2008 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
Glass	500
Glycerol	2400
Ice	2100
Lead	128
Silica	1033
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}

K&U	PS

Marks

1. A high definition television picture has 1080 lines and there are 25 pictures produced each second.

(a) (i) Calculate how long it takes to produce one picture on the screen.

Space for working and answer

(time for one picture $= \frac{1}{25}$ **s)**

= 0·04 s (1)
deduct (½) if no unit

1

(ii) Explain why a continuous moving picture is seen on the television screen and not 25 individual pictures each second.

new image is different from previous image (1) the brain retains the image (1) (while the new image is being displayed) 2

(b) The television picture is in colour.

(i) Which two colours are used to produce magenta on the screen?

red and blue (1) for both 1

(ii) Due to a fault, the colour yellow appears as orange on the screen. Which colour should be reduced in brightness to correct this problem?

red (1) 1

NOTES

(i) **If wrong final answer but correct substitution deduct (½)**

Accept: $\frac{1}{25}$ **s**

(ii) **Look for answer connecting following two statements**

- **the image is retained**
- **short time (interval) between each image OR each image is different (or phrase that suggests this)**

statements could be in different order

K&U	PS

Marks

2. A television company is making a programme in China.

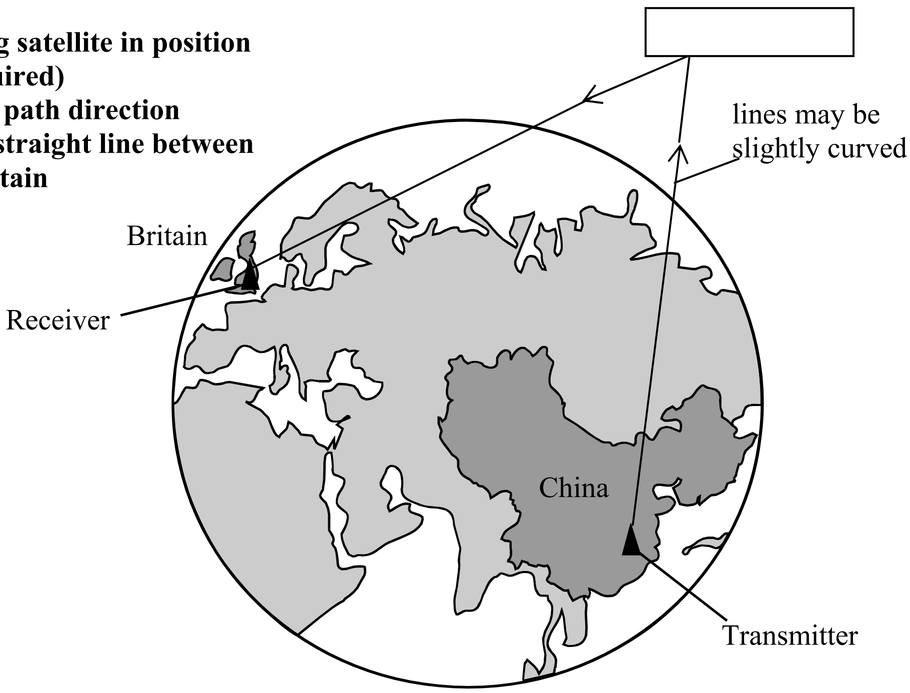
Britain receives television pictures live from China. The television signals are transmitted using microwaves. The microwave signals travel from China **via** a satellite, which is in a geostationary orbit.

(a) State what is meant by a geostationary orbit.

period is 24 hours OR always above the same point above the Earth OR period same as Earth **1**

(b) The diagram shows the position of the transmitter and receiver. Complete the diagram to show the path of the microwave signals **from** China **to** Britain.

(1) for showing satellite in position (label not required)
(1) for correct path direction
(0) marks for straight line between China and Britain



2

(c) The frequency of the microwave signals being used for transmission is 8 GHz.

(i) What is the speed of the microwaves?

3×10^8 m/s (1) or (0) unit required **1**

(ii) Calculate the wavelength of these microwaves.

Space for working and answer

$$\lambda = \frac{v}{f} \quad (½)$$

$$= \frac{3\times10^8}{8\times10^9} \quad (½)$$

$$= 0\cdot0375 \text{ m} \quad (1)$$

2

NOTES

(a) **Accept:**
- **same rate of rotation as Earth**
- **36000 km orbit**

Do not accept:
- **same speed as Earth**
- **same point (in space)**
- **stationary**

(b) **(1) for a 'V' shape (indicates re-transmission)**
(1) for direction arrow or arrows (C to B)
not necessary to show or label satellite

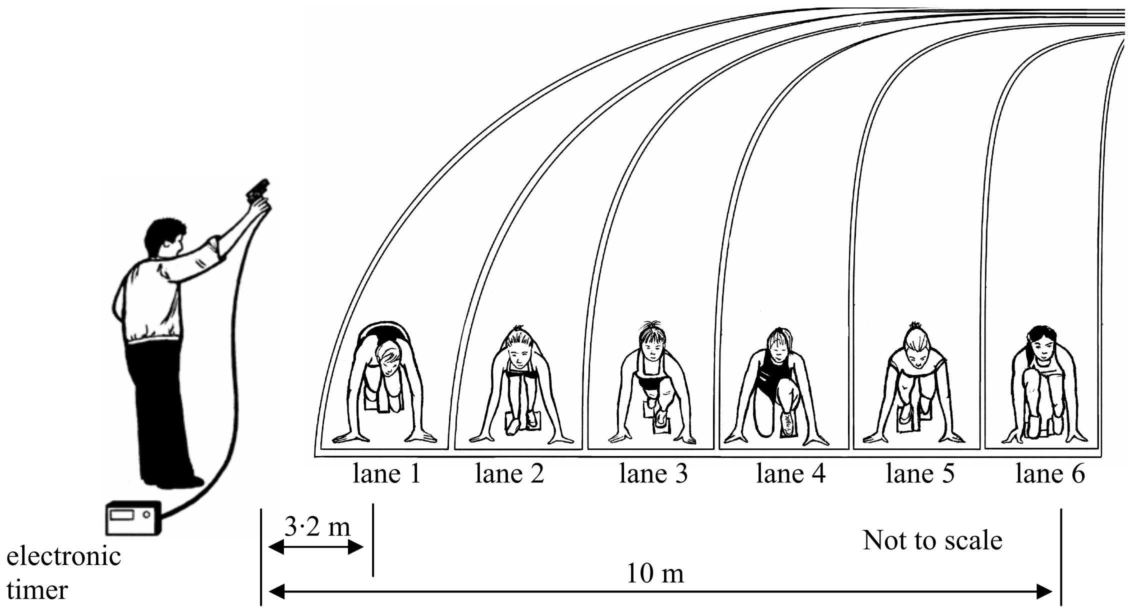
0 marks for straight line between China and Britain (even with arrow)
BUT may see a straight line with a box or circle between China/Britain which represents satellite – if direction arrow included (2) marks
ALSO could be 2 satellites shown with signals connecting in space

deduct (½) if no/wrong conversion
sig fig range: 0·04 0·038 0·0375

K&U	PS

Marks

3. In a sprint race at a school sports day, the runners start when they hear the sound of the starting pistol. An electronic timer is also started when the pistol is fired into the air.



