FOR OFFICIAL USE

National Qualifications 2019

Mark

X857/75/01

Physics
Section 1 — Answer grid and Section 2

WEDNESDAY, 15 MAY

1:00 PM – 3:30 PM

* X 8 5 7 7 5 0 1 *

Fill in these boxes and read what is printed below.

Full name of centre: St. Trinians

Town: Hogsmead

Forename(s): Drew

Surname: Escutcheon.

Number of seat: 007

Date of birth

Day	Month	Year
09	12	92

Scottish candidate number: 0345279 10

Total marks — 135

SECTION 1 — 25 marks
Attempt ALL questions.
Instructions for completion of Section 1 are given on *page 02*.

SECTION 2 — 110 marks
Attempt ALL questions.

Reference may be made to the Data sheet on *page 02* of the question paper X857/75/02 and to the Relationships sheet X857/75/11.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. Score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

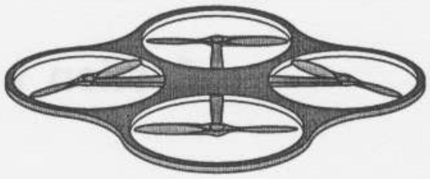
SQA ©

DO NOT WRITE IN THIS MARGIN

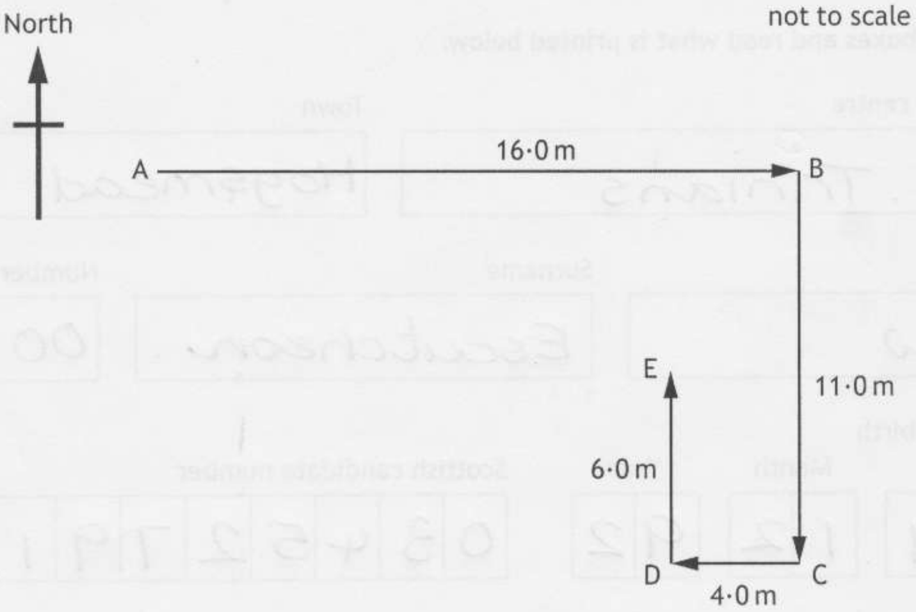
SECTION 2 — 110 marks

Attempt ALL questions

1. A quadcopter is a drone with four rotating blades.



(a) In a race, the quadcopter is flown along a route from point A to point E.

