SCOTTISH
QUALIFICATIONS
AUTHORITY

2006 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.	$R = \frac{V}{I} = \frac{7\cdot5}{1\cdot5} = 4\cdot0\,\Omega$	(1½) Arithmetic error	GMI 7
7.	$R = \frac{V}{I} = 4\cdot0\,\Omega$	(½) Formula only	GMI 4 and 1
8.	$R = \frac{V}{I} = \underline{\qquad}\,\Omega$	(½) Formula only	GMI 4 and 1
9.	$R = \frac{V}{I} = \frac{7\cdot5}{1\cdot5} = \underline{\qquad}\,\Omega$	(1) Formula + subs/No final answer	GMI 4 and 1
10.	$R = \frac{V}{I} = \frac{7\cdot5}{1\cdot5} = 4\cdot0$	(1) Formula + substitution	GMI 2 (a) and 7
11.	$R = \frac{V}{I} = \frac{1\cdot5}{7\cdot5} = 5\cdot0\,\Omega$	(½) Formula but wrong substitution	GMI 5
12.	$R = \frac{V}{I} = \frac{75}{1\cdot5} = 5\cdot0\,\Omega$	(½) Formula but wrong substitution	GMI 5
13.	$R = \frac{I}{V} = \frac{7\cdot5}{1\cdot5} = 5\cdot0\,\Omega$	(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 $R = \frac{I}{V} = \frac{1\cdot5}{7\cdot5} = 0\cdot2\,\Omega$	(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	$22 \cdot 6 \times 10^5$

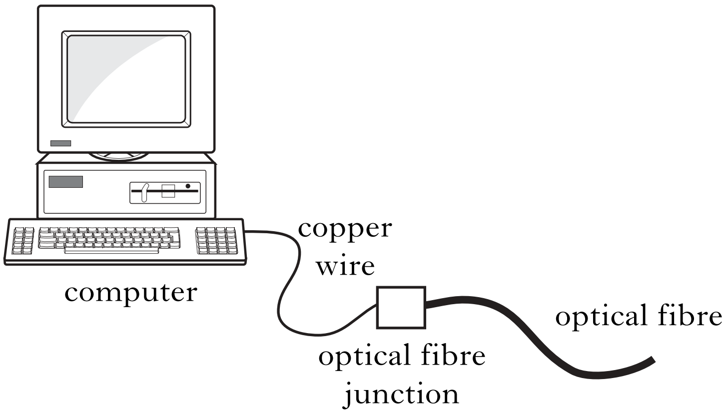
SI Prefixes and Multiplication Factors

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 computer is connected to the Internet by means of a copper wire and a glass optical fibre as shown.



(*a*) In the table below, enter:

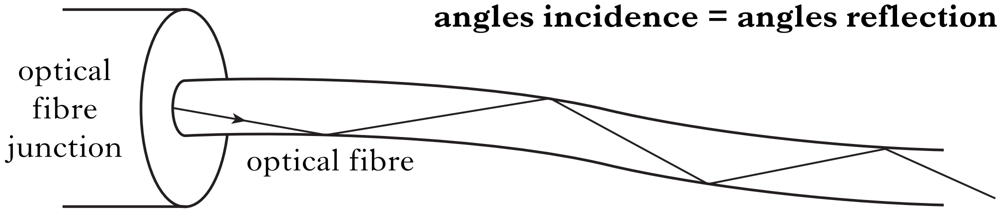
(i) the speed of the signal in each material;

(ii) the type of signal in each material.

	Copper wire	*Glass optical fibre*	
Speed of signal	**$3 \cdot 0 \times 10^8$ m/s**	**$2 \cdot 0 \times 10^8$ m/s**	**2 × (1)** 2
Type of signal	**electrical/electric**	**UV/IR/light**	**2 × (1)** 2

(*b*) Complete the diagram to show how the signal travels along the optical fibre.

Maximum 6 reflections (1)
angles incidence = angles reflection (1)



2

(*c*) Copper wire or glass optical fibre can be used in telecommunication systems.

(i) Explain which material, copper or glass, would need less repeater amplifiers over a long distance.

glass (1) (only award if accompanied by an attempted explanation)
less energy/power/signal loss (per metre) (1)

2

(ii) A broadband communication system carries 100 television channels and 200 phone channels.
Explain which material, copper or glass, should be used in this system.

glass (1) (only award if accompanied by an attempted explanation)
higher signal capacity/carries more signals/information/ has greater band width

2

NOTES

For copper wire: accept **speeds in range $2{\cdot}0 \times 10^8$ m/s $< v \leq$ $3{\cdot}0 \times 10^8$ m/s**
accept: "almost 3×10^8 m/s"

if no/incorrect unit then (–½) mark total penalty

For copper wire: not "electricity", "electromagnetic"
For glass optical fibre: not "laser" alone, not "optical"

accept reasonably straight lines

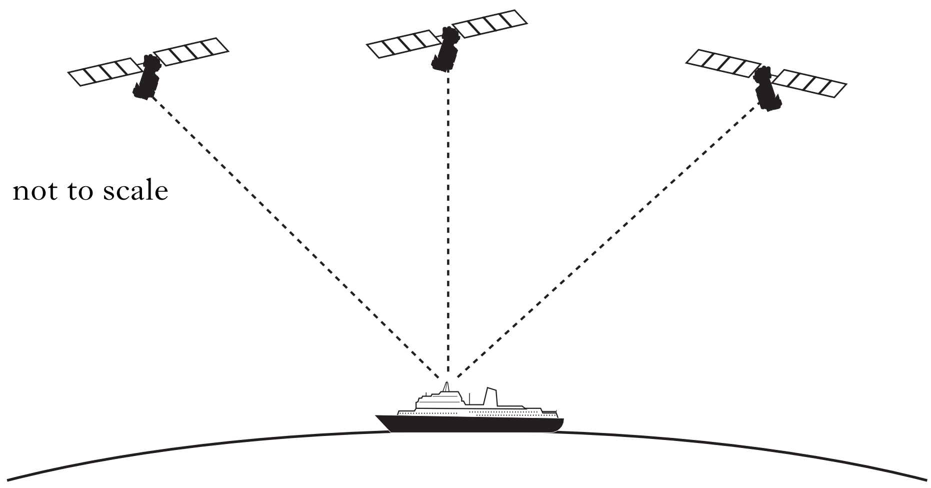
Do not accept "because there is <u>no</u> loss of signal for light"
Do not accept "because there are less boosters"

if copper chosen—then must be accompanied with a <u>good</u> up to date explanation of increased bandwidth

DO NOT WRITE IN THIS MARGIN

2. A ship has a satellite navigation system. A receiver on the ship picks up signals from three global positioning satellites.

Marks | K&U | PS


not to scale

These satellites can transmit radio signals at three different frequencies, 1176 MHz, 1228 MHz and 1575 MHz. The satellites orbit at a height of 20 200 km above the Earth's surface.

(*a*) (i) State the speed of the radio signals.

3×10^8 m/s (1 or 0) **1**

(ii) One of the satellites is directly above the ship.

Calculate the time taken for the signal from this satellite to reach the ship.