The runner in lane 1 is 3·2 m from the starting pistol. The runner in lane 6 is 10 m from the starting pistol.

(a) The runner in lane 1 hears the starting pistol first.

Calculate how much later the runner in lane 6 hears this sound after the runner in lane 1.

Space for working and answer

$$t = \frac{d}{v} \quad (½)$$

(1) for data selection of 340 (m/s)

$$= \frac{6 \cdot 8}{340} \quad (½)$$

$$= 0 \cdot 02 \text{ s} \quad (1)$$

3

if any other value for v from speed of sound in materials table (2) max still possible
any other value of v (½) max only

NOTES

(a) alternative – 2 stages (½) formula (½) both workings (1) final answer

$$d = 3 \cdot 2 \text{ m}$$
$$t = \frac{d}{v}$$
$$= \frac{3 \cdot 2}{340}$$
$$= 0{\cdot}00941 \text{(s)}$$

$$d = 10 \text{ m}$$
$$t = \frac{d}{v}$$
$$= \frac{10}{340}$$
$$= 0 \cdot 029 \text{ (s)}$$

$$\text{so } t = 0 \cdot 029 - 0 \cdot 0094$$
$$= 0 \cdot 0196$$

(accept $0 \cdot 02$ or $0 \cdot 0196$ s)

if more sig figs then deduct (½)

K&U	PS

Marks

(b) A sensor detects each runner crossing the finishing line to record their time.

The table gives information about the race.

Place	*Lane*	*Time* (s)
1st	1	13·11
2nd	6	13·12
3rd	3	13·21

Using your answer to part (a), explain why the runner in lane 6 should have been awarded first place.

Space for working and answer

(1) for showing a correction/appreciation of times for runners 1 and 6

(1) for comparison to show that 6 is winner

2

(c) One runner of mass 60 kg has a speed of 9 m/s when crossing the finishing line.

Calculate the kinetic energy of the runner at this point.

Space for working and answer

$$\mathbf{E_K = \frac{1}{2}mv^2} \quad \textbf{(½)}$$

$$\mathbf{= \frac{1}{2}\times 60\times 9^2} \quad \textbf{(½)}$$

$$\mathbf{= 2430\ J} \quad \textbf{(1)}$$

2

NOTES

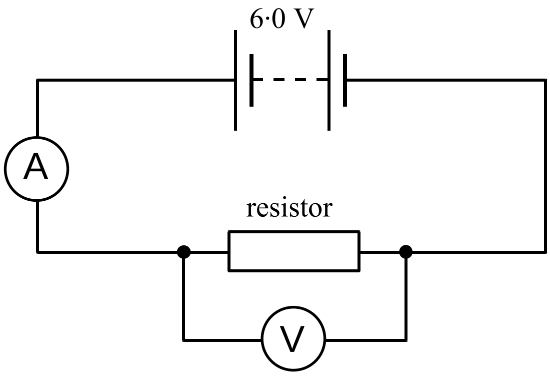
(b) Candidates with Δt less than 0·015 can still get (1) out of (2) for showing correction/appreciation of times

if no square at 9^2 – substitution error then (½) max

K&U	PS

Marks

4. A student has four resistors labelled A, B, C and D. The student sets up Circuit 1 to identify the value of each resistor.



Circuit 1

Each resistor is placed in the circuit in turn and the following results are obtained.

Resistor	Voltage across resistor (V)	Current (A)
A	6·0	0·017
B	6·0	0·027
C	6·0	0·050
D	6·0	0·033

(a) (i) Show, by calculation, which of the resistors has a value of 120 Ω.

Space for working and answer

$\mathbf{I = \frac{V}{R}}$ **(½)** **<u>OR</u>** $\mathbf{V = IR}$ **(½)** **<u>OR</u>** $\mathbf{R = \frac{V}{I}}$ **(½)**

$\mathbf{= \frac{6}{120}}$ **(½)** $\mathbf{= 0{\cdot}05 \times 120}$ **(½)** $\mathbf{= \frac{6}{0{\cdot}05}}$ **(½)**

= 0·05(A) (1) **= 6(V) (1)** **= 120(Ω) (1)**

ie it is resistor C (1)

must show working to obtain final mark
no sig. fig. issue in calculation

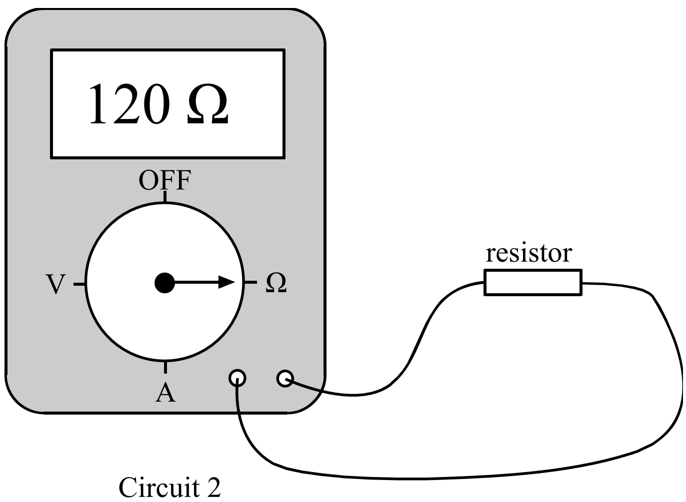
3

NOTES
may see sequential calculations until 120 Ω is reached **ignore other calculations even if in error**

K&U	PS

Marks

(ii) The student then sets up Circuit 2 to measure the resistance of each resistor.



Circuit 2

State **one** advantage of using Circuit 2 to measure the resistance compared to using Circuit 1.

direct reading OR no need for calculation OR easier (to obtain answer) or quicker **1**

(b) The resistances of the other three resistors are 180 Ω, 220 Ω and 360 Ω.

The student collects all four resistors in series.

Calculate the total resistance.