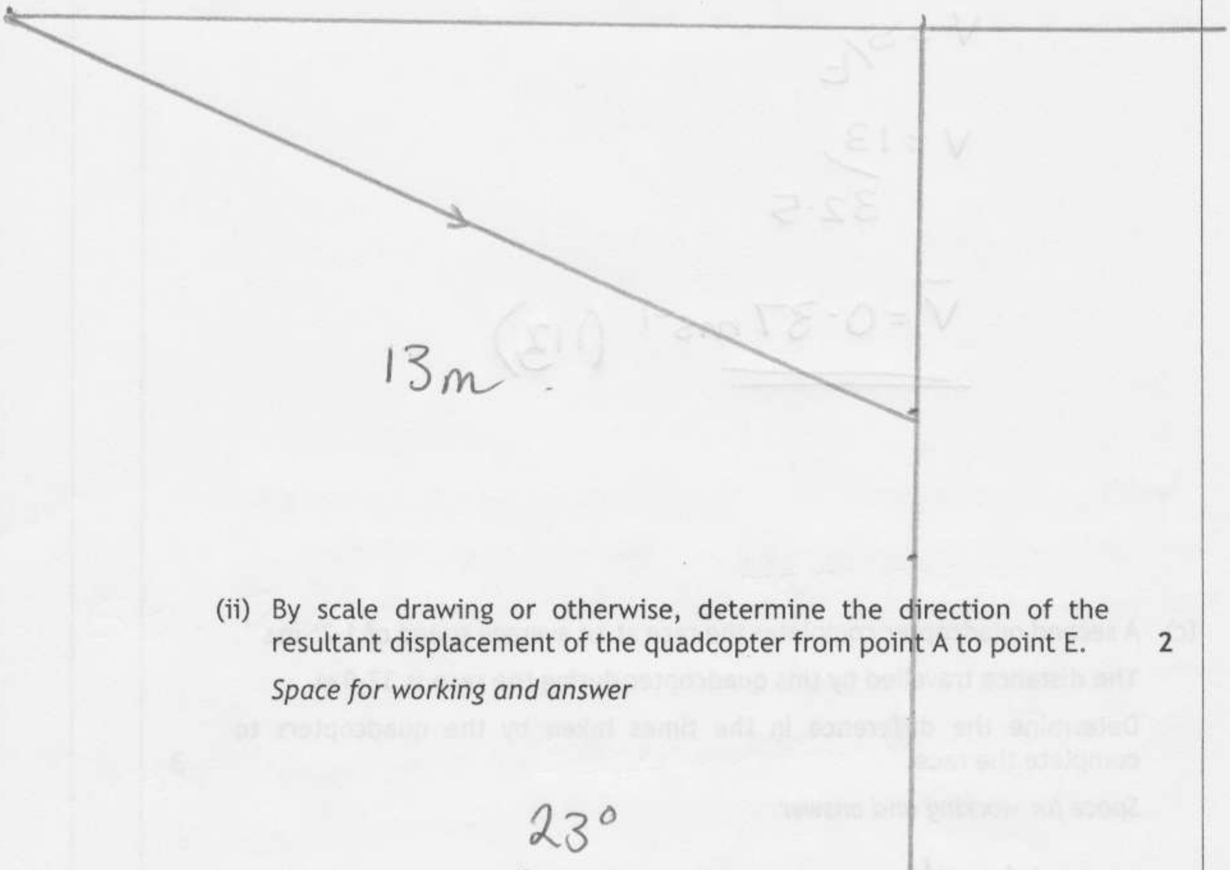


MARKS | DO NOT WRITE IN THIS MARGIN

1. (a) (continued)

(i) By scale drawing or otherwise, determine the magnitude of the resultant displacement of the quadcopter from point A to point E. **2**

Space for working and answer



(ii) By scale drawing or otherwise, determine the direction of the resultant displacement of the quadcopter from point A to point E. **2**

Space for working and answer

23°

(113)

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

1. (continued)

(b) The quadcopter takes 32·5 s to complete the race.

Determine the average velocity of the quadcopter over the whole race. 3

Space for working and answer

$V = s/t$

$V = \frac{13}{32.5}$

$\bar{V} = 0.37\ ms^{-1}$ (1 1 3)

(c) A second quadcopter completes the race at an average speed of $1·25\ m\ s^{-1}$.

The distance travelled by this quadcopter during the race is 37·0 m.

Determine the **difference** in the times taken by the quadcopters to complete the race. 3

Space for working and answer

$V = d/t$

$1.25 = \frac{37}{t}$

$t = 29.6s$

$\Delta t = 2.9s$

X857750108

MARKS | DO NOT WRITE IN THIS MARGIN

1. (continued)

(d) After passing point E, the quadcopter hovers at a constant height.

Describe how the overall lift force provided by the four rotating blades compares to the weight of the quadcopter. 1