Space for working and answer

$$v = \frac{d}{t} \quad (½)$$

$$3 \times 10^8 = \frac{20\,200 \times 10^3}{t} \quad (½)$$

$$t = 0{\cdot}067\ s \quad (1)$$

2

(iii) Calculate the wavelength of the 1228 MHz signal.

Space for working and answer

$$\lambda = \frac{v}{f} \quad (½)$$

$$= \frac{3 \times 10^8}{1228 \times 10^6} \quad (½)$$

$$= 0{\cdot}244\ m \quad (1)$$

2

NOTES
Significant Figures: deduct (½) mark MAX in this question
must have stated <u>value</u> **unit required** **the value given in (*a*)(i) must be carried to (ii) and (iii)** **if no answer given in (*a*)(i) then must use 3×10^8 m/s in (ii) and (iii)**
accept answer in **significant figure range   0·07 → 0·06733 s**
accept answer in **significant figure range   0·2 → 0·2443**

DO NOT WRITE IN THIS MARGIN

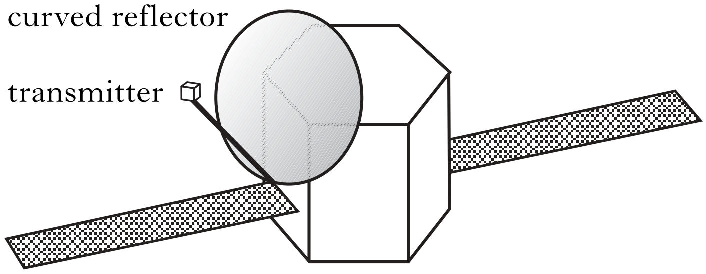
Marks | K&U | PS

2. (continued)

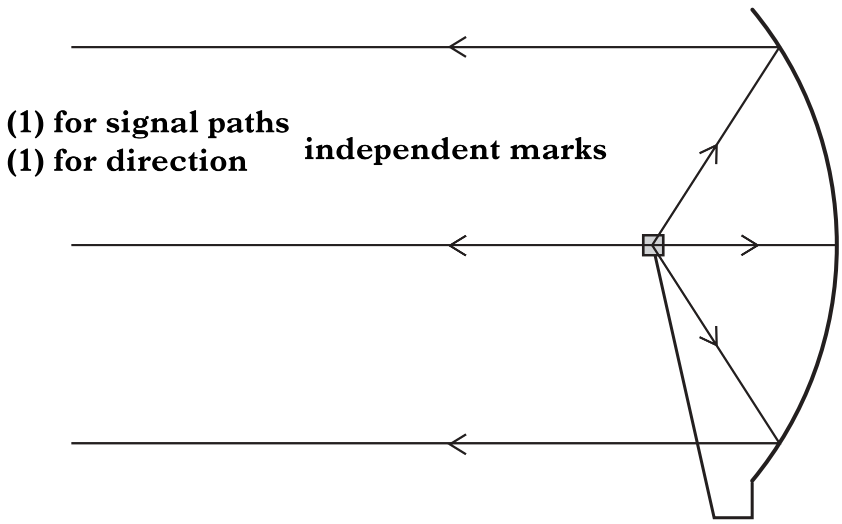
(*b*) State which of the three signals has the shortest wavelength.

the 1575 MHz signal (unit not required) 1

(*c*) One of the global positioning satellites is shown below.



(i) Complete the diagram below to show the effect of the curved reflector on the transmitted signals.



2

(ii) A satellite in orbit a few hundred kilometres above Earth has a period of one hour. A geostationary satellite orbits 36 000 km above Earth.

Suggest the period of the global positioning satellite.

any <u>stated</u> value greater than 1 hour and less than 24 hours **(1) or (0) marks** 1

NOTES

accept: 'highest frequency'

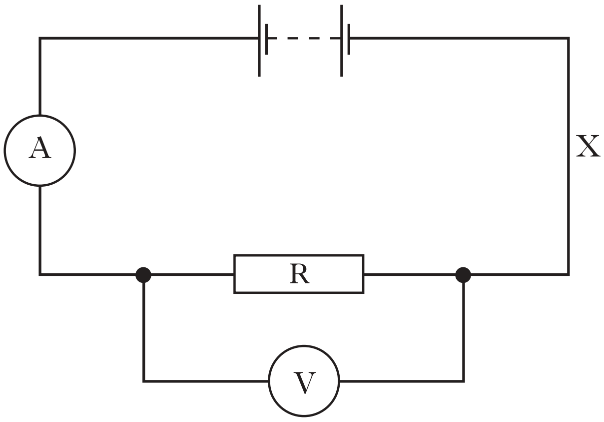
must have minimum of 2 rays shown, reasonably horizontal

do not accept a range of values

Marks | K&U | PS

3. Two students are investigating voltage, current and resistance.

(*a*) The first student builds the circuit shown.



The ammeter displays a current of 0·10 A and the voltmeter displays a voltage of 3·0 V.

(i) Calculate the resistance of R when the current is 0·10 A.

Space for working and answer

$$\mathbf{R = \frac{V}{I}} \quad \textbf{(½)}$$

$$\mathbf{= \frac{3{\cdot}0}{0{\cdot}10}} \quad \textbf{(½)}$$

$$\mathbf{= 30\,\Omega} \quad \textbf{(1)}$$

2

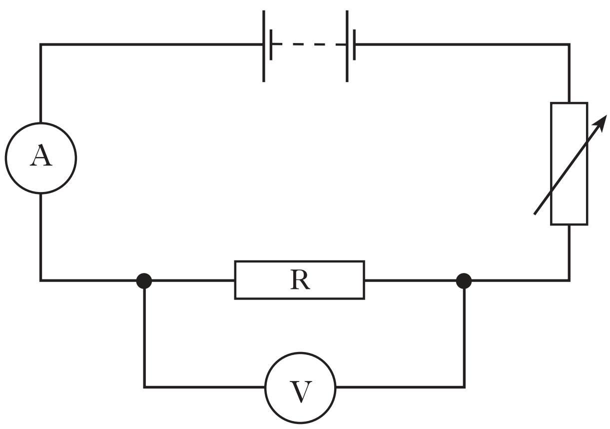
(ii) The student inserts another ammeter at position X.

What is the reading on this ammeter?

0·10 A/ (no ½ mark)
0·1 A

1

(*b*) The second student uses the **same** resistor in the circuit below.



NOTES

do not accept 'same as before'

Marks | K&U | PS

3. (*b*) (continued)

This student obtains the following set of results.

Result number	*Voltage across R* (V)	*Current through R* (A)
1	6·0	0·20
2	7·5	0·25
3	9·0	0·30
4	10·0	0·35
5	12·0	0·40

(i) Describe how these different values of voltage and current are obtained.

