melting and boiling points of materials

Material	*Melting point in °C*	*Boiling point in °C*
Alcohol	–98	65
Aluminium	660	2470
Copper	1077	2567
Glycerol	18	290
Lead	328	1737
Turpentine	–10	156

Specific latent heat of vaporisation of materials

Material	*Specific latent heat of vaporisation in J/kg*
Alcohol	$11{\cdot}2 \times 10^5$
Carbon dioxide	$3{\cdot}77 \times 10^5$
Glycerol	$8{\cdot}30 \times 10^5$
Turpentine	$2{\cdot}90 \times 10^5$
Water	$22{\cdot}6 \times 10^5$

SI Prefixes and Multiplication Factors

Prefix	*Symbol*	*Factor*
giga	G	1 000 000 000 $= 10^9$
mega	M	1 000 000 $= 10^6$
kilo	k	1000 $= 10^3$
milli	m	0·001 $= 10^{-3}$
micro	μ	0·000 001 $= 10^{-6}$
nano	n	0·000 000 001 $= 10^{-9}$

DO NOT WRITE IN THIS MARGIN

Marks | K&U | PS

1. A pupil is sent exam results by a text message on a mobile phone. The frequency of the signal received by the phone is 1900 MHz.

The mobile phone receives radio waves (signals).

(*a*) What is the speed of radio waves?

3×10^8 m/s (1) or (0) — **1**

(*b*) Calculate the wavelength of the signal. — **2**

Space for working and answer

$\lambda = \frac{v}{f}$ (½)

$= \frac{3 \times 10^8}{1900 \times 10^6}$ (½)

$= 0{\cdot}16$ m (1)

OR

$v = f\lambda$

$3 \times 10^8 = 1900 \times 10^6 \times \lambda$

$\lambda = 0{\cdot}16$ m

(*c*) The pupil sends a video message from the mobile phone. The message is transmitted by microwaves. The message travels a total distance of 72 000 km.

Calculate the time between the message being transmitted and received. — **2**

Space for working and answer

$t = \frac{d}{v}$

$= \frac{72000000}{3 \times 10^8}$

$= 0{\cdot}24$ s

NOTES

(*a*) unit required

(*b*) unit penalty if no conversion into Hz (–½)

significant figure range:

0·2 0·16 0·158 0·1579

(*c*) unit penalty if no conversion into m (–½)

DO NOT WRITE IN THIS MARGIN

Marks K&U PS

2. Radio waves have a wide range of frequencies.

The table gives information about different wavebands.

Waveband	*Frequency Range*	*Example*
Low frequency (LF)	30 kHz – 300 kHz	Radio 4
Medium frequency (MF)	300 kHz – 3 MHz	Radio Scotland
High frequency (HF)	3 MHz – 30 MHz	Amateur radio
Very high frequency (VHF)	30 MHz – 300 MHz	Radio 1 FM
Ultra high frequency (UHF)	300 MHz – 3 GHz	BBC 1 and ITV
Super high frequency (SHF)	3 GHz – 30 GHz	Satellite TV

(*a*) Coastguards use signals of frequency 500 kHz.

What waveband do these signals belong to?

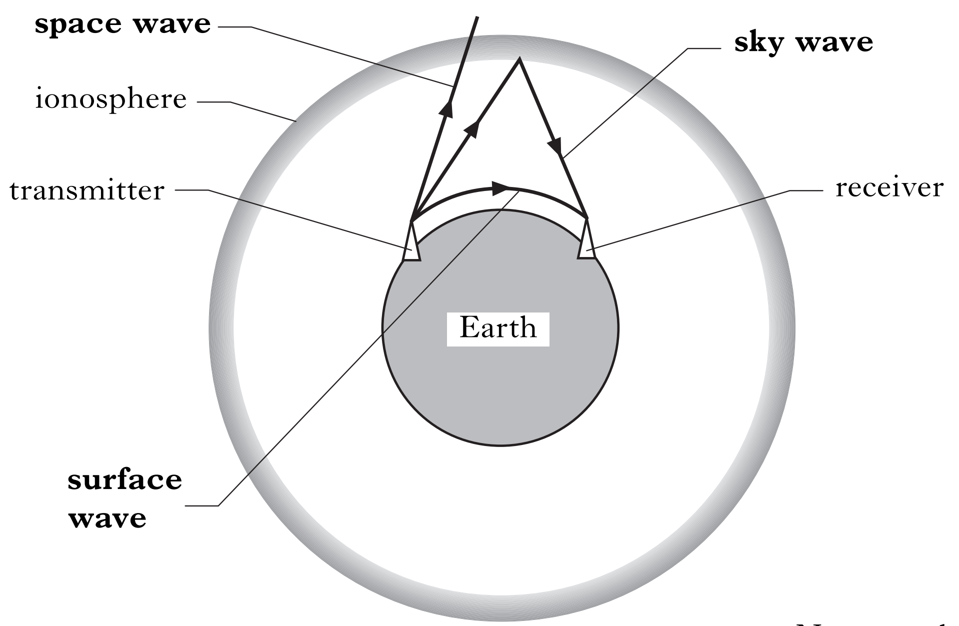
medium frequency OR mf **1**

NOTES

not: Radio Scotland

2. (continued)

(*b*) The diagram shows how radio signals of different wavelengths are sent between a transmitter and a receiver.



Not to scale

(i) Which of the waves in the diagram shows diffraction? — **1**

surface (waves)

(ii) What does this indicate about the wavelength of the diffracted wave compared to the other two waves? — **1**

longer (wavelength)

(iii) The Earth's ionosphere is shown on the diagram. The ionosphere is a layer of charged particles in the upper atmosphere. High frequency waves are transmitted as sky waves.

Explain how the transmitted waves reach the receiver. — **1**

the (radio) waves are reflected by the ionosphere

(iv) Super high frequency (SHF) signals are shown as space waves on the diagram. Although they can only travel in straight lines, they can be used for communications on Earth between a transmitter and receiver.