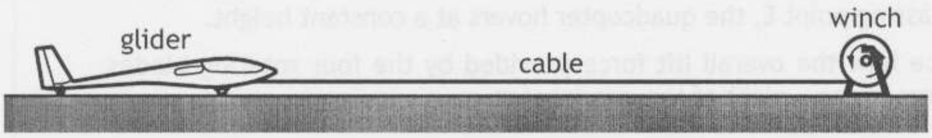
balanced forces

[Turn over

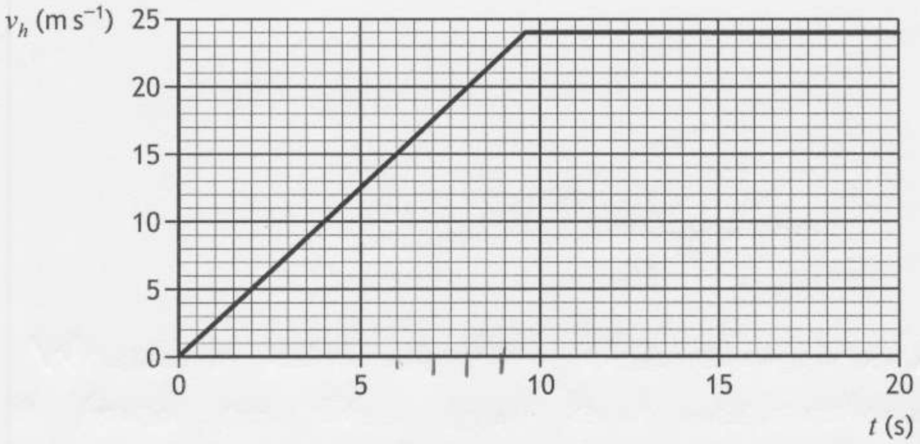
* X 8 5 7 7 5 0 1 0 9 *

MARKS | DO NOT WRITE IN THIS MARGIN

2. A glider is accelerated from rest by a cable attached to a winch.



The graph shows the horizontal velocity v_h of the glider for the first 20 s of its motion.



(a) The glider is accelerated by a constant unbalanced force of 925 N.

(i) Show that the initial acceleration of the glider is $2{\cdot}5\ \text{m s}^{-2}$. 2

Space for working and answer

a = gradient

$= \frac{24-0}{9{\cdot}5-0}$

$= 2{\cdot}5\ \text{ms}^{-1}$

(ii) Calculate the mass of the glider. 3

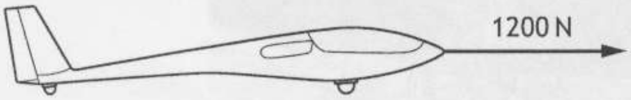
Space for working and answer

F = ma

m = 370 kg

2. (a) (continued)

(iii) At 2·0 s the cable pulls the glider with a force of 1200 N.



(A) Determine the size of the frictional forces acting on the glider at this time. 1

275N

(B) Suggest one design feature of the glider that reduces the frictional forces acting on it. 1

Streamlining

(b) At 8·0 s the glider reaches its take-off speed and leaves the ground.

Determine the distance the glider travels along the ground before take-off. 3

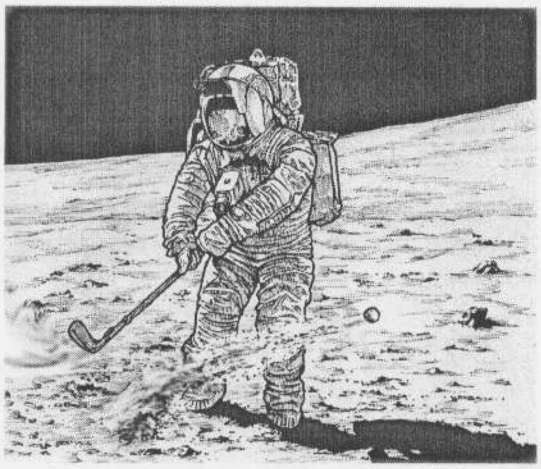
Space for working and answer

$\bar{v} = d/t$

$10 = d/8$

$d = 80\ m$

3. In 1971, the astronaut Alan Shepard hit a golf ball on the surface of the Moon.



Using your knowledge of physics, comment on the similarities and/or differences between this event and hitting an identical ball on the surface of the Earth. 3