(1) (1)
by adjusting/the variable resistor/

(1) (1)
OR changing the resistance/of the variable/resistor
resistance 2

(ii) Explain which result should be retaken.

or identified by values/ result 4 (1) because the calculated resistance

is not 30 Ω/not the same (1) 2

(*c*) What additional information about resistance does the second student's experiment give compared to the first student's experiment?

resistance is independent of current/voltage

resistance remains constant

1

NOTES

do not accept: 'lowering resistor', 'add more cells'

an attempt at explanation is required to obtain first mark

accept: **any explanation involving recognising a pattern in the voltage**

for 10 V the current should be lower / 0·33 A

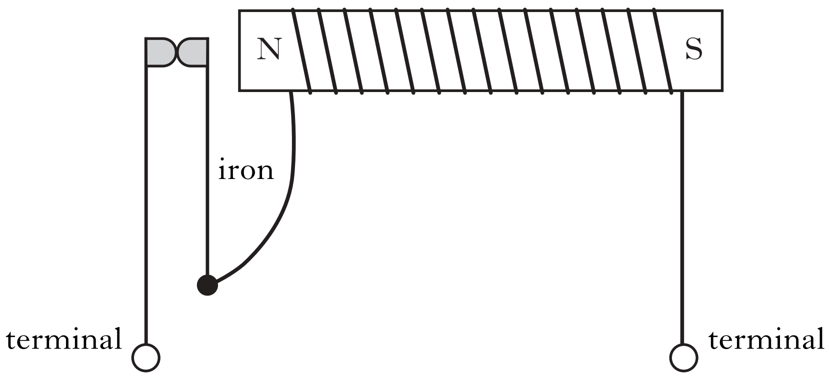
voltage in result 4 should be higher / 10·5 V

$\frac{V}{I} \neq 30\,\Omega$

DO NOT WRITE IN THIS MARGIN

Marks | K&U | PS

4. A circuit breaker as shown below is used in a circuit.

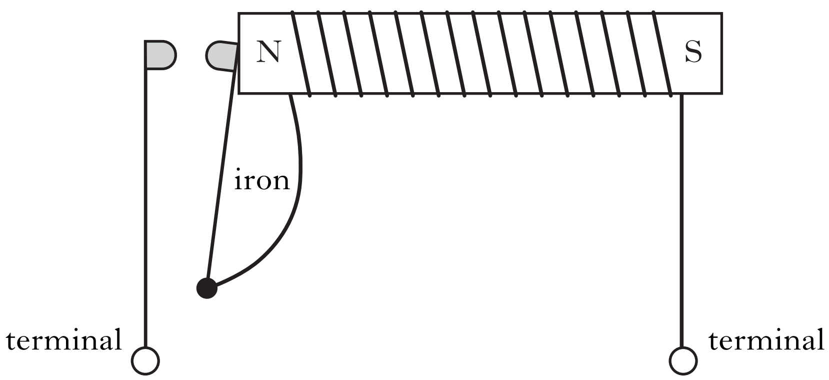


(*a*) (i) State **one** advantage of a circuit breaker compared to a fuse.

can be reset/fuse needs to be replaced

<u>or</u> responds more quickly/does not need replaced **1**

(ii) The circuit breaker breaks the circuit when the current becomes too high.



Explain how the circuit breaker operates when the current becomes too high.

(When the current becomes (too) high) the magnetic field becomes stronger/the electromagnet switches on (1).

This attracts the moveable contact (and breaks the circuit) (1). **2**

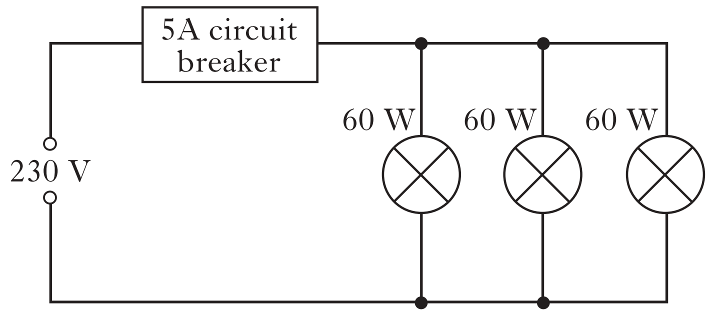
NOTES
do not accept: **'safer' alone** **'more convenient'**

DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

4. (continued)

(*b*) A 5 ampere circuit breaker is used in a household lighting circuit which has three 60 W lamps as shown below.



(i) Show that the resistance of **one** lamp is 882 Ω.

Space for working and answer

$$\mathbf{P = \frac{V^2}{R}} \quad \mathbf{(½)}$$

$$\mathbf{60 = \frac{230^2}{R}} \quad \mathbf{(½)}$$

$$\mathbf{\therefore\ R = \frac{230^2}{60}} \quad \mathbf{(1)}$$

2

(ii) Calculate the combined resistance of the three lamps in this circuit.

Space for working and answer

$$\mathbf{\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} \quad \mathbf{(½)} \qquad \textbf{OR} \quad \mathbf{R = \frac{V^2}{P}} \quad \mathbf{(½)}$$

$$\mathbf{= \frac{1}{882} + \frac{1}{882} + \frac{1}{882}} \quad \mathbf{(½)} \qquad \mathbf{= \frac{230^2}{180}} \quad \mathbf{(½)}$$

$$\mathbf{\therefore R_T = 294\,\Omega} \quad \mathbf{(1)} \qquad \mathbf{= 294\,\Omega} \quad \mathbf{(1)}$$

2

(iii) Show by calculation whether the circuit breaker will switch off the lamps when all three are lit.

Space for working and answer

$$\mathbf{I = \frac{V}{R}} \quad \mathbf{(½)}$$

$$\mathbf{= \frac{230}{294}} \quad \mathbf{(½)}$$

no sig. fig. penalty
unit must be included

$\mathbf{= 0{\cdot}78\ A}$ **(1)**

(This is less than 5 A) so will NOT switch off (1)

3

NOTES

alternatives:

if R = 882 Ω

$$I = \frac{P}{V} \quad \overset{\text{both}}{(\tfrac{1}{2})}\ \text{then} \quad R = \frac{V}{I}$$

$$= \frac{60}{230} \qquad\qquad = \frac{230}{0{\cdot}261}\ (1)$$

$$= 0{\cdot}261(A)(\tfrac{1}{2})$$

$$I = \frac{V}{R} \quad \overset{\text{both}}{(\tfrac{1}{2})}\ \text{then} \quad P = IV$$

$$= \frac{230}{882} \qquad\qquad = 0{\cdot}261 \times 230\ (1)$$

$$(= 60W)$$

$$= 0{\cdot}261(A)(\tfrac{1}{2})$$

$$I = \frac{P}{V} \quad \overset{\text{both}}{(\tfrac{1}{2})}\ \text{then} \quad R = \frac{P}{I^2}$$

$$= \frac{180}{230} \qquad\qquad = \frac{60}{(0{\cdot}261)^2}\ (1)$$

$$= 0{\cdot}261(A)(\tfrac{1}{2}) \qquad = (882\,\Omega)$$

must use R = 882 Ω

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

if $R_T = \frac{1}{R_1} + \frac{1}{R2} + \frac{1}{R_3}$ **then award 0 marks**

accept: $\frac{1}{R_T} = \frac{3}{882} \underset{\uparrow\ \text{accept}}{=} \frac{882}{3} = 294\,\Omega$