Describe how the SHF signals get to the receiver. — **2**

mention of satellite (1)
+ any valid function of satellite (1)
eg "signals transmitted back to Earth"
"signal amplified/focused"
"signal frequency altered"

DO NOT WRITE IN THIS MARGIN: K&U | PS

NOTES

(*b*) (ii) **<u>accept</u>:**
bigger/larger/greater/higher/large/high
<u>not</u>: "wider", any answer based on frequency

(*b*) (iii) **<u>accept</u>:**
reflection, (total internal) reflection
<u>do not accept</u>:
"bounce (off ionosphere)", refraction

DO NOT WRITE IN THIS MARGIN

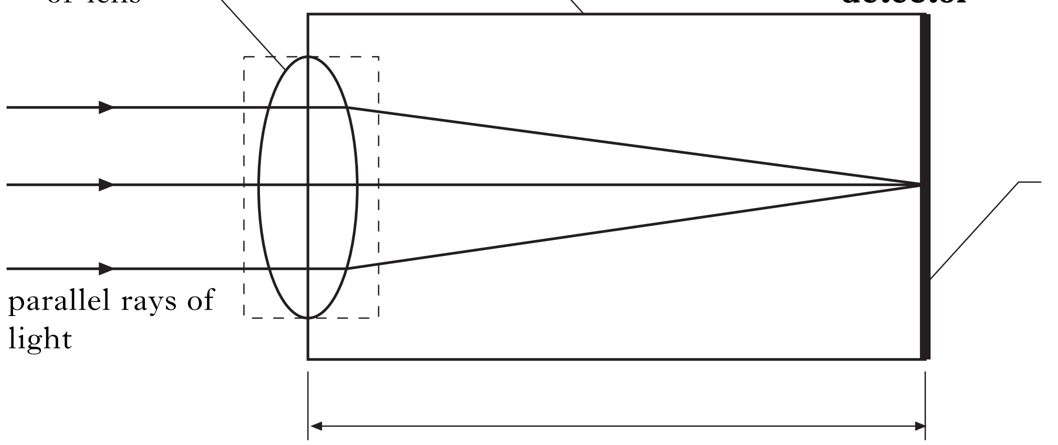
Marks K&U PS

3. A door entry system in an office block allows video and audio information to be sent between two people.

(*a*) A camera at the entrance uses a lens to focus parallel rays of light onto a detector.

Part of the camera is shown in the diagram below.

independent marks
(1) for correct lens shape
(1) for focused rays on detector



(i) Complete the diagram above by:

(A) drawing the lens used;

(B) completing the path of the light rays. **2**

(ii) Using information from the diagram, calculate the power of the lens used in the camera. **2**

Space for working and answer

$$\mathbf{P} = \frac{1}{f}$$

$$= \frac{1}{0{\cdot}016}$$

$$= 62{\cdot}5\,\mathrm{D}$$

NOTES

rays must meet at mid-point of detector

rays drawn must be reasonably straight

ignore rays drawn <u>inside</u> dotted box

if P = 0·0625 D as final answer – deduct (½) (unit error)

DO NOT WRITE IN THIS MARGIN

Marks | K&U | PS

3. (continued)

(*b*) The door entry system uses a black and white television screen.

Describe how a moving picture is seen on the television screen.

Your description must include the terms:

line build up **image retention** **brightness variation**.

award marks: 2 × (½) for describing line build up

2 × (½) for describing image retention

(½) for describing brightness variation

(½) for mention of all 3 terms in context with correct explanation **3**

eg

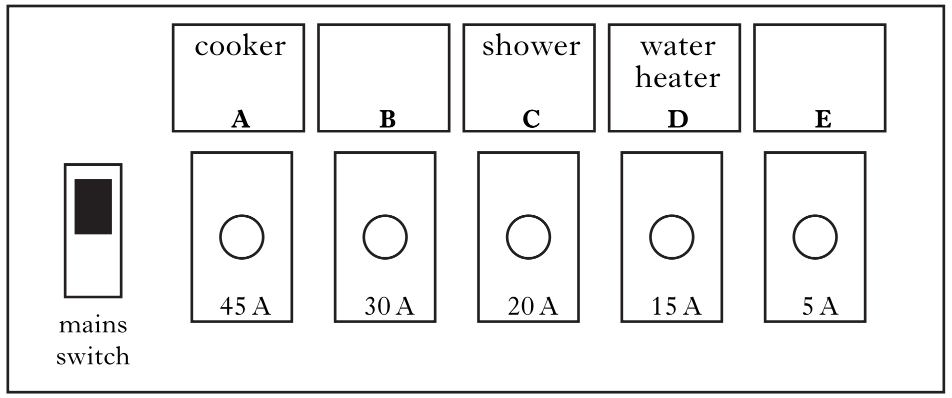
- **line build up is when electrons (½) scan across screen (½)**
- **image retention is when brain/eye retains (½) each picture while next is produced (½) (or picture is produced 25 times per second)**
- **brightness variation is by changing number/intensity of electron beam (½)**

+ all 3 terms correctly used in context (½)

NOTES

Marks K&U PS

4. The consumer unit in a house contains a mains switch and circuit breakers for different circuits.



(*a*) (i) What is the purpose of the mains switch?

to switch off all circuits — 1

(ii) Two of the circuits have not been labelled.

Which circuit is: the ring circuit? **B** **(½)**

the lighting circuit? **E** **(½)** — 1

(iii) The current ratings for the ring circuit and the lighting circuit are different.

State another difference between the ring circuit and the lighting circuit.

thicker wire in ring circuit OR two paths (for current) in ring circuit — 1

NOTES

(*a*) (i) **<u>accept</u>:**
to turn on/off <u>all</u> circuits/electrical appliances
to switch off: electricity supply/power/current
to isolate mains

<u>do not accept</u>:
"to switch off mains", "to change fuse"

(*a*) (iii) **<u>accept</u>:**
wire thickness
cost
cheaper/thinner wire for lighting circuit

DO NOT WRITE IN THIS MARGIN

4. (continued)

(*b*) (i) A 25 W lamp is designed to be used with mains voltage.

Calculate the resistance of the lamp. **3** (Marks: K&U)

Space for working and answer

V = 230 V (1)

$$I = \frac{P}{V} = \frac{25}{230} = 0{\cdot}109 \quad \textbf{OR} \quad R = \frac{V^2}{P} \ (½)$$

$$R = \frac{V}{I} \ (½) \qquad = \frac{230^2}{25} \ (½)$$

$$= \frac{230}{0{\cdot}109} \ (½) \qquad = 2116\,\Omega \ (1)$$

$$= 2110\,\Omega \ (1)$$

s.f. range: 2000 2100 2120 2116

(ii) Four of these lamps are connected in parallel.