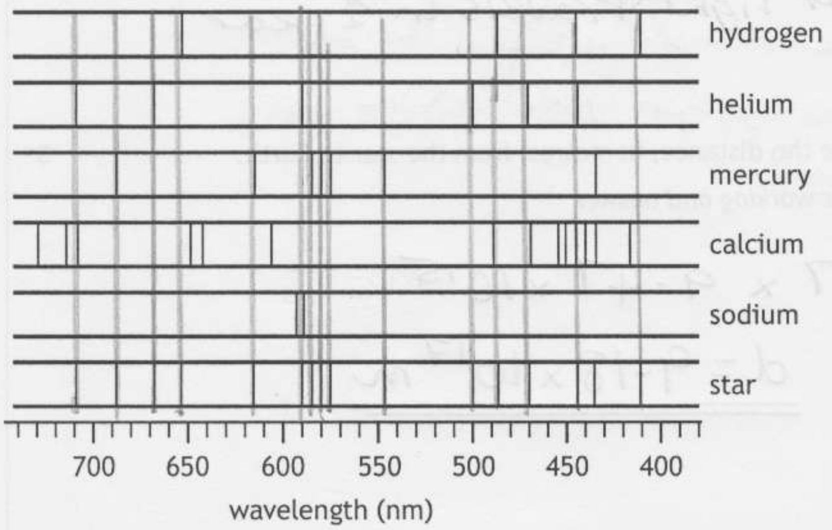
When a ball is hit the club exerts a force on the ball but according to Newton's 3rd law the ball exerts an equal but opposite force on the ball. According to N1L an object will move at constant speed unless acted on by an unbalanced force. The club exerts an unbalanced force on the ball so the ball will accelerate. The ball will accelerate according to N2L F=ma.

This is the same on Earth and moon. Hitting the ball in the spacesuit will be harder so Alan Shephard probably didn't apply such a big force.

MARKS | DO NOT WRITE IN THIS MARGIN

4. Astronomers studying a distant star analyse the light from the star that reaches Earth.

The line spectrum from the star is shown, along with the line spectra of the elements hydrogen, helium, mercury, calcium, and sodium.



(a) Determine which of these elements are present in the star. 1

H_2 He_2 Hg

* X 8 5 7 7 5 0 1 1 4 *

MARKS | DO NOT WRITE IN THIS MARGIN

4. (continued)

(b) The star is 97 light-years from Earth.

(i) State what is meant by the term *light-year*. 1

how far light travels in 1 year

(ii) Calculate the distance, in metres, from the star to Earth. 3

Space for working and answer

$97 \times 9.47 \times 10^{15}$

$d = 9.18 \times 10^{17}$ m

(c) Astronomers use satellite-based telescopes to collect information about objects in space.

(i) Suggest an advantage of using satellite-based telescopes such as the Hubble Space Telescope. 1

no atmosphere or light pollution and its bigger

(ii) State one other use of satellites. 1

GPS

X857750115

[Turn over

5. A student is investigating how the length of a wire affects its resistance.

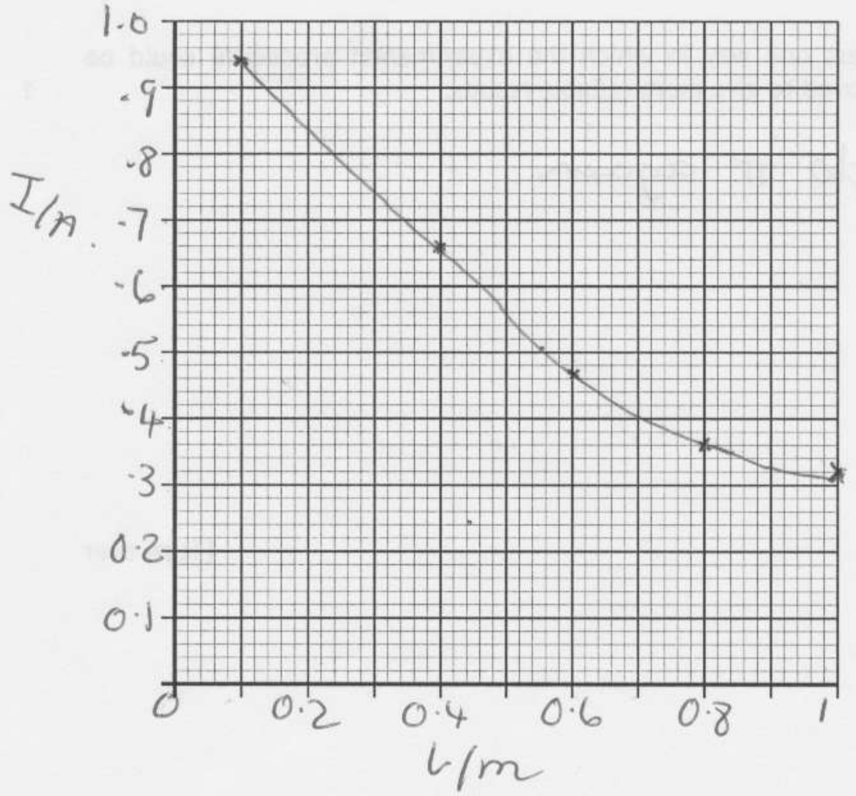
The student connects different lengths of wire to a power supply of fixed voltage and measures the current in each length of wire.