alternative: use $I = \frac{P_{total}}{V}$

$$= \frac{180}{230}$$

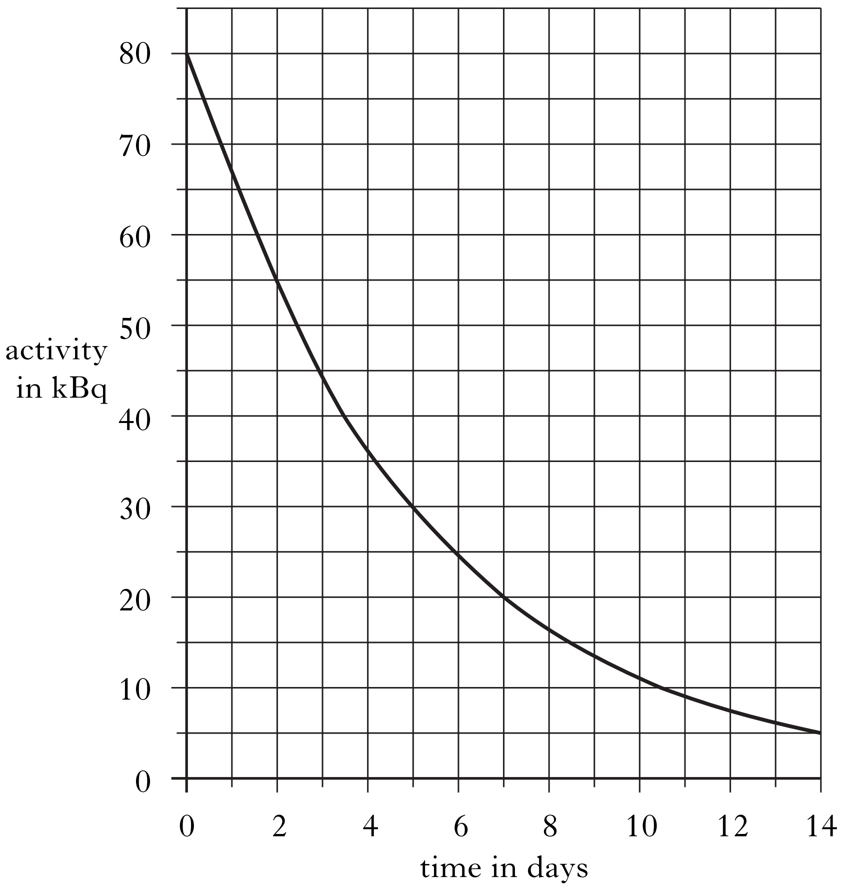
$$= 0{\cdot}78\,A$$

must have final statement/indication of result

DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

5. A radioactive source is used for medical treatment. The graph shows the activity of this source over a period of time.



(*a*) Use information from the graph to calculate the half-life of this source.

Space for working and answer

80 → 40 k Bq

0 → 3½ days

∴ half-life is 3·5 days (1) (1) or (0) marks

1

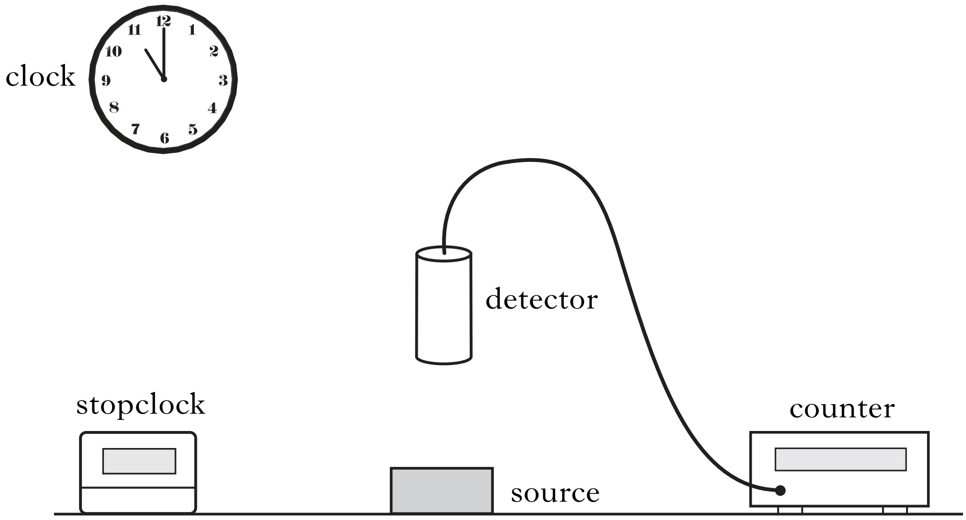
NOTES

DO NOT WRITE IN THIS MARGIN

Marks	K&U	PS

5. (continued)

(*b*) Describe a method that could be used to measure the half-life of this radioactive source, using the apparatus shown. You can ignore background radiation.



Record counter reading over a fixed time on stopclock (½)

Repeat for a period of time (½)

Draw graph of reading/ – v– time to find half-life (1)
activity

2

(*c*) A sample of this source is to be given to a patient at 9.30 am on May 17. When the sample is prepared, its initial activity is 200 kBq. The activity of the sample when given to the patient must be 12·5 kBq.

Calculate at what time and on what date the sample should be prepared.

Space for working and answer

200 → 100 → 50 → 25 → 12·5 kBq (½) for halving

1 2 3 4 half-lives (½) for four half lives

4 half-lives ⇒ 4 × 3·5 days = 14 days (2 weeks) (½)

so 9.30 am on May 3rd (½)

2

NOTES

Do not accept: **explanation implying use of ratemeter**
measure count at start and finish

DO NOT WRITE IN THIS MARGIN

Marks | K&U | PS

6. The table below gives information about some types of laser.

Type of laser	*Wavelength* (nm)	*Output power* (W)
Krypton fluoride	248	1·0
Argon	488	2·0
Helium neon	633	0·005
Rhodamine	570 to 650	50·0
Carbon dioxide	10 600	200·0

(*a*) The visible spectrum has wavelengths ranging from 400 nm to 700 nm.

(i) Name one type of laser **from the table** that emits visible radiation.

any one of: argon/helium neon/rhodamine **1**

(ii) Name one type of laser **from the table** that emits ultraviolet radiation.

krypton fluoride **1**

(iii) Give **one** medical use of ultraviolet radiation.

any suitable, eg treat skin complaints/set dental fillings /increase vitamin D level **1**

(*b*) A rhodamine laser can be adjusted to emit a range of wavelengths.

What difference is observed in the light from this laser beam as the wavelength changes?

colour (changes) **1**

(*c*) The beam from the carbon dioxide laser is used to cut steel. A section of steel is cut in 10 minutes.

Using information from the table, calculate the energy given out by the laser during this cutting process.