Calculate the **total** resistance of the lamps. **2** (Marks: PS)

Space for working and answer

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} \quad (½)$$

$$= \frac{1}{2116} + \frac{1}{2116} + \frac{1}{2116} + \frac{1}{2116} \quad (½)$$

$$= \frac{4}{2116}$$

$$R_T = \frac{2116}{4} = 529\,\Omega \quad (1)$$

OR $P = 4 \times 25 = 100\,W \Rightarrow P = \frac{V^2}{R}$ (½)

$$100 = \frac{230^2}{R} \quad (½)$$

$$R = 529\,\Omega \quad (1)$$

NOTES

(*b*) (i) (½) max if any voltage other than 230 V or 240 V used
if 240 V used then deduct (1)
if 230 V is left as the final answer then must have unit for (1)
sig.fig. range: if I = 0·109 A ⇒ R = 2000 2100 2110

(*b*) (ii) if less than 4 "components" eg

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \Rightarrow$$ then award (½) only

if: $$R_T = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$ award 0 marks

accept: $$\frac{1}{R_T} = \frac{4}{2116} = \frac{2116}{4} = 529\,\Omega$$

accept

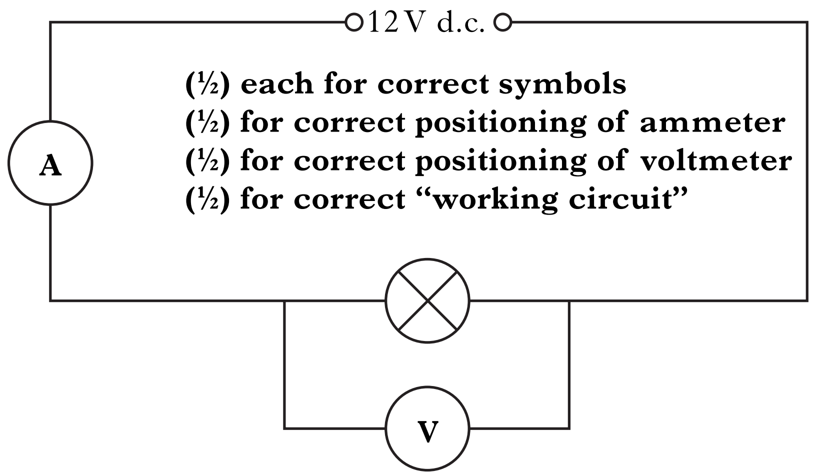
DO NOT WRITE IN THIS MARGIN

5. Two groups of pupils are investigating the electrical properties of a lamp.

(*a*) Group 1 is given the following equipment:

ammeter; voltmeter; 12 V d.c. supply; lamp; connecting leads.

Complete the circuit diagram to show how this equipment is used to measure the current through, and the voltage across, the lamp.



(½) each for correct symbols
(½) for correct positioning of ammeter
(½) for correct positioning of voltmeter
(½) for correct "working circuit"

Marks: 3

(*b*) Group 2 uses the same lamp and is only given the following equipment:

lamp; ohmmeter; connecting leads.

What property of the lamp is measured by the ohmmeter?

Resistance / R — 1

(*c*) The results of both groups are combined and recorded in the table below.

I(A)	V(V)	R(Ω)	IV	I^2R
2	12	6	**24**	**24**

(i) Use these results to complete the last two columns of the table.

Space for working

(1) for each correct entry
deduct (½) if answers not inserted into table

IV = 2 × 12 = 24 **$I^2R = 2^2 \times 6 = 24$ unit not necessary** — 2

(ii) What quantity is represented by the last two columns of the table?

Power (not P) — 1

(iii) What is the unit for this quantity?

Watt / W — 1

NOTES

(*a*) for wrong positioning of ammeter or voltmeter lose "working circuit" mark

(*b*) Not "ohms"

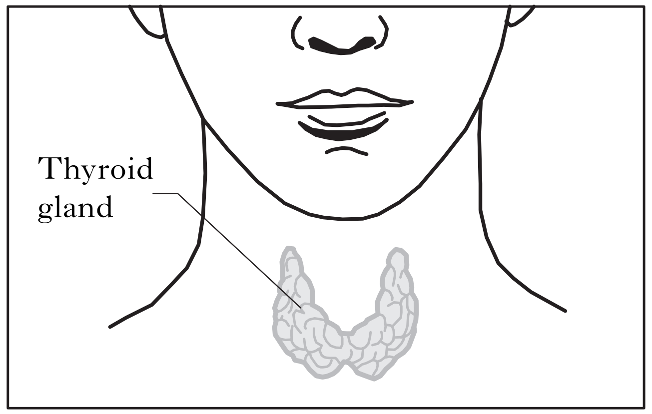
(*c*) (i) if answers do not appear in table deduct (½) but the answers must be identifiable as IV and I^2R if outwith the table

Question Nos 5(a), (b) and (c)

DO NOT WRITE IN THIS MARGIN

Marks K&U PS

6. The thyroid gland, located in the neck, is essential for maintaining good health.



(*a*) (i) A radioactive source, which is a gamma radiation emitter, is used as a radioactive tracer for the diagnosis of thyroid gland disorders.

A small quantity of this tracer, with an activity of 20 MBq, is injected into a patient's body. After 52 hours, the activity of the tracer is measured at 1·25 MBq.

Calculate the half life of the tracer.

Space for working and answer

20 → 10 → 5 → 2·5 → 1·25 MBq **(½) for halving**

4 half lives = 52 hours **(½) for correct no of ½ lives**

half life = 13 hours **(1) for answer (unit required)**

2

(ii) Another radioactive source is used to **treat** cancer of the thyroid gland. This source emits only beta radiation.

Why is this source unsuitable as a **tracer**?

it is a beta emitter, absorbed within the body

OR gamma emitter required, to pass through body 1

(iii) The equivalent dose is much higher for the beta emitter than for the gamma emitter.

Why is this higher dose necessary?

(larger dose required) to kill the (cancerous) cells 1

(*b*) What are the units of equivalent dose?

Sievert (Sv) 1

NOTES

(*a*) (ii) **<u>accept</u>: any answer indicating the absorption of β or penetration by γ**

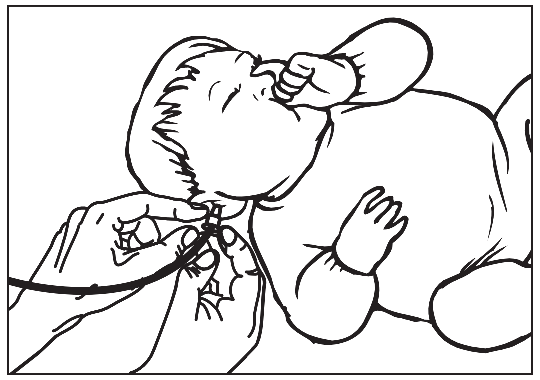
<u>do not accept</u>: any answer involving ½ life, "β more ionising", "β is weaker"

(*a*) (iii) **<u>not</u>: weaker/stronger/shrink answer OR "to be more effective"**

DO NOT WRITE IN THIS MARGIN

Marks | K&U | PS

7. A newborn baby is given a hearing test. A small device, containing a loudspeaker and a microphone, is placed in the baby's ear.