Space for working and answer

$\mathbf{R = R_1 + R_2 + R_3 + R_4}$ **(½)**

$\mathbf{= 120 + 180 + 220 + 360}$ **(½)**

$\mathbf{= 880\ \Omega}$ **(1)**

2

NOTES

Do not accept: • **'more accurate'**

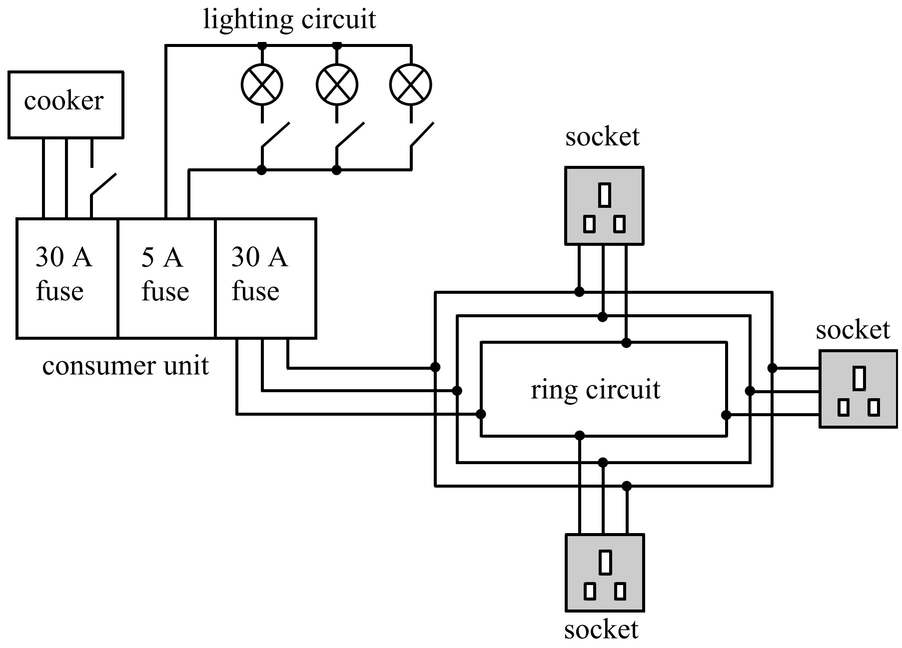
Accept:

- **$R = R_1 + R_2$ as formula**
- **if only 3 resistors added then (½) max for (implied) formula**

K&U	PS

Marks

5. The diagram shows three household circuits connected to a consumer unit.



(a) (i) State **one** advantage of a ring circuit.

cheaper/less current in each branch/thinner wire **1**

(ii) State the value of mains voltage.

230 V (1) or (0) unit required **1**

(b) Each of the lamps in the lighting circuit has a power rating of 100 W.

One of the lamps is switched on.

(i) Calculate the current in the lamp.

Space for working and answer

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

$$\mathbf{= \frac{100}{230}} \quad \mathbf{(½)}$$

$$\mathbf{= 0{\cdot}435\ A\ \ (1)}$$

sig. figs.: 0·43 0·435 0·4348 0·43478

2

NOTES

(i) **Accept:**

- **convenient for adding extra sockets**
- **2 paths for current**
- **less voltage drop**
- **less heat**

Do not accept:

- **less wire**
- **less current per ring**
- **any comparison with series circuit**
- **safer**

	K&U	PS

Marks

(b) (ii) Explain why a house with twenty 100 W lamps requires two separate lighting circuits.

the current/power is too high (1) so fuse could break if only one circuit (1) OR the fuse value is not enough (1) **2**

NOTES

1 statement about power or current
1 conclusion about fuse size being insufficient eg 'too much current (implied >5 A (1)) so fuse 'breaks' (1)
OR there is too much current/power (1) so too big for one fuse (1)

Do not accept:

- **'too much power for lights'**
- **'there is not a big enough fuse for all 20'**

Marks

6. A short-sighted person has difficulty seeing the picture on a cinema screen. Figure 1 shows rays of light from the screen entering an eye of the person until the rays reach the retina.

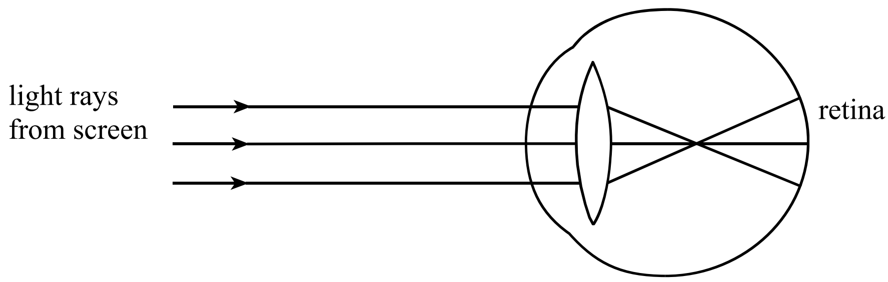


Figure 1

(a) (i) In the dotted box in Figure 2, draw the shape of the lens that would correct this eye defect. **1**

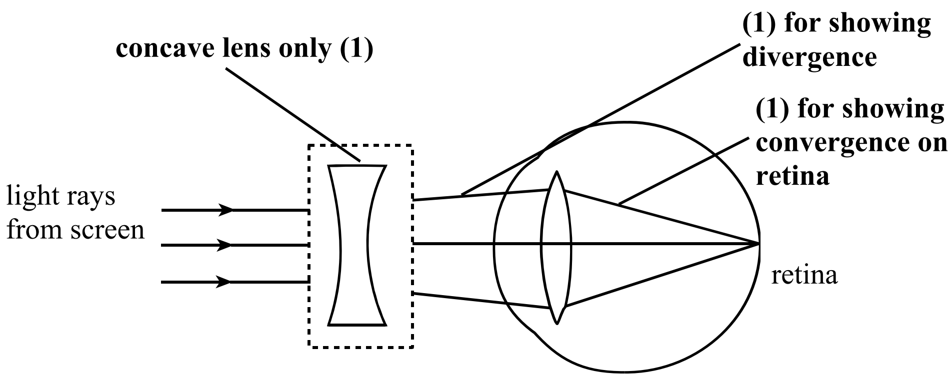


Figure 2

(ii) In figure 2, complete the path of the rays of light from this lens until they reach the retina.

(a) (i) independent from (ii) **2**

K&U	PS

NOTES

rays may start converging at cornea – ok

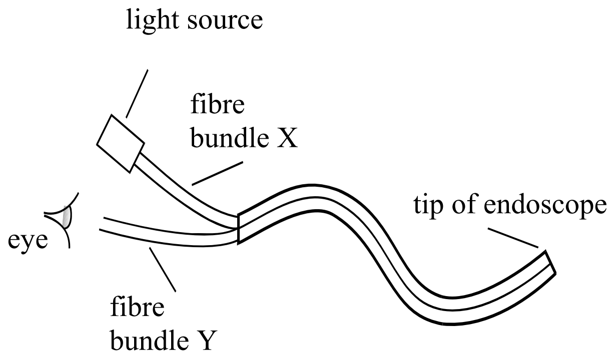
ignore rays drawn inside dotted box

ok

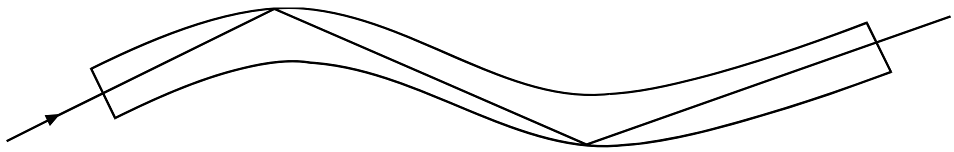
K&U	PS

Marks

(b) Doctors can use an endoscope to examine internal organs of a patient. The endoscope has two separate bundles of optical fibres that are flexible.