Space for working and answer

E = Pt (½)

= 200 × 10 × 60 (½)

= 120 000 J (1)

2

NOTES

apply ± rule if more than one answer

apply ± rule if more than one answer

not: treat tumours
accept: sterilise instruments

do not accept 'brightness changes'

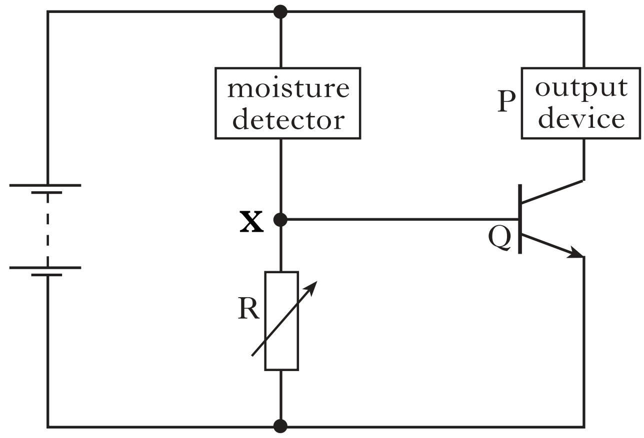
if wrong conversion to seconds then treat as unit error (–½)

if wrong P selected from table then (½) max

DO NOT WRITE IN THIS MARGIN

7. A student designs a lie detector using the following circuit.

Marks | K&U | PS



Moisture detector:

high resistance when dry
low resistance when wet

(*a*) Name component Q.

transistor **ignore any prefixes** **1**

(*b*) Suggest a suitable output device that could be used at P to produce an audible output.

bell/buzzer **not: (loud) speaker** **1**

(*c*) This lie detector is based on the fact that when a person tells a lie, the moisture on their skin increases. Initially, the person holds the moisture detector in dry hands and component R is adjusted until the output device is silent.

(i) What happens to the resistance of the moisture detector when the person holding it tells a lie?

(resistance) decreases **or equivalent** **1**

(ii) Explain how the circuit operates as a lie detector.

(when the person tells a lie, the resistance of the moisture detector decreases so) voltage at Q increases (1)

Q/the transistor switches on (and the output device sounds/operates) (1) **2**

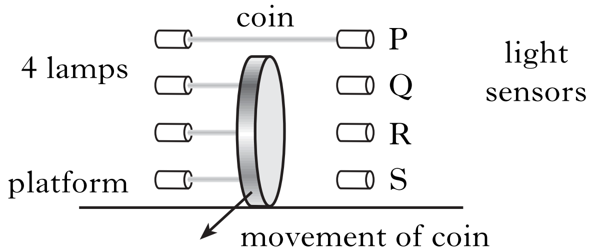
NOTES

or: voltage across detector decreases (1)
or: voltage across variable resistor increases (1)

do not accept answer with a wrongly identified component for Q

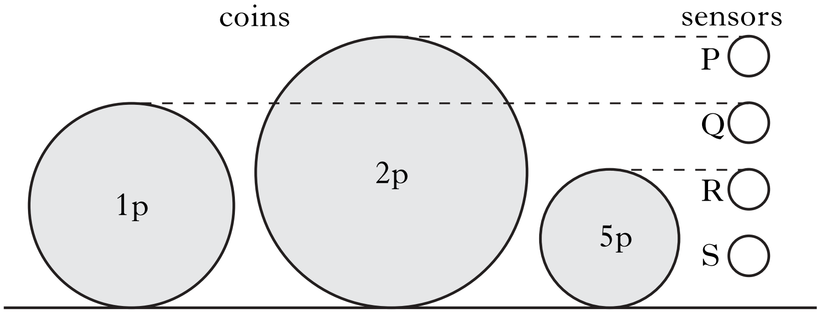
accept: current into base of transistor increases (1)
so transistor switches on (1)

8. An automatic vending machine accepts 1p, 2p and 5p coins. Four light sensors P, Q, R and S are arranged as shown in the coin slot.



When a coin passes between a lamp and its sensor, the light is blocked. Coins of different diameters block the light from different lamps.

The position of the sensors in relation to the diameters of coins is shown below.



The logic output of the sensors is as follows:

light blocked – logic output 1
light not blocked – logic output 0

(*a*) (i) Name a suitable input device to be used as a sensor.

light dependent resistor (LDR) 1

(ii) Complete the truth table for the outputs of the sensors when each of the coins passes between the lamps and the sensors.

	1p coin	*2p coin*	*5p coin*
Sensor P	**0**	**1**	**0**
Sensor Q	**1**	**1**	**0**
Sensor R	**1**	**1**	**1**
Sensor S	**1**	**1**	**1**

3

3 × (1) for each column (independent of each other)

NOTES

accept: photocell, photodiode, phototransistor

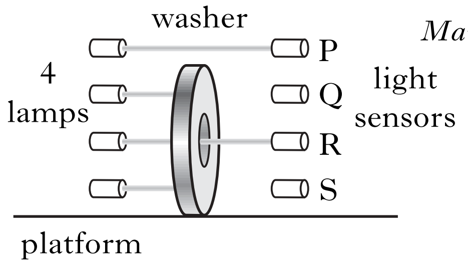
do not accept: solar cell, light gate

accept only 0 or 1 digital entries

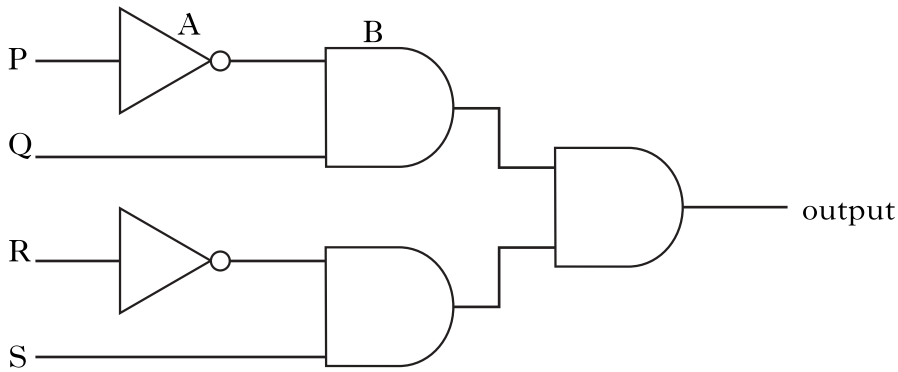
8. (continued)

Marks | K&U | PS

(*b*) A washer is a metal disc with a hole in the middle. The machine is able to reject washers, when they are inserted instead of coins. A washer the same diameter as a 1p coin blocks the light from reaching sensors Q and S only.



Part of the circuit used is shown below.



(i) Name gate A

NOT (gate)/inverter 1

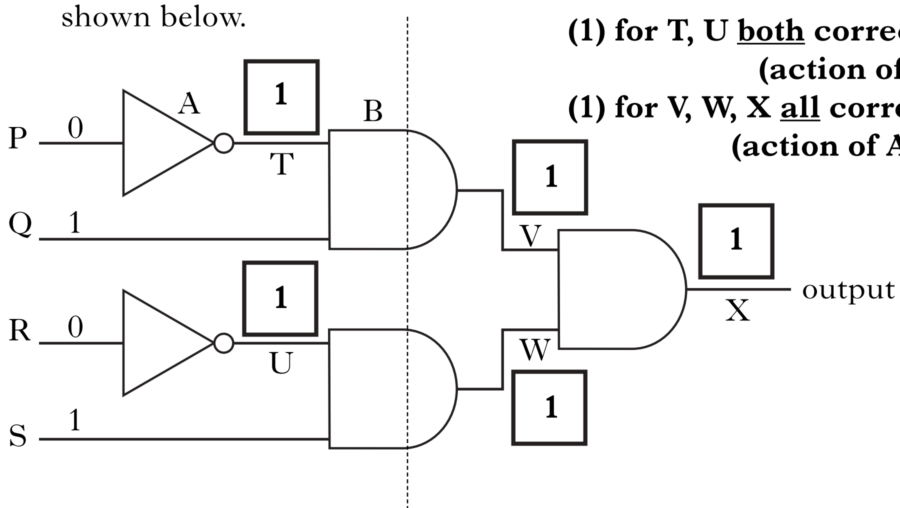
(ii) Name gate B

AND (gate) 1

(iii) When a washer is inserted, the logic levels at P, Q, R and S are as shown below.