(*a*) A pulse of audible sound lasting 10 μs is transmitted through the loudspeaker. The sound is played at a level of 80 dB.

(i) Give a reason why this pulse of sound does not cause damage to the baby's hearing. **1**

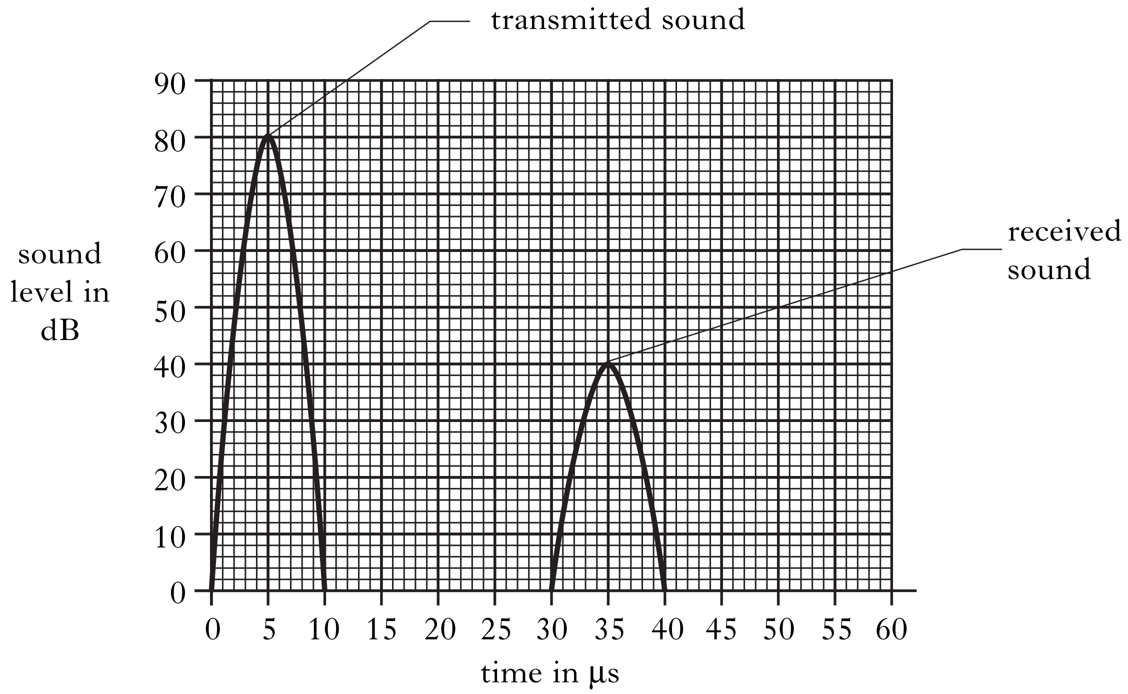
The duration of the pulse, 10 microseconds, is very small.
OR Only prolonged exposure at this level will cause damage
OR 80 dB is threshold level for damage
OR 90 dB is threshold level for damage

NOTES

7. (*a*) (continued)

(ii) The transmitted pulse of sound makes the inner ear vibrate to produce a new sound, which is received by the microphone.

Signals from the transmitted and received sounds are viewed on an oscilloscope screen, as shown below.



The average speed of sound inside the ear is 1500 m/s.

Calculate the distance between the device and the inner ear.

Space for working and answer

total time = 30×10^{-6} (½)

$t = \frac{30 \times 10^{-6}}{2}$

$= 15 \times 10^{-6}$ (½)

$d = \bar{v} \times t$ (½)

$= 1500 \times 15 \times 10^{-6}$ (½)

= 0·0225 m (1)

Marks 3

(iii) Suggest a frequency that could be used for the hearing test.

any stated value between 20 – 20000 Hz inclusive (unit required) 1

(*b*) An ultrasound scan can be used to produce an image of an unborn baby. Explain how the image of an unborn baby is formed by ultrasound.

(1) mark for indicating reflection
eg "ultrasound reflects of baby in womb"

+ (1) mark for another relevant point
eg "ultrasound takes different times to reflect from different depths of tissue"

"reflected ultrasound is detected by receiver/computer"
"apply jelly + valid description" 2

DO NOT WRITE IN THIS MARGIN

K&U	PS

NOTES

(*a*) (ii) **divide total t by 2 can appear at any stage in answer if wrong time selected from graph then:**

(½) for d = v × t, (½) for divide by 2 only

must use v = 1500 m/s

deduct (½) if no conversion of t into seconds

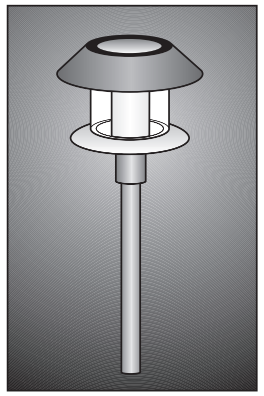
(*a*) (iii) **range of values <u>not</u> acceptable**

(*b*) **<u>not</u>: "ultrasound bounces back"**
"sound rays"

DO NOT WRITE IN THIS MARGIN

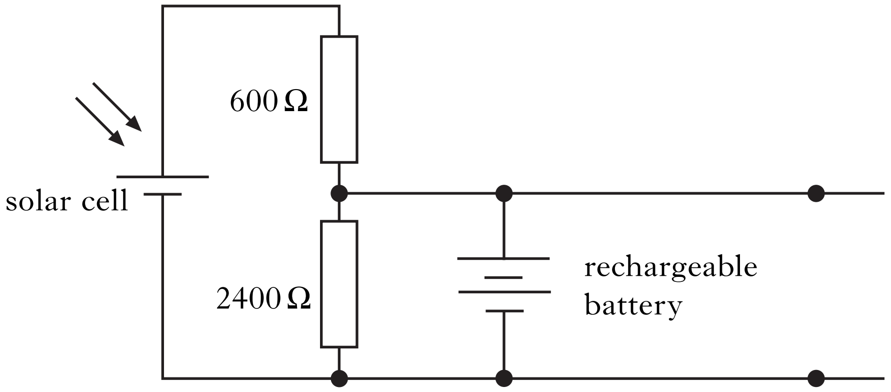
Marks | K&U | PS

8. A high intensity LED is used as a garden light. The light turns on automatically when it becomes dark.



The light also contains a solar cell which charges a rechargeable battery during daylight hours.