A section of optical fibre used in the endoscope is shown below.



(i) Complete the diagram to show how light is transmitted along the optical fibre.

(1) for showing total internal reflection **2**

(1) for 'quality' (no more than 6 reflections)

(ii) Explain the purpose of each bundle of optical fibres in the endoscope.

Fibre bundle X **transmits the light inside the patient**

Fibre bundle Y **transmits the (reflected) light/image back to the doctor's eye** **2**

(iii) The tip of the endoscope that is inside the patient is designed to be very flexible. Suggest **one** reason for this.

to allow the doctor to see/steer/manoeuvre to different parts of inside the body/the organ **1**

NOTES

(b) (i) **(1) mark for quality**

lost if:
- **not passably straight lines**
- **not passably equal <i = <r**

note: arrows, normals NOT required

(ii) **look for the following principles:**

X **"light" "into" → are keywords**
Y **"light/image" "out" → are keywords**

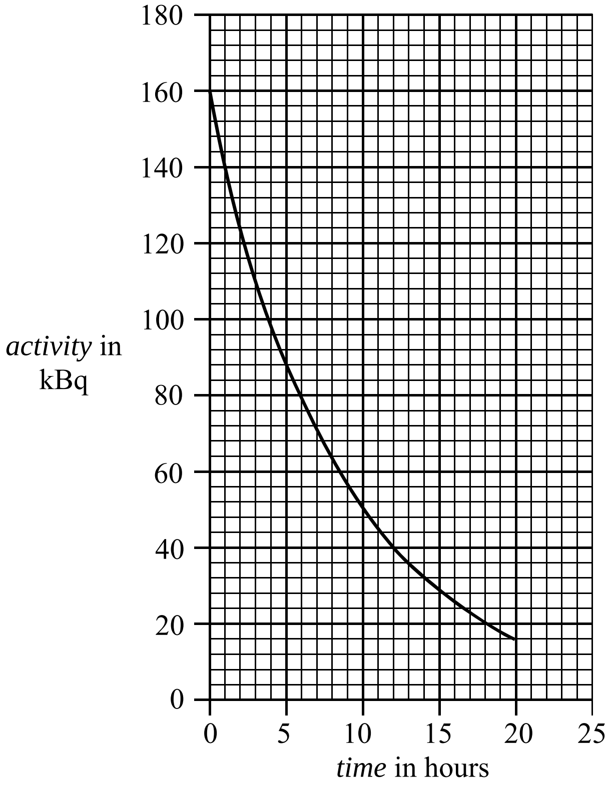
do not accept: "to let the doctor see inside the patient"

(iii) **Do not accept:**
- **to stop getting jammed**
- **if rigid would cause damage**

K&U	PS

Marks

7. A hospital technician is working with a radioactive source. The graph shows the activity of the source over a period of time.



(a) (i) State what is meant by the term *half-life*.

time for the activity (or number of nuclei) (of a radioactive source) to reduce to half the original number/activity/its value **1**

(ii) Use information from the graph to calculate the half-life of the radioactive source.

Space for working and answer

Activity 160 $\longrightarrow$ 80 kBq $\Rightarrow$ 6 hours(1)

deduct (½) if no/wrong unit

1

NOTES
Do not accept: • **count rate** • **radio activity** • **radiation** • **strength** • **power** • **'something'** **Accept abbreviations:** • **hrs or h**

K&U	PS

Marks

(iii) The initial activity of the source is 160 kBq.

Calculate the activity, in kBq, of the radioactive source after four half-lives.

Space for working and answer

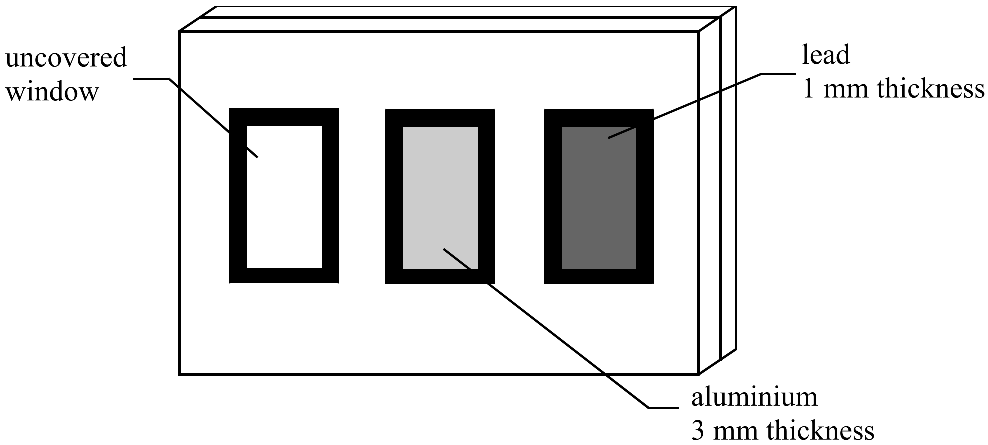
160 → 80 → 40 → 20 → 10 (½) for halving
1 2 3 4

So activity is 10 (kBq) (½) (unit not required)

if wrong unit given deduct (½)

1

(b) As a safety precaution the technician wears a film badge when working with radioactive sources. The film badge contains photographic film. Light cannot enter the badge.



Describe how the film badge indicates the **type** and **amount** of radiation received.

windows allow different radiations to pass through (1)

film becomes fogged/blackened/darkened (1)

2

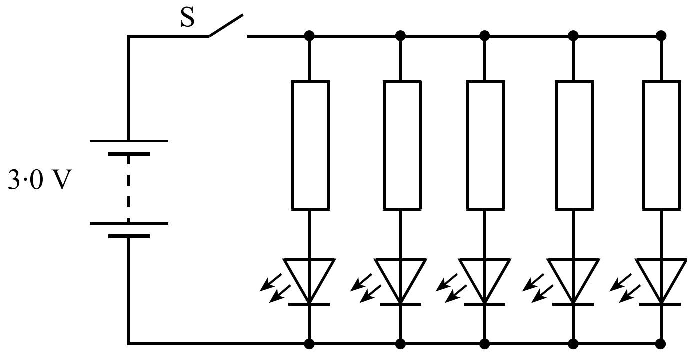
NOTES

look for:
answer relating to type of radiation
answer relating to amount of radiation

K&U	PS

Marks

8. A torch contains five identical LEDs connected to a 3·0 V battery as shown.



(a) State the purpose of the resistor connected in series with each LED.

to limit current (flowing through LED) OR prevent damage to LED **1**

(b) When lit, each LED operates at a voltage of 1·8 V and a current of 30 mA.