(1) for T, U <u>both</u> correct (action of inverter)

(1) for V, W, X <u>all</u> correct (action of AND gate)



In the boxes on the diagram above, enter the logic levels at each position T, U, V, W and X. 2

(iv) When a washer is detected, this circuit activates an output device that pushes the washer to reject it.

Name a suitable device to be used as the output device.

solenoid/motor 1

NOTES

output at V, W, X must follow from output at T, U

not: relay, electromagnet

DO NOT WRITE IN THIS MARGIN

Marks | K&U | PS

9. A table from the Highway Code giving overall stopping distances for vehicles is shown.

The overall stopping distance is made up of:

the **thinking distance –** the distance travelled while the driver "thinks" about braking. This distance depends on the driver's reaction time.
plus
the **braking distance –** the distance travelled while braking.

Speed of vehicle (m/s)	*Overall stopping distance* (m)
8·9	6 6
13·4	9 14
17·8	12 24
26·7	18 55
thinking distance	braking distance

(*a*) (i) How far does a vehicle travelling at 13·4 m/s travel while the driver thinks about braking?

9 m (1 or 0) unit required **1**

(ii) Use information **from the table** to calculate the reaction time.

Space for working and answer

$$t = \frac{d}{v} \quad (½)$$

$$= \frac{6}{8{\cdot}9} \quad (½)$$

$$= 0{\cdot}67\,s \quad (1)$$

accept any correct pair of d, v, values **2**

NOTES

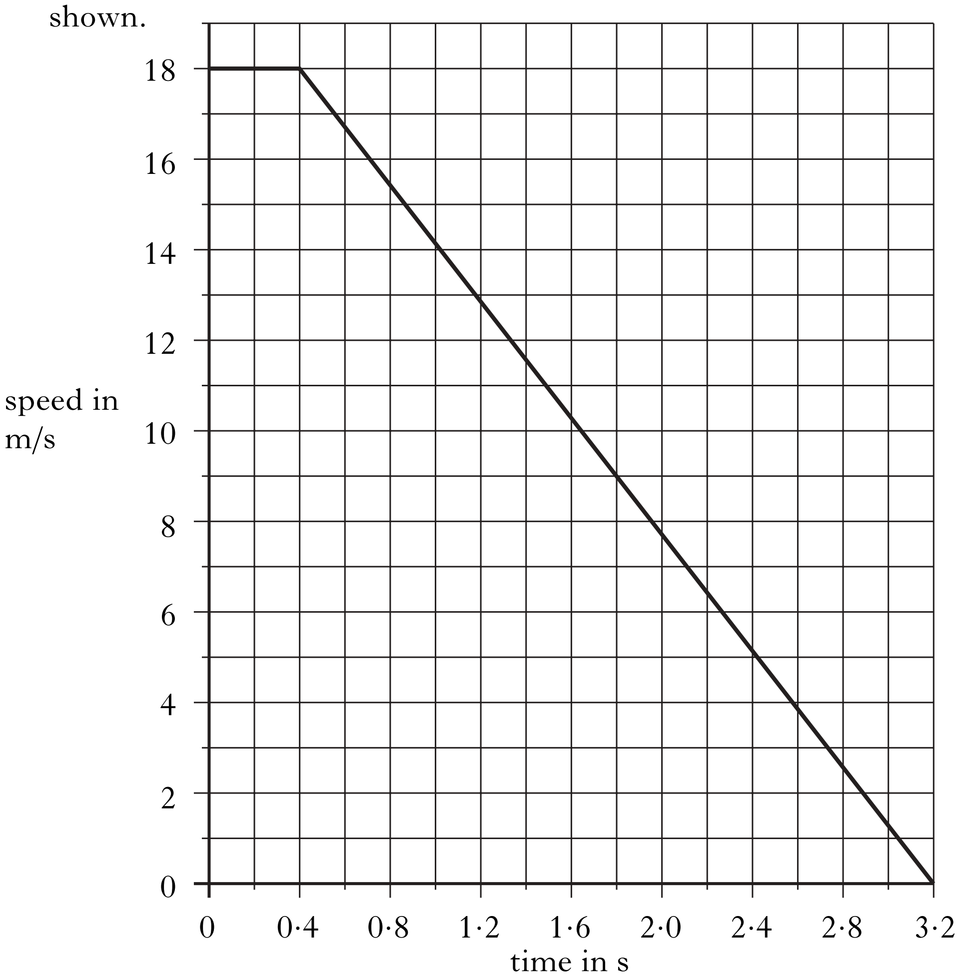
sig. fig range **$0{\cdot}7 \rightarrow 0{\cdot}6742$ for 1st, 3rd, 4th pair of readings**

$0{\cdot}7 \rightarrow 0{\cdot}6716$ for 2nd pair of readings

DO NOT WRITE IN THIS MARGIN

9. (continued)

(*b*) A car travels along a road. The driver sees traffic lights ahead change from green and starts to brake as soon as possible. A graph of the car's motion, from the moment the driver sees the traffic lights change, is shown.



Marks | K&U | PS

(i) What is **this** driver's reaction time?

0·4 s (1 or 0) unit required 1

(ii) Calculate the overall stopping distance.

Space for working and answer

distance = area between graph and time axis (½)

$$= (18 \times \overset{(½)}{0{\cdot}4}) + (\tfrac{1}{2} \times 18 \times \overset{(½)}{2{\cdot}8}) \quad (½)$$

= 32·4 m (1)

3

(iii) Calculate the acceleration of the car from the time the driver applies the brakes.

Space for working and answer

$$a = \frac{v - u}{t} \quad (½)$$

$$= \frac{0 - 18}{2{\cdot}8} \; (½) \quad = -6{\cdot}4\ m/s^2 \quad (1)$$

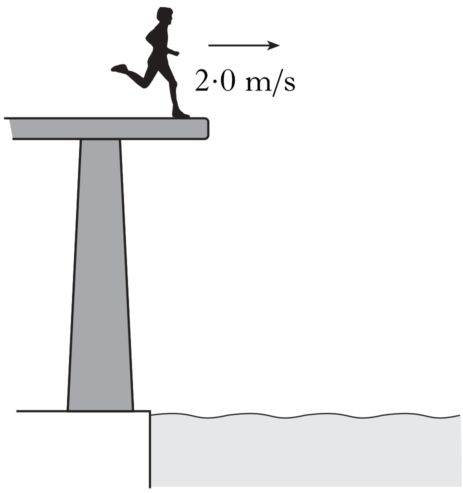
no negative sign—deduct final mark

2

NOTES
if a single calculation of d = vt is used award 0 marks **if wrong arithmetic is clearly shown then treat as arithmetic error in final answer** **sig. figs range $-6 \rightarrow -6{\cdot}429$** **if $a = \frac{18}{2{\cdot}8}$ wrong substitution** **accept $a = \frac{\Delta V}{t}$**

Marks	K&U	PS

10. A student runs along a diving platform and leaves the platform horizontally with a speed of 2·0 m/s. The student lands in the water 0·3 s later. Air resistance is negligible.