(*a*) Part of the circuit is shown below.



(i) State the energy transformation in a solar cell.

light to electrical (energy) **1**

(ii) At a particular light level, the voltage generated by the solar cell is 1·5 V.

Calculate the voltage across the rechargeable battery at this light level. **2**

Space for working and answer

$$\mathbf{V_B = \frac{R_2}{R_1 + R_2} \times V_S \; (½)}$$
$$\mathbf{= \frac{2400}{3000} \times 1{\cdot}5 \quad (½)}$$
$$\mathbf{= 1{\cdot}2V \quad (1)}$$

OR

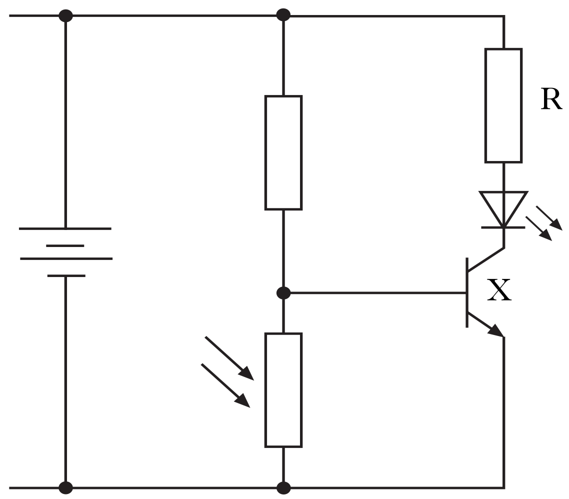
$$\mathbf{R_T = R_1 + R_2}$$
$$\mathbf{= 600 + 2400 = 3000\,(\Omega)\,(½)}$$
$$\mathbf{I = \frac{V_{cell}}{R_T} = \frac{1\cdot5}{3000} = 0\cdot0005(A)}$$
$$\mathbf{V_B = IR}$$
$$\mathbf{= 0\cdot0005 \times 2400 \; (½)}$$
$$\mathbf{= 1\cdot2V \; (1)}$$

NOTES

accept **"electric"**
do not accept **"electricity"**

8. (continued)

(*b*) The LED is switched on using the following circuit.

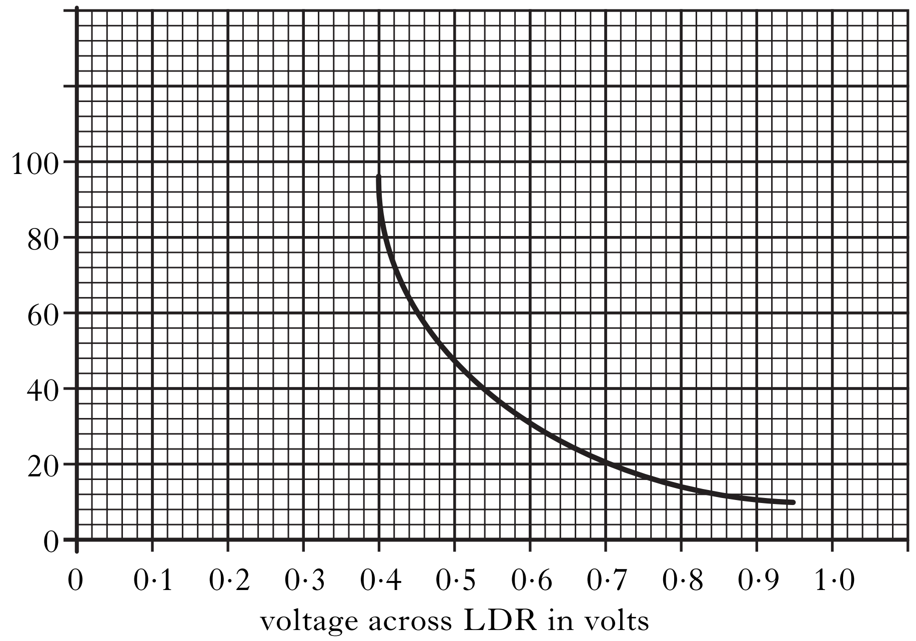


(i) Name component X.

transistor (switch) — **1**

The graph below shows the voltage across the LDR in this circuit for different light levels.

Light level is measured in lux.



(ii) For the LED to be lit, the voltage across the LDR must be at least 0·7 V.

What is the maximum light level for the LED to be lit?

20 (lux) — **1**

(iii) Explain the purpose of resistor R.

to protect the LED OR to limit the current OR to reduce the voltage across the LED — **1**

Marks	K&U	PS
1 (b)(i)		(shaded)
1 (b)(ii)	(shaded)	
1 (b)(iii)		(shaded)

DO NOT WRITE IN THIS MARGIN

NOTES

(*b*) (i) <u>**ignore**</u>**: "pnp", "npn"**
<u>**not**</u>**: phototransistor, mosfet transistor, switch**

(*b*) (iii) <u>**do not accept:**</u>
"to reduce voltage" only
"to stop LED blowing"
"to reduce the voltage through/in the LED"
"to reduce charge/power to the LED"

DO NOT WRITE IN THIS MARGIN

Marks | K&U | PS

9. An electronic tuner for a guitar contains a microphone and an amplifier. The output voltage from the amplifier is 9 V.

(*a*) The voltage gain of the amplifier is 150.

Calculate the input voltage to the amplifier.

Space for working and answer

$$\textbf{Gain} = \frac{V_{out}}{V_{in}} \quad (½)$$

$$150 = \frac{9}{V_{in}} \quad (½)$$

$$V_{in} = 0{\cdot}06\ \text{V} \quad (1)$$

2

(*b*) The tuner is used to measure the frequency of six guitar strings.

The number and frequency of each string is given in the table below.

Number of string	*Frequency* (Hz)
1	330·0
2	247·0
3	196·0
4	147·0
5	110·0
6	82·5

The tuner has an output socket which has been connected to an oscilloscope. The trace for string 5 is shown in Figure 1.