(i) Calculate the value of the resistor in series with each LED.

Space for working and answer

$$\mathbf{V_R = 3 - 1{\cdot}8 = 1{\cdot}2\ (V)}\quad \mathbf{(1)}$$

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

$$\mathbf{= \frac{1{\cdot}2}{0{\cdot}03}}\quad \mathbf{(½)}$$

$$\mathbf{= 40\ \Omega}\quad \mathbf{(1)}$$

(½) max if 3 V or 1·8 V used

3

(ii) Calculate the total current from the supply when all five LEDs are lit.

Space for working and answer

$$\mathbf{I = 5 \times 30}$$

$$\mathbf{= 150\ mA}\quad \mathbf{(1)}$$

deduct (½) if no/wrong unit

1

NOTES

(a) **Accept:**

- **protect the LED**
- **reduce voltage across LED**

Do not accept:

- **to reduce voltage alone**
- **the voltage 'through'**
- **to stop LED blowing**
- **to reduce charge/power to LED**
- **to prevent LED overheating**

(b) **(i)** **if error in subtraction for V can still get (2) marks**

(ii) **if there is a <u>clear</u> arith error then deduct (½) eg** $I = 5 \times 30 = 160\ \text{mA}$ **(½)**

if wrong conversion then (½) for correct arith

	K&U	PS

Marks

(iii) Calculate the power supplied by the battery when all five LEDs are lit.

> *Space for working and answer*
>
> **P = IV (½)**
>
> **= 0·15 × 3 (½)**
>
> **= 0·45 W (1)**
>
> **unit penalty if wrong conversion to W deduct (½)**

2

(c) State **one** advantage of using five LEDs rather than a single filament lamp in the torch.

uses less energy/power OR more efficient OR if one fails – others stay on **1**

NOTES

Accept:
- **less current**
- **lasts longer**

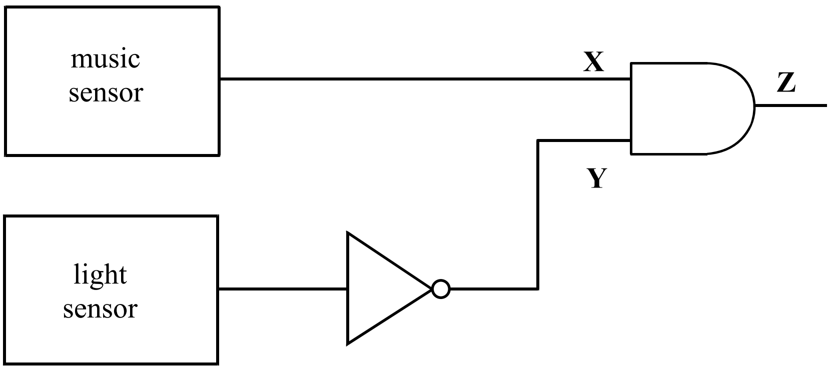
Do not accept:
- **brighter**
- **less fragile**

	K&U	PS

Marks

9. An electronic device produces a changing light pattern when it detects music, but only when it is in the dark.

The device contains the logic circuit shown.



The music sensor produces logic 1 when the music is on and logic 0 when the music is off.

The light sensor produces logic 1 when it detects light and logic 0 when it is dark.

(a) (i) Suggest a suitable input device for the light sensor.

LDR OR solar cell OR photodiode
accept correct symbol **1**

(ii) Complete the truth table for the logic levels at points **X**, **Y** and **Z** in the circuit.

(1) for each correct column

Music	*Light level*	**X**	**Y**	**Z**
off	dark	**0**	**1**	**0**
off	light	**0**	**0**	**0**
on	dark	**1**	**1**	**1**
on	light	**1**	**0**	**0**

3

NOTES

K&U	PS

Marks

(b) The device detects music from a CD player. The CD player contains an amplifier that produces an output voltage of 5·6 V when connected to a loudspeaker of resistance 3·2 Ω.

(i) Calculate the output power of the amplifier.

Space for working and answer **(½) for both**

$$\mathbf{P = \frac{V^2}{R}} \ (\tfrac{1}{2}) \quad \textbf{OR} \quad \mathbf{I = \frac{V}{R}} \qquad \mathbf{P = IV}$$

$$= \mathbf{\frac{5\cdot6^2}{3\cdot2}} \ (\tfrac{1}{2}) \qquad = \mathbf{\frac{5\cdot6}{3\cdot2}} \qquad = \mathbf{1{\cdot}75 \times 5{\cdot}6}$$

$$= \mathbf{9{\cdot}8\ W\ (1)} \qquad = \mathbf{1{\cdot}75\ (A)}\ (\tfrac{1}{2}) \qquad = \mathbf{9{\cdot}8\ W\ (1)}$$

2

(ii) The input power to the amplifier is 4·9 mW.

Calculate the power gain of the amplifier.

Space for working and answer

$$\mathbf{P_{gain} = \frac{P_{out}}{P_{in}}} \quad (\tfrac{1}{2})$$

$$= \mathbf{\frac{9\cdot8}{0\cdot0049}} \quad (\tfrac{1}{2})$$

$$= \mathbf{2000} \quad \mathbf{(1)}$$

deduct (½) if unit given

2

(iii) One particular signal from the CD to the amplifier has a frequency of 170 Hz.

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

170 (Hz) accept 'the same' **1**

unit not required
not: 170 MHz

NOTES

(ii) if no conversion from 4·9 mW then unit penalty

K&U	PS

Marks

10. A railway train travels uphill between two stations.

Information about the train and its journey is given below.

average speed of train	5 m/s
time for journey	150 s
power of train	120 kW
mass of train plus passengers	20 000 kg

(a) Calculate the energy used by the train during the journey.

Space for working and answer

$E = P \times t$ (½)

$= 120 \times 10^3 \times 150$ (½)

$= 1{\cdot}8 \times 10^7$ J (1)

unit penalty if no conversion deduct (½)

2

NOTES

K&U | PS

Marks

(b) Calculate the height gained by the train during the journey.