(*a*) (i) Calculate the horizontal distance travelled by the student before landing in the water.

Space for working and answer

∴ d = v × t (½)

= 2·0 × 0·3 (½)

= 0·6 m (1)

2

(ii) The student has a vertical acceleration of 10 m/s^2.

Calculate the vertical speed as the student enters the water.

Space for working and answer

v = u + at (½)

= 0 + (10 × 0·3) (½)

= 3·0 m/s (1)

2

(*b*) Later the student runs off the end of the same platform with a horizontal speed of 3·0 m/s.

How long does the student take to reach the water this time? Explain your answer.

same time/0·3 s (1)

because the (vertical) height and vertical acceleration

are the same (1)

2

NOTES

accept $v = at$ **if $\Delta v = at$ (½)**

$\Delta v = 10 \times 0{\cdot}3$ (½)

but $\Delta v = 3\,m/s$ (0) marks

independent marks

accept: 'gravitational field strengths are the same'

'vertical and horizontal motion are independent'

'because of the acceleration due to gravity'

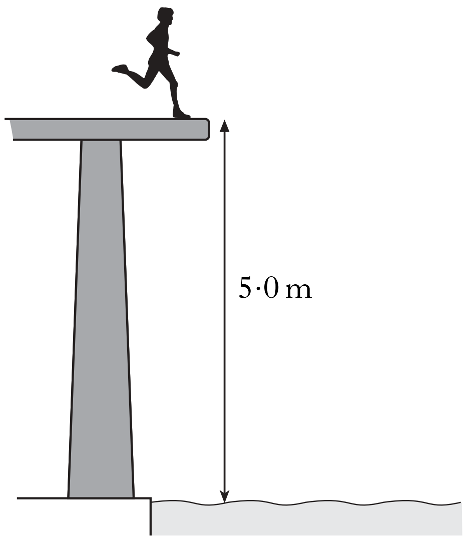
do not accept: 'gravitational field strength' alone

'gravity' alone

Marks K&U PS

10. (continued)

(*c*) The student climbs from the water level to a higher platform. This platform is 5·0 m above the water. The student has a mass of 50 kg.



(i) Calculate the gain in gravitational potential energy of the student.

Space for working and answer

$E_P = mgh$ **(½)**

$= 50 \times 10 \times 5$ **(½)**

$= 2500\,J$ **(1)**

2

(ii) The student drops from the edge of the platform and lands in the water.

Calculate the vertical speed as the student enters the water.

Space for working and answer

$E_k = E_P$ **(½)** $\therefore \frac{1}{2}mv^2 = mgh$

$\therefore \frac{1}{2} \times 50 \times v^2 = 2500$ **(½)**

$\therefore v = \sqrt{\frac{2 \times 2500}{50}}$

$= 10\,m/s$ **(1)**

2

NOTES

if m is converted into grams then unit error (–½)

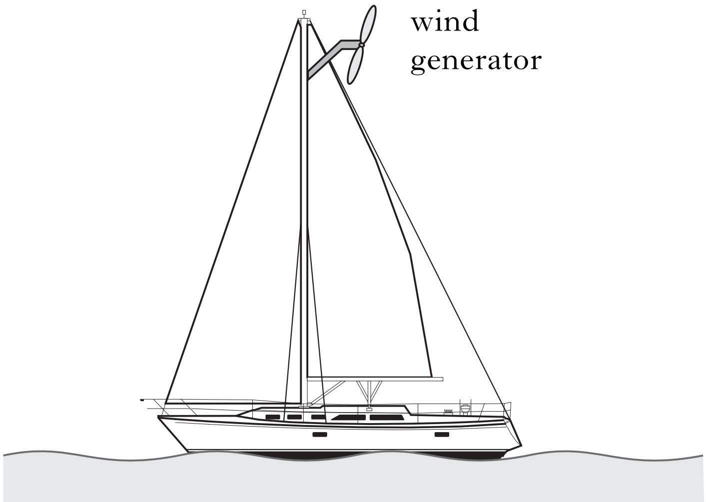
accept: $\mathbf{v} = \sqrt{2gh}$ **(½)**

$= \sqrt{2 \times 10 \times 5}$ **(½)**

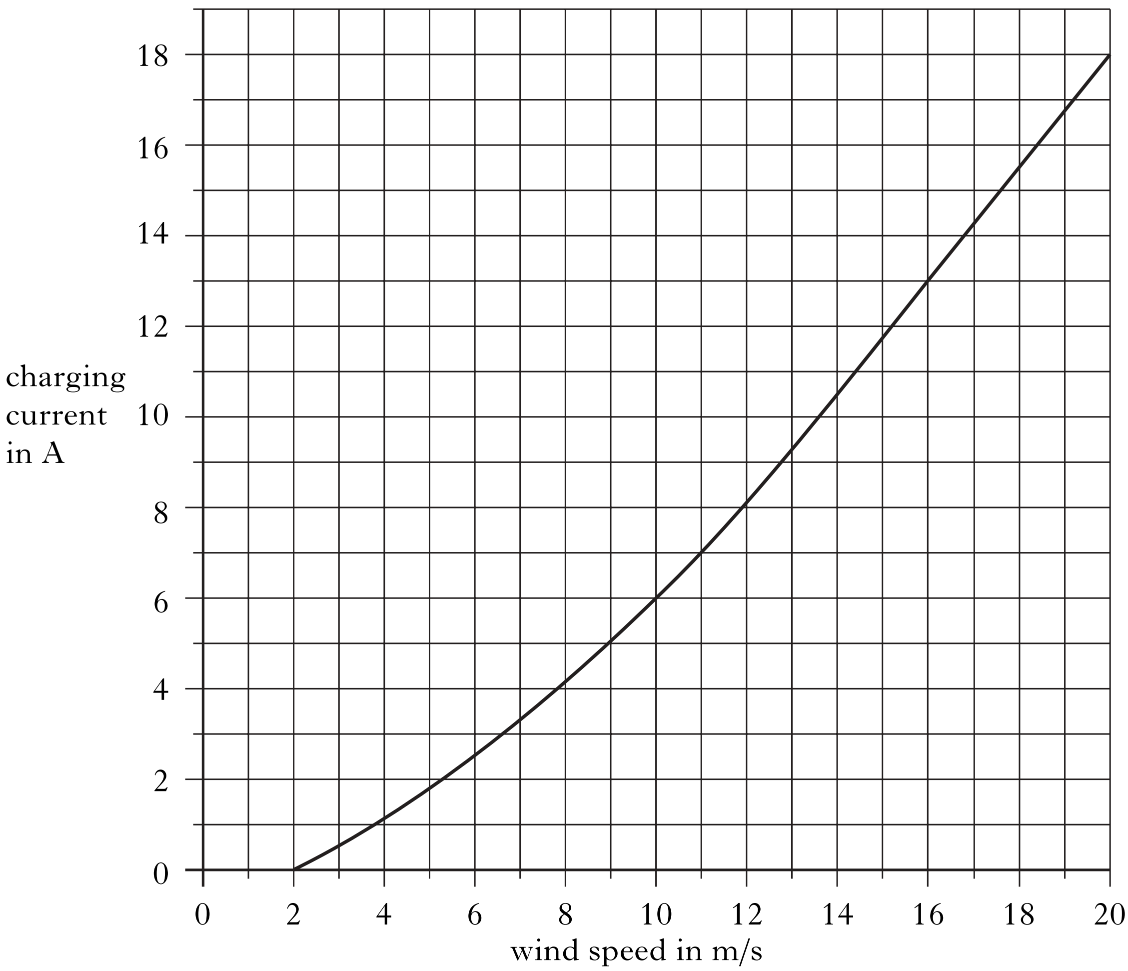
$= 10\,\mathrm{m/s}$ **(1)**

	Marks	K&U	PS

11. A wind generator on a yacht is used to charge a battery at 12 V.



The graph shows the charging current at different wind speeds.