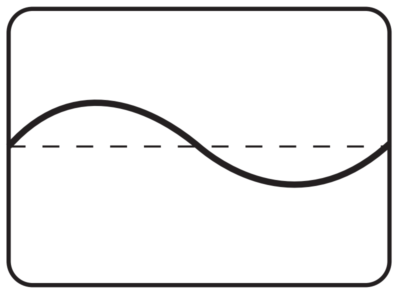


Figure 1

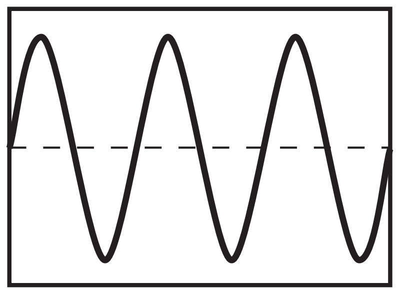


Figure 2

Independent marks
(1) for showing increased amplitude
(1) for showing three waves

(i) The controls of the oscilloscope are **not** altered.

In Figure 2, draw the trace obtained if string 1 is played **louder** than string 5.

2

(ii) String 3 is plucked.

What is the frequency of the output signal from the amplifier?

.... **196 Hz** ....

1

NOTES

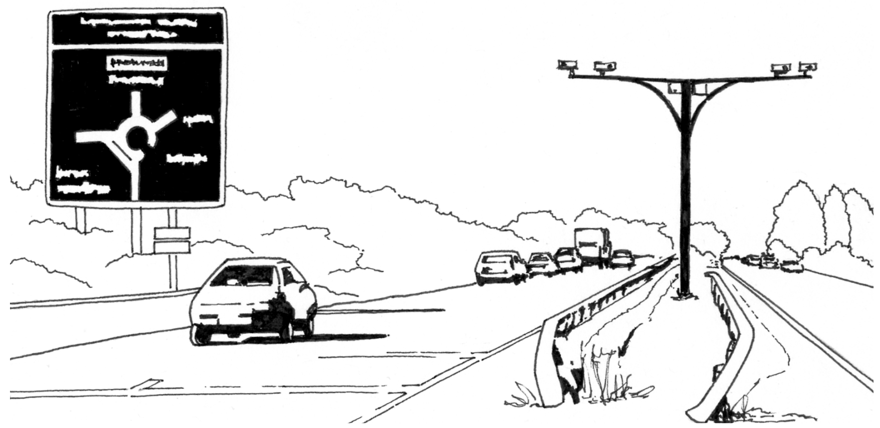
(*b*) (i) **must show 3 waves only**

(*b*) (ii) **<u>do not accept</u>: "the same"**
(1) or (0) marks unit required

DO NOT WRITE IN THIS MARGIN

Marks | K&U | PS

10. Cameras placed at 5 km intervals along a stretch of road are used to record the average speed of a car.



The car is travelling on a road which has a speed limit of 100 km/h. The car travels a distance of 5 km in 2·5 minutes.

(*a*) Does the average speed of the car stay within the speed limit?

You must justify your answer with a calculation.

Space for working and answer

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

$$\mathbf{= \frac{5}{(2{\cdot}5 \div 60)}} \quad \mathbf{(½)}$$

$$\mathbf{= 120\,km/h} \quad \mathbf{(1)}$$

Final answer must be consistent with calculated value and unit (or implied unit)

No (1) must attempt to justify to obtain final mark

3

(*b*) At one point in the journey, the car speedometer records 90 km/h.

Explain why the average speed for the entire journey is not always the same as the speed recorded on the car speedometer.

Explanation must include the following:

- **car speedometer measures instantaneous speed (½)**
- **instantaneous speed will change during journey (½)**
- **average speed is measured over/greater time/whole journey (1)** 2

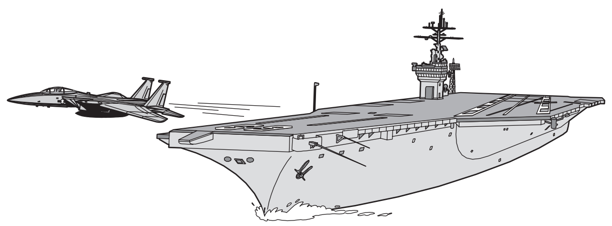
NOTES

Note: if t rounded to 0·04 hours ⇒ v = 125 km/h then accept

DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

11. An aeroplane on an aircraft carrier must reach a minimum speed of 70 m/s to safely take off. The mass of the aeroplane is 28 000 kg.



(*a*) The aeroplane accelerates from rest to its minimum take off speed in 2 s.

(i) Calculate the acceleration of the aeroplane. **2**

Space for working and answer

$\mathbf{a = \frac{v - u}{t}}$

$\mathbf{= \frac{70 - (0)}{2}}$

$\mathbf{= 35\ m/s^2}$

(ii) Calculate the force required to produce this acceleration. **2**

Space for working and answer

F = ma

= 28 000 × 35

= 980 000 N

(iii) The aeroplane's engines provide a total thrust of 240 kN. An additional force is supplied by a catapult to produce the acceleration required.

Calculate the force supplied by the catapult. **1**

Space for working and answer

additional force required = total force – aircraft thrust

= 980 000 – 240 000

= 740 000 N

NOTES

(*a*) (i) **not:** $\mathbf{a = \frac{v}{t}}$

(*a*) (iii) if 980 000 – 240 then unit penalty (–½)

11. (continued)

(*b*) Later, the same aeroplane travelling at a speed of 65 m/s, touches down on the carrier.

(i) Calculate the kinetic energy of the aeroplane at this speed. **2**

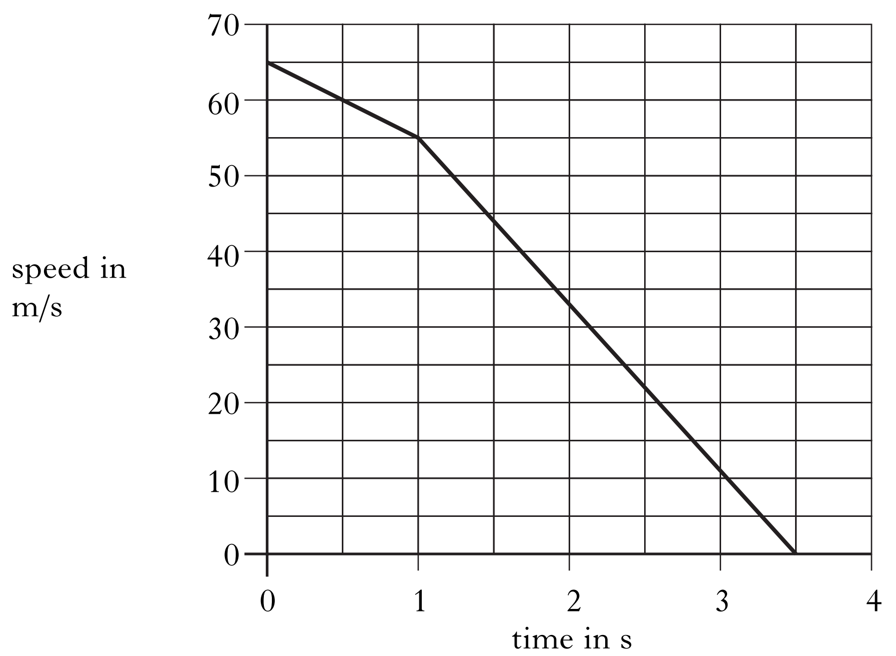
Space for working and answer

$$\mathbf{E_k = \frac{1}{2}mv^2}$$

$$\mathbf{= \frac{1}{2} \times 28000 \times 65^2}$$

$$\mathbf{= 59{\cdot}2\,MJ}$$

(ii) The graph shows the motion of the aeroplane from the point when it touches down on the carrier until it stops.