(a) The measurements taken by the student are shown in the table.

Length of wire (m)	Current (A)
0·20	0·94
0·40	0·66
0·60	0·47
0·80	0·37
1·00	0·32

(i) Using the graph paper, draw a graph of these measurements. 3

(Additional graph paper, if required, can be found on *page 38*)



MARKS | DO NOT WRITE IN THIS MARGIN

5. (a) (continued)

(ii) State whether the resistance of the wire increases, decreases or stays the same, as the length of wire increases.

Justify your answer. 2

decrease as the Line on the graph goes down not straight

(iii) Use your graph to predict the current in a 0·50 m length of wire, when connected to the power supply. 1

0·56A

(iv) Suggest one way in which the experimental procedure could be improved to give more reliable results. 1

do it again.

[Turn over

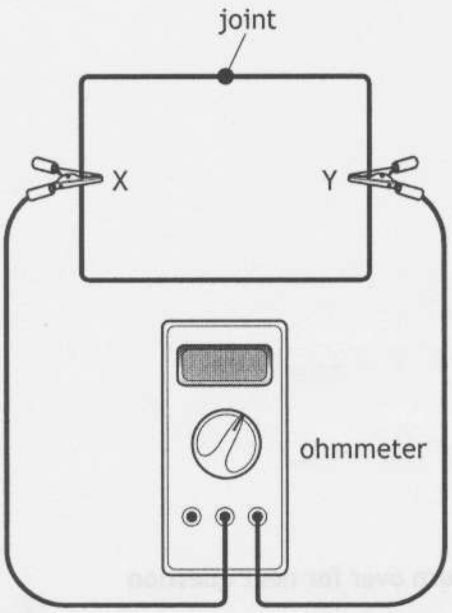
* X 8 5 7 7 5 0 1 1 7 *

MARKS | DO NOT WRITE IN THIS MARGIN

5. (continued)

(b) A length of the wire with a resistance of $5 \cdot 2\,\Omega$ is then folded into a rectangular shape and the ends are joined together.

An ohmmeter is connected across the wire between point X and point Y as shown.



State whether the reading on the ohmmeter would be less than, equal to or greater than $5 \cdot 2\,\Omega$.

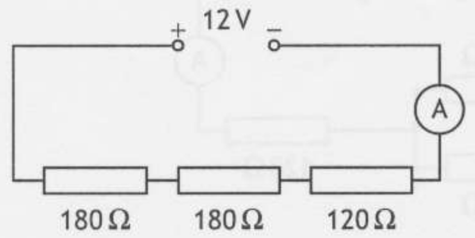
You must justify your answer. 2

less as they're in parallel.

X857750118

6. A student is investigating connecting different combinations of resistors in circuits.

(a) The student sets up a circuit as shown.



(i) Calculate the current in the circuit. 4

Space for working and answer

I = 0·025A

(ii) Calculate the power dissipated in the 120 Ω resistor. 3

Space for working and answer

P = IV

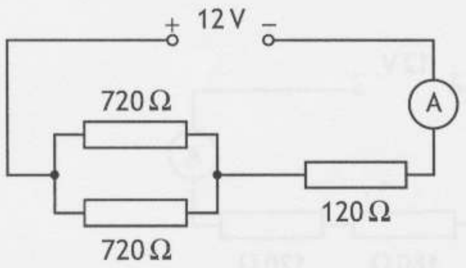
P = 0·025 x 3

P = 0·075W

MARKS | DO NOT WRITE IN THIS MARGIN

6. (continued)

(b) The student then sets up a different circuit as shown.



(i) Determine the total resistance of this circuit. **4**

Space for working and answer

360 + 120

= 480 Ω

(ii) State how the power dissipated in the 120 Ω resistor in this circuit compares to the power dissipated in the 120 Ω resistor in the circuit in part (a) (ii).

Justify your answer. **2**

$V_{120} = 3V$

$P = 0.025 \times 3 = 0.075W$

Same

X857750121

[Turn over

7. A hot water dispenser is used to heat enough water for one cup at a time.

The rating plate for the hot water dispenser is shown.

Model: 1-KUPPA
3·5 kW
230 V
50 Hz

The hot water dispenser takes 26 s to heat enough water for one cup.