Space for working and answer

$$\mathbf{h} = \frac{\mathbf{E_p}}{\mathbf{mg}} \quad (½)$$

$$= \frac{1\cdot 8 \times 10^7}{20000 \times 10} \quad (½)$$

$$= 90 \text{ m} \quad (1)$$

2

(c) Suggest why the actual height gained by the train is less than the value calculated in part (b).

energy is lost as heat energy OR frictional heat losses OR energy is lost because of friction 1

NOTES

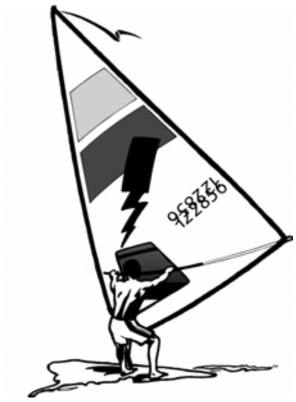
Do not accept:

- **'air resistance' alone**
- **'energy losses' alone**
- **'friction'**

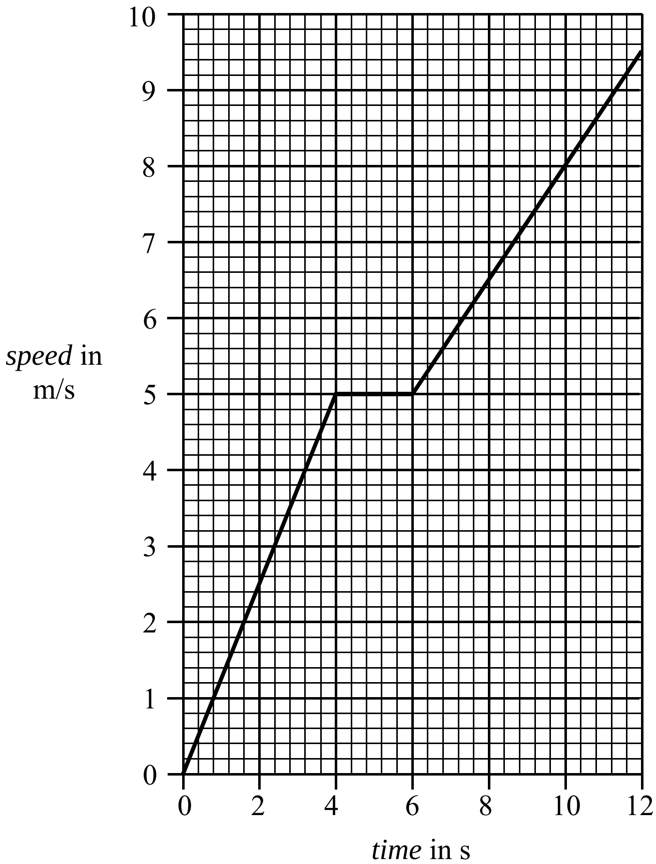
K&U	PS

Marks

11. A windsurfer takes part in a race. The windsurfer takes 120 seconds to complete the race. The total mass of the windsurfer and the board is 90 kg.



The graph shows how the speed of the windsurfer and board changes with the time during part of the race.



NOTES

K&U	PS

Marks

(a) (i) Calculate the acceleration of the windsurfer and board during the first 4 s of the race.

Space for working and answer

$a = \frac{v - u}{t}$ (½)

$= \frac{5 - 0}{4}$ (½)

$= 1{\cdot}25\ m/s^2$ (1)

2

(ii) Calculate the unbalanced force causing this acceleration.

Space for working and answer

$F = ma$ (½)

$= 90 \times 1{\cdot}25$ (½)

$= 112{\cdot}5\ N$ (1)

sig fig range: 110 N 112·5 N 113 N

2

(b) Calculate the total distance travelled by the windsurfer during the 12 s time interval shown on the graph.

Space for working and answer

distance travelled = area under graph (½) (or implied)

$= \left(\frac{1}{2} \times 4 \times 5\right) + (8 \times 5) + \left(\frac{1}{2} \times 6 \times 4 \cdot 5\right)$ (½) for correct substitution

$(= 10 + 40 + 13 \cdot 5)$

$= 63{\cdot}5\ m$ (1)

2

(c) What can be said about the horizontal forces acting on the windsurfer between 4 s and 6 s?

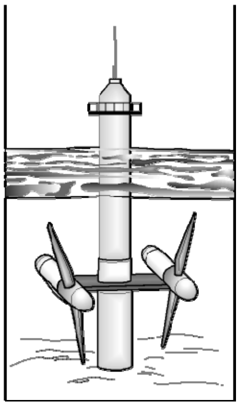
forces are balanced (not 'equal') OR 'forces are equal and opposite' 1

NOTES
Accept units: **m/s/s** **$m\,s^{-2}$** **Do not accept units:** **mpsps**

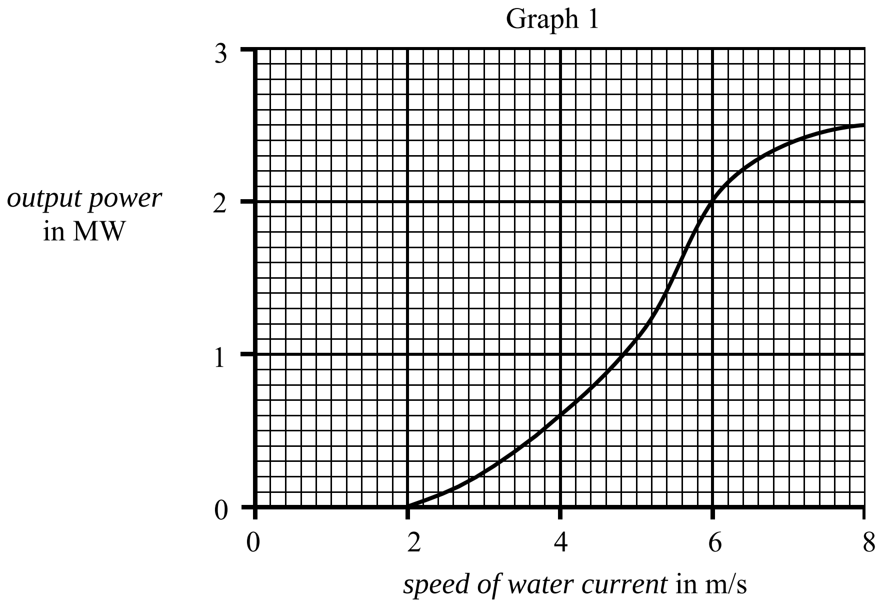
K&U	PS

Marks

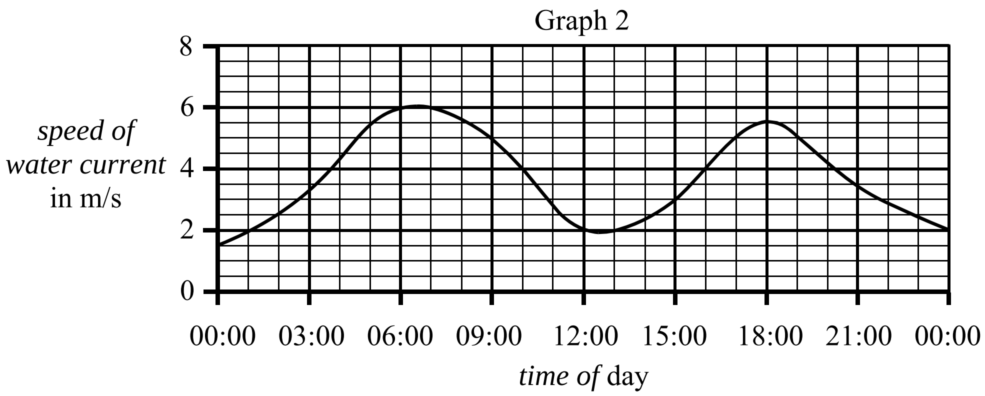
12. An underwater generator is designed to produce electricity from water currents in the sea.