(*a*) The wind blows at a speed of 10 m/s.

(i) What is the charging current at this wind speed?

6 A (1 or 0) unit required 1

NOTES

Marks K&U PS

11. (*a*) (continued)

(ii) Calculate the electrical power produced by the generator at this wind speed.

Space for working and answer

P = IV (½)

= 6 × 12 (½)

= 72 W (1)

2

(iii) The wind speed does not change.

Calculate the energy supplied to the battery in 3·5 hours.

Space for working and answer

E = Pt (½)

= 72 × 3·5 × 60 × 60 (½)

= 907 200 J (1)

2

(*b*) The yacht has a stand-by petrol powered generator to charge the battery.

Why is the petrol generator necessary, in addition to the wind generator?

wind does not always blow OR wind speed may be less than 2 m/s

1

NOTES

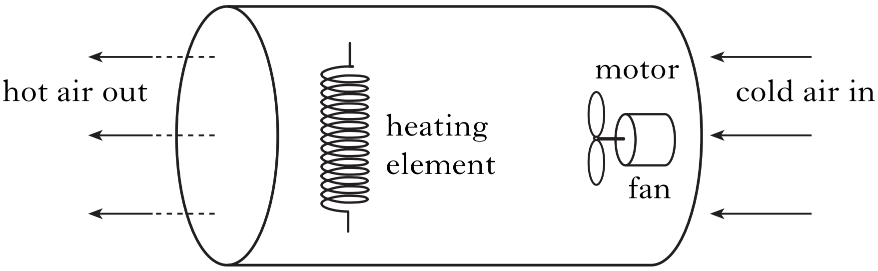
if wrong conversion into seconds then unit error (–½)

sig. fig. range: 900 000, 910 000, 907 000, 907 200

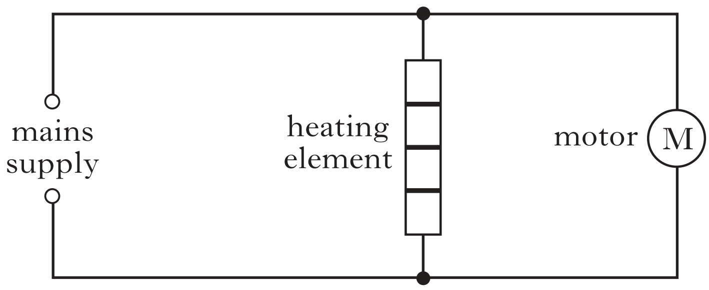
accept: an answer relating to a 'back-up' in case of damage etc

Marks | K&U | PS

12. A mains operated air heater contains a fan, driven by a motor, and a heating element. Cold air is drawn into the heater by the fan. The air is heated as it passes the heating element.



The circuit diagram for the air heater is shown.



(*a*) (i) What is the voltage across the heating element when the heater is operating?

230 V (1 or 0) unit required — 1

(ii) What type of circuit is used for the air heater?

parallel (circuit) — 1

(*b*) The following data relates to the heater when the fan rotates at a particular speed.

mass of air passing through per second	0·2 kg
energy supplied to air per second	2000 J
specific heat capacity of air	1000 J/kg °C

(i) Calculate the increase in air temperature.

Space for working and answer

$\mathbf{E_h = cm\Delta T}$ **(½)**

$\mathbf{2000 = 1000 \times 0{\cdot}2 \times \Delta T}$ **(½)**

$\mathbf{\therefore \Delta T = \dfrac{2000}{1000 \times 0{\cdot}2} = 10\,^{\circ}C}$ **(1)**

2

NOTES

do not accept: ac/current divider

DO NOT WRITE IN THIS MARGIN

Marks | K&U | PS

12. (*b*) (continued)

(ii) The motor is adjusted to rotate the fan at a higher speed. This draws a greater mass of air per second through the heater. Explain any difference this causes to the temperature of the hot air.

(the temperature is) lower/air is cooler (1)

(greater mass of air) heated by same energy (1)

2

NOTES

award first mark only if an attempt is made to explain

accept: ‘heated for a shorter time’

Marks	K&U	PS

13. Titan is the largest of Saturn's moons. The gravitational field strength on Titan is 1·35 N/kg.

(*a*) (i) What is a moon?

a satellite that orbits a planet/

a natural satellite (of the Earth) **1**

(ii) What is meant by gravitational field strength?

weight per unit mass

or: force/pull per kg **1**

(*b*) Early in 2005, a probe was released from a spacecraft orbiting Titan. The probe, of mass 318 kg, travelled through the atmosphere of Titan.

(i) Calculate the weight of the probe on Titan.

Space for working and answer

w = mg (½)

= 318 × 1·35 (½)

= 429·3N (1)

2

(ii) As the probe descended through the atmosphere, a parachute attached to it opened.

State why the parachute was used.

to slow down the probe/increase friction (or drag) **1**

NOTES

accept: satellite / mass / body / rock — that orbits a planet

not: something
object

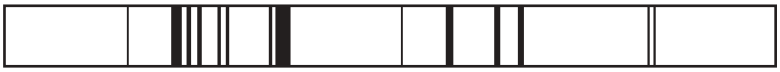
accept: 'weight per kg'
do not accept: 'gravity per kg', 'same as 10 m/s^2'

sig. fig. range: 430, 429, 429·3, 429·30

accept: 'to increase air resistance'
do not accept: 'to prevent damage'
'to stop crashing'

13. (*b*) (continued)

(iii) The probe carried equipment to analyse the spectral lines of radiation from gases in the atmosphere of Titan. These lines are shown. The spectral lines of a number of elements are also shown.

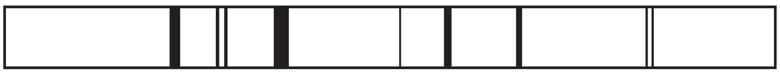


Spectral lines from gases in Titan's atmosphere

Helium

Hydrogen

Mercury



Nitrogen

Use the spectral lines of the elements to identify which elements are present in the atmosphere of Titan.

helium (1)

nitrogen (1)

(deduct (1) mark for each <u>extra</u> element given) 2

[*END OF MARKING INSTRUCTIONS*]

NOTES