Calculate the distance travelled by the aeroplane on the carrier. **2**

Space for working and answer

distance = area under speed time graph **(½)**

$$\mathbf{= \frac{1}{2}b \times h + 1 \times b + \frac{1}{2}b \times h}$$

$$\mathbf{= \left(\frac{1}{2} \times 1 \times 10\right) + (1 \times 55) + \left(\frac{1}{2} \times 2{\cdot}5 \times 55\right)}$$ **(½)**

$$\mathbf{= 128{\cdot}75\,m}$$ **(1)**

Marks	K&U	PS
2		
2		

DO NOT WRITE IN THIS MARGIN

NOTES

(*b*) (i) **<u>accept</u>: 59 200 000 J**
59 150 000 J
59·15 MJ

(*b*) (ii) **if any portions missing then (½) max for (implied) relationship**
if wrong value(s) extracted from graph treat as substitution error (½) max

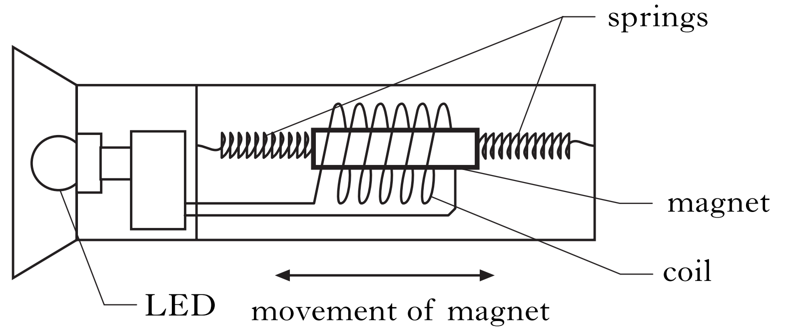
significant figure range 100 130 129 128·8
<u>accept</u> 128·75 m

DO NOT WRITE IN THIS MARGIN

Marks | K&U | PS

12. The advertisement below is for a new torch.

Kinetic Torch
No batteries needed – magnet powered!
Bright white LED won't burn out!
30-40 seconds of gentle shaking produces 10-15 minutes of light!
Capacitor holds the charge generated by passing the magnet through the



(*a*) (i) Explain how a voltage is induced in the coil.

(shaking the torch) makes the magnet move (1) in and out of the coils (1)

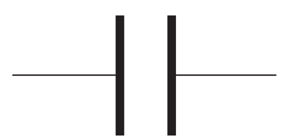
OR changing the magnetic field at coils (1) caused by shaking the magnet (1) 2

(ii) What is the effect of shaking the torch faster?

the (induced) voltage will increase 1

(iii) Draw the circuit symbol for a capacitor.

Space for symbol



must show connecting wires 1

(*b*) When lit, the current in the LED is 20 mA .

Calculate how much charge flows through the LED in 12 minutes.

Space for working and answer

Q = It

= 0·02 × 12 × 60

= 14·4 C 2

NOTES

(*a*) (i) **answer should indicate movement**
eg magnet is moved (1) in/out of coils/wires (1)

(*a*) (ii) **<u>accept</u>: "(induced) current will increase"**
"will charge more quickly"
"produce more electrical energy/power"
"more charge in the capacitor"

<u>do not accept</u>: "lamp will shine brighter"

(*b*) if no conversion into amperes and/or seconds then unit error (–½)

DO NOT WRITE IN THIS MARGIN

12. (continued)

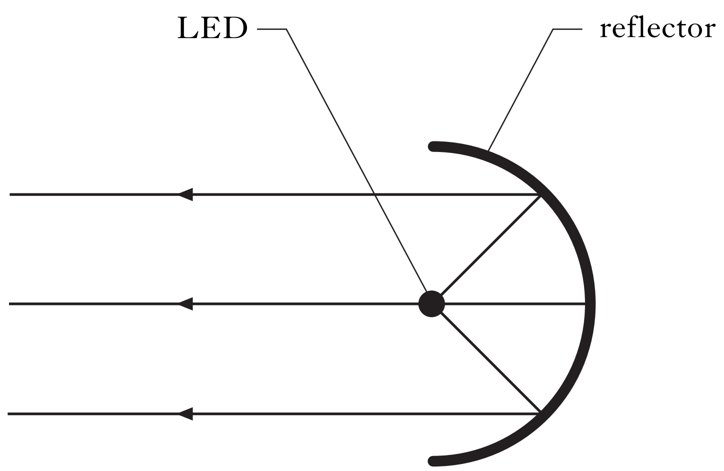
(*c*) The torch produces a beam of light.

The diagram shows the LED positioned at the focus of the torch reflector.

(1) for light ray paths

(1) for direction

independent marks



Complete the diagram by drawing light rays to show how the beam of light is produced. **2**

Marks	K&U	PS

NOTES

minimum of 2 rays drawn reasonably straight/parallel

DO NOT WRITE IN THIS MARGIN

Marks K&U PS

13. An electric kettle is used to heat 0·4 kg of water.

(*a*) The initial temperature of the water is 15 °C.

Calculate how much heat energy is required to bring this water to its boiling point of 100 °C.

Space for working and answer

C = 4180 (JKg^{-1}°C^{-1})

(1) data mark

E = mcΔT (½)

= 4180 × 0·4 × 85 (½)

= 142 120 J (1)

3

(*b*) The automatic switch on the kettle is not working. The kettle is switched off 5 minutes after it had been switched on.

The power rating of the kettle is 2000 W.

(i) Calculate how much electrical energy is converted into heat energy in this time.