The output power of the generator depends on the speed of the water current as shown in Graph 1.



The speed of the water current is recorded at different times of the day shown in Graph 2.



NOTES

K&U	PS

Marks

(a) (i) State the output power of the generator at 09:00.

1·1 MW **deduct (½) if no/wrong unit** **1**

(ii) State **one** disadvantage of using this type of generator.

(power) output not consistent OR expensive OR dangerous to build/ maintain OR few suitable locations **1**

(b) The voltage produced by the generator is stepped-up by a transformer.

At one point in the day the electrical current in the primary coils of the transformer is 900 A and the voltage is 2000 V.

The transformer is 96% efficient.

(i) Calculate the output power of the transformer at this time.

Space for working and answer

P	**=**	**IV**	**(½)** $\mathbf{P_{out}}$	**=**	$\mathbf{\dfrac{Efficiency \times P_{in}}{100}}$	**(½)**
	=	**900 × 2000**		**=**	$\mathbf{\dfrac{96 \times 1800000}{100}}$	**(½)**
	=	**1,800,000 (W)(½)**		**=**	**1,728,000 W**	**(1)**

3

(ii) State **one** reason why a transformer is not 100% efficient.

heat losses in coils OR magnetic losses in core OR eddy currents in core **1**

NOTES

(a) (ii) Accept:

- **current varies**
- **variable output**
- **water speed changeable**
- **hazard to shipping/wildlife**
- **input power variable**
- **no output at times**

Do not accept:

- **waves vary (ie not 'calm sea')**

(b) (i) must calculate 96% of power ie not 96% of I or V

(b) (ii) look for answer giving '<u>loss'</u> and '<u>location'</u> eg:

- **transformer hum**
- **heat loss in core/windings**
- **energy loss in wires**
- **magnetisation of core**

Accept:

- **hysteresis**

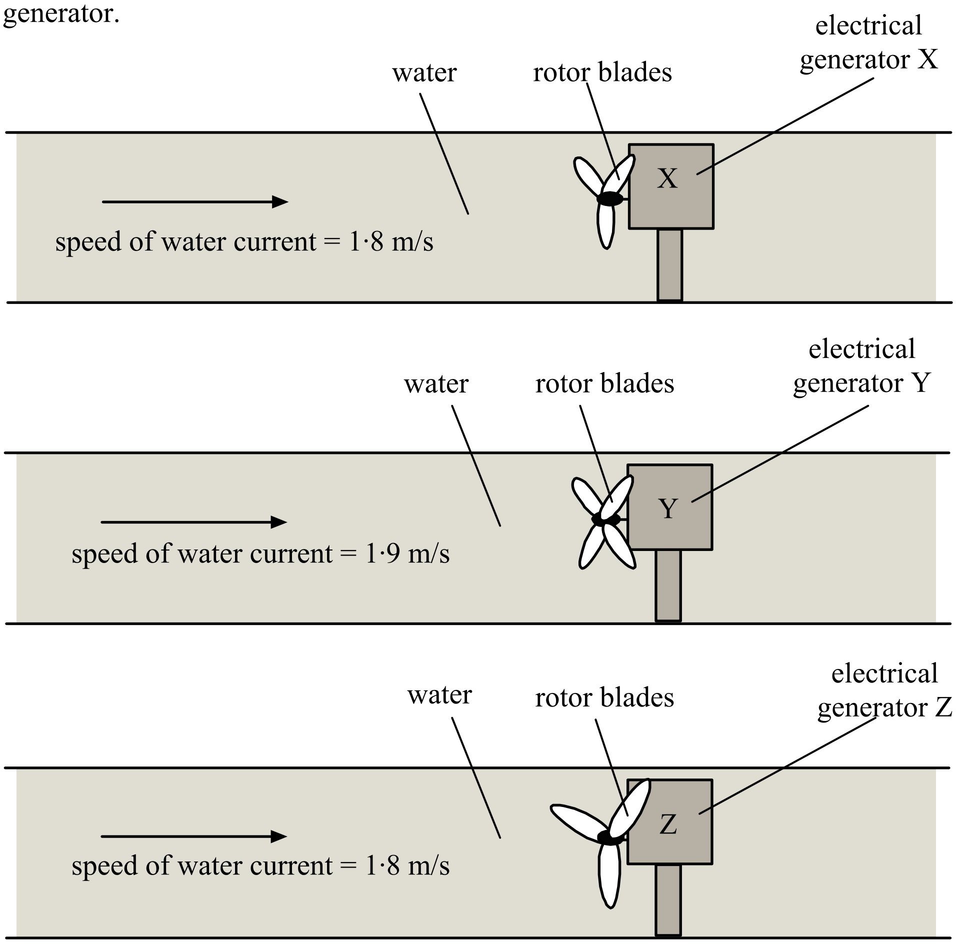
Do not accept:

- **'friction and heat'**

	K&U	PS

Marks

(c) Three different types of electrical generator X, Y and Z are tested in a special tank with a current of water as shown to find out the efficiency of each generator.



Give **two** reasons why this is not a fair test.

different water speeds OR different sizes of rotor blades OR different

number of rotor blades (½) each correct 1

if one reason is 'different <u>types</u> of rotor blades' (½)
then the other reason must be 'different water speeds' (½)

NOTES

K&U	PS

Marks

13. In the reactor of a nuclear power station, neutrons split uranium nuclei to produce heat in what is known as a "chain reaction".

(a) Explain what is meant by the term "chain reaction".

in each reaction more neutrons are released (1) these cause further reactions (1) **2**

(b) In the nuclear power station, 1 kg of uranium fuel produces 4 200 000 MJ of heat. In a coal-fired power station 1 kg of coal produces 28 MJ of heat.

Calculate how many kilograms of coal are required to produce the same amount of heat as 1 kg of uranium.