Space for working and answer

E = P × t

= 2000 × 5 × 60

= 600 000 J

2

(ii) Calculate the mass of water changed into steam in this time.

Space for working and answer

ℓ_V = 22·6 × 10^5 (J/Kg)

(1) data mark

E = 600 000 – 142 120 = 457 880 J (½)

E_H = m × l (½)

457 880 = m × 22·6 × 10^5

m = 0·2 Kg

3

NOTES

(*a*) if wrong value of c selected from specific heat capacity of materials data table then can get (2) marks max

if c = 4200 or any other value then (½) mark max

significant figure range: 100 000 140 000 142 000

(*b*) (i) if E = 100 000 J (no conversion into seconds then deduct (½) unit error)

(*b*) (ii) if wrong value of ℓ_V selected from ℓ_V data table then can get (2) marks max
any other value of ℓ_V then (½) mark max

DO NOT WRITE IN THIS MARGIN

Marks | K&U | PS

14. The diagram represents the electromagnetic spectrum in order of increasing wavelength. Some of the radiations have not been named.

Electromagnetic Spectrum

Gamma rays	**P**	Ultraviolet	**Q**	Infrared	**R**	TV and Radio

increasing wavelength →

(*a*) (i) Name radiation: **P** **X-rays** **(½) for each name**

Q **visible light** **(½) for correct order**

R **microwaves** **2**

(ii) Which radiation in the electromagnetic spectrum has the highest frequency?

gamma rays **1**

(*b*) Stars emit **ultraviolet** and **infrared** radiation.

Name a detector for **each** of these two radiations.

Infrared **(black bulb) thermometer OR photodiode OR phototransistor**

Ultraviolet **fluorescent paint/material/UV film** **2**

NOTES

(*a*) (i) **<u>do not accept</u>: Q—spectrum/ROYGBIV/laser radiation/visible radiation**
R — "micro" or "µ"

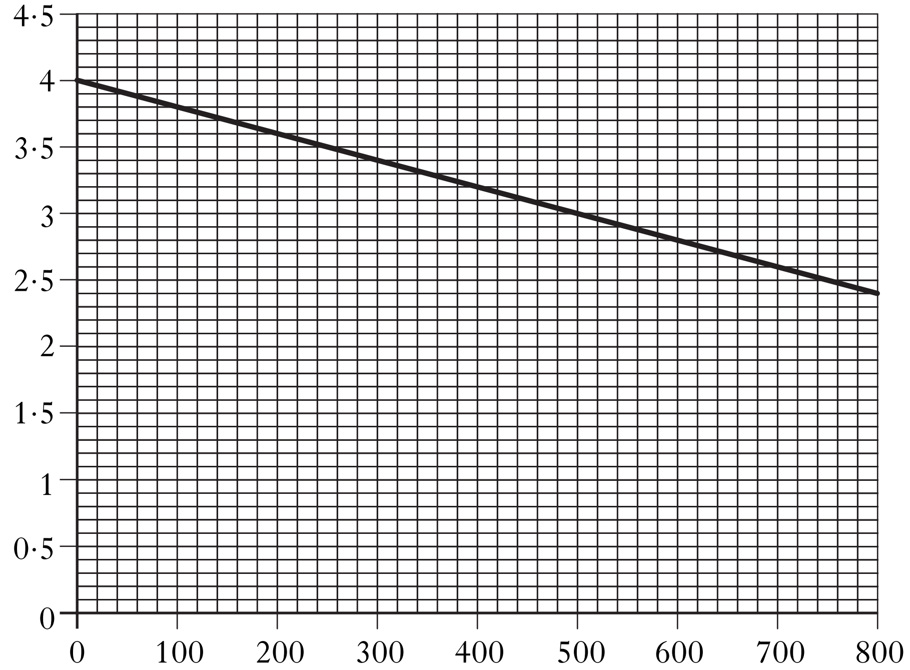
if any entries are blank/wrong then lose "order" (½) mark

(*b*) **<u>accept</u>: IR— thermofilm/thermistor/thermopile/thermocouple/ thermographic film/heat sensitive paper/IR film**

<u>do not accept</u>: IR — skin/photographic film
IR camera
UV—photographic film

15. In June 2005, a space vehicle called Mars Lander was sent to the planet Mars.

(*a*) The graph shows the gravitational field strength at different heights above the surface of Mars.



(i) The Mars Lander orbited Mars at a height of 200 km above the planet's surface.

What is the value of the gravitational field strength at this height?

3·6 m/s^2 OR N/kg unit required **1**

(ii) The Mars Lander, of mass 530 kg, then landed.

Calculate the weight of the Mars Lander on the surface.

Space for working and answer

(1) for 4 N/kg

W = mg (½)

= 530 × 4 (½)

= 2120 N (1)

3

Marks | DO NOT WRITE IN THIS MARGIN | K&U | PS

NOTES

(*a*) (i) **3·6 value <u>only</u> — no range of answers**

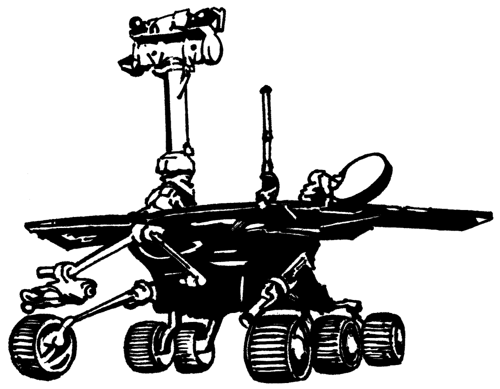
(*a*) (ii) **if any other value of g from gravitational field strength data table is used then (2) max**

if any other value of g is used then (½) max

DO NOT WRITE IN THIS MARGIN

15. (continued)

(*b*) The Mars Lander released a rover exploration vehicle on to the surface of Mars.



To collect data from the bottom of a large crater, the rover launched a probe horizontally at 30 m/s. The probe took 6 s to reach the bottom of the crater.

(i) Calculate the horizontal distance travelled by the probe. **2** (K&U)

Space for working and answer

d = v × t (½)

= 30 × 6 (½)

= 180 m (1)

(ii) Calculate the vertical speed of the probe as it reached the bottom of the crater. **2** (PS)

Space for working and answer

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

$$\mathbf{4 = \frac{v(-0)}{6}} \quad \textbf{(½)}$$

v = 24 m/s (1)

[*END OF MARKING INSTRUCTIONS*]

NOTES

(*b*) (ii) not $\mathbf{a = \frac{v}{t}}$

if a ≠ then (½) max