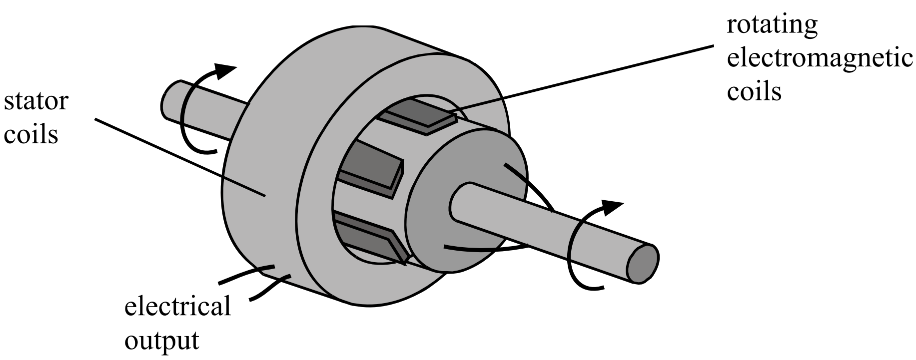
Space for working and answer

No of kg $= \dfrac{\mathbf{4200000}}{\mathbf{28}}$

$=$ **150 000 (kg)** **(1) unit not required**
if wrong unit given deduct (½)

1

(c) A power station uses an a.c. generator to convert kinetic energy from a turbine into electrical energy. A diagram of an a.c. generator is shown.



(i) Explain how the a.c. generator works.

(electromagnetic) coils produce moving/changing magnetic field (1)

voltage/current is induced in the (stator) coils (1) **2**

(ii) State **two** changes that can be made to the generator to increase the output power.

Change 1: **increase rate/speed of rotation (1)**

Change 2: **increase number of coils in (stator) OR (field) coils (1)** **2**

NOTES

(a) **look for:**
- **neutrons causing fission**
- **further reactions resulting**

accept <u>labelled</u> diagram

(b) **if there is a clear arith error then deduct (½)**

(c) **(i)** **look for:**
- **indication of changing magnetic field**
- **indication of voltage induced**

beware of simply a repeat of information given in question/diagram

(ii) **accept:**
- **increase current in rotating electromagnetic coils**
- **increase magnetic field**
- **use stronger electromagnet**
- **if use bigger, stronger magnet use ± rule**

do not accept:
- **'bigger/larger coils'**
- **'bigger magnets'**

apply ± rule if more than 2 answers

K&U	PS

Marks

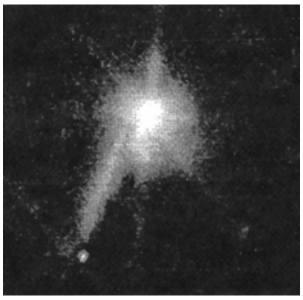
14. A team of astronomers observes a star 200 light-years away.

(a) State what is meant by the term “light-year”.

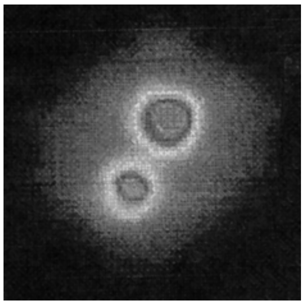
distance travelled by light in one year **1**

(b) Images of the star are taken with three different types of telescope as shown.

Telescope A
visible light



Telescope B
infrared



Telescope C
X-ray

(i) Explain why different types of telescope are used to detect signals from space.

different detectors (1) are required for different radiations/ frequencies/wavelengths (1) **2**

(ii) Place the telescopes in order of the increasing wavelength of the radiation which they detect.

C A B (1) or (0) **1**

accept: X-ray Visible Infrared

(iii) State a detector that could be used in telescope C.

G-M tube OR photographic film **1**

(c) Telescope A is a refracting telescope with an objective lens of focal length 400 mm and diameter 80 mm.

(i) Calculate the power of the objective lens.

Space for working and answer

$$\mathbf{P} = \frac{\mathbf{1}}{\mathbf{f}} \quad (½)$$

$$= \frac{\mathbf{1}}{\mathbf{0 \cdot 4}} \quad (½)$$

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

2

NOTES
(i) **look for:** • **an indication of different radiations** • **so different detectors are needed** **eg 'some radiations are invisible so we need something other than the eye to detect it'**
Accept: <u>C</u>harge <u>C</u>oupled <u>D</u>evice
if no conversion to metres (P = 0·0025 D then unit error) **accept D or d** **ignore ± signs**

	K&U	PS

Marks

(ii) One of the astronomers suggests replacing the objective lens in this telescope with one of larger diameter.

State an advantage of doing this.

fainter objects can be observed OR telescope gathers more light **1**

NOTES

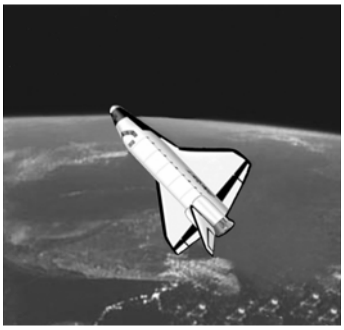
Accept:
- **more detail**
- **clearer**
- **brighter image**

Do not accept:
- **bigger picture**
- **the more you can see**
- **more focussed**
- **sharper**

	K&U	PS

Marks

15. (a) A spacecraft is used to transport astronauts and equipment to a space station. On its return from space the spacecraft must re-enter the Earth's atmosphere. The spacecraft has a heat shield made from special silica tiles to prevent the inside from becoming too hot.



(i) Why does the spacecraft increase in temperature when it re-enters the atmosphere?

friction (between craft and atmosphere causes heat production) 1

(ii) The mass of the heat shield is $3{\cdot}5 \times 10^3$ kg and the gain in heat energy of the silica tiles is 4·7 GJ.

Calculate the increase in temperature of the silica tiles.

Space for working and answer

$$\Delta T = \frac{E_H}{mc}$$

$$= \frac{4\cdot7\times10^9}{3\cdot5\times10^3\times1033}$$

$$= 1300°C$$

(1) for selection of 1033 (J/Kg °C)
if wrong value for c selected from 'Specific heat capacity of materials' table then can continue with this value (2 max)
any other value of c then (½) max 3

(iii) Explain why the actual temperature rise of the silica tiles is less than the value calculated in (a) (ii).

some heat (generated) is lost to surroundings OR some heat energy reached the rest of the spacecraft 1

(b) When a piece of equipment was loaded on to the spacecraft on Earth, two people were required to lift it.

One person was able to lift the same piece of equipment in the Space Station.

Explain why one person was able to lift the equipment in the Space Station.

weighs less (in space) 1

[END OF MARKING INSTRUCTIONS]

NOTES

(i)	**Accept:**	• **because of the friction** • **air resistance**
(b)	**Accept:**	• **the force of gravity is less**
	Do not accept:	• **no gravity** • **less gravity** • **lighter**