(a) Show that the energy supplied to the hot water dispenser during this time is 91 000 J. **2**

Space for working and answer

E = P × t

E = 3·5 × 26

E = 91 KJ

7. (continued)

(b) The hot water dispenser heats 0·250 kg of water for each cup.

(i) Calculate the minimum energy required to heat 0·250 kg of water from an initial temperature of 20·0 °C to its boiling point. 3

Space for working and answer

$E = mc\Delta T$

$E = 0{\cdot}25 \times 4180 \times 80$

$E = 83{\cdot}6\,kJ$

(ii) As the water is dispensed into the cup, steam is released.

Determine the maximum mass of steam that can be produced while the water for one cup is being heated. 4

Space for working and answer

$E = 7{\cdot}4\,kJ$

$7{\cdot}4 = m \times 22{\cdot}6 \times 10^5$

$m = 3{\cdot}3 \times 10^{-6}\,kg$

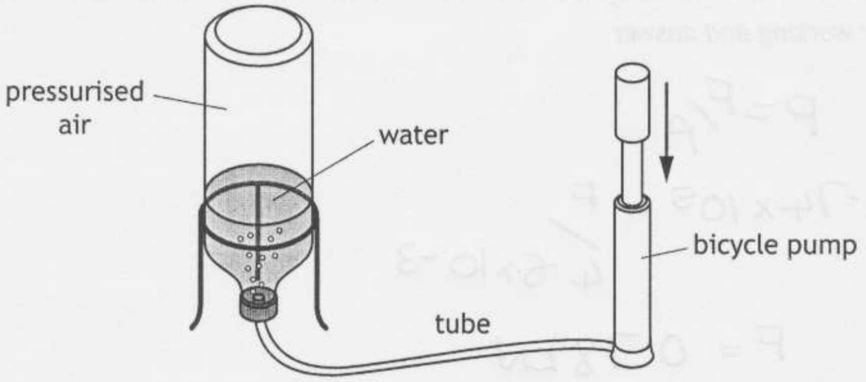
(iii) Explain why, in practice, the mass of steam produced is less than calculated in (b)(ii). 1

heat lost to air

X857750123

[Turn over

8. A water rocket consists of a plastic bottle partly filled with water. Air is pumped in through the water. When the pressure is great enough, the tube detaches from the bottle. Water is forced out of the bottle, which causes the bottle to be launched upwards.

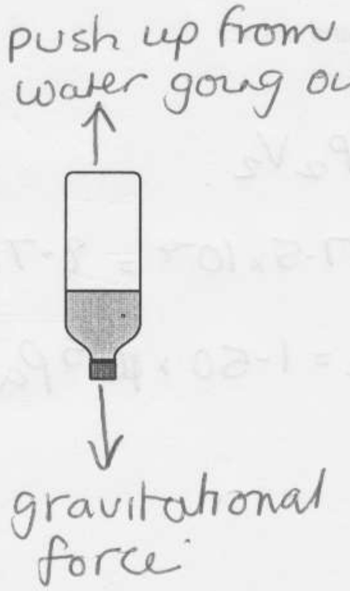


At launch, the air in the bottle is at a pressure of $1\cdot74 \times 10^5$ Pa.

(a) On the diagram below, show all the forces acting vertically on the bottle as it is launched.

You must name these forces and show their directions. 2

(An additional diagram, if required, can be found on *page 39*)



8. (continued)

(b) The area of water in contact with the pressurised air in the bottle is $4{\cdot}50 \times 10^{-3}\,m^2$.

Calculate the force exerted on the water by the pressurised air at launch. **3**

Space for working and answer

$P = F/A$

$1{\cdot}74 \times 10^5 = \frac{F}{4{\cdot}5 \times 10^{-3}}$

$F = 0{\cdot}78\,kN$

(c) At launch, the air in the bottle has a volume of $7{\cdot}5 \times 10^{-4}\,m^3$.

At one point in the flight, the volume of air in the bottle has **increased by** $1{\cdot}2 \times 10^{-4}\,m^3$.

During the flight the temperature of the air in the bottle remains constant.

(i) Calculate the pressure of the air inside the bottle at this point in the flight. **4**

Space for working and answer

$P_1V_1 = P_2V_2$

$1{\cdot}74 \times 10^5 \times 7{\cdot}5 \times 10^{-4} = 8{\cdot}7 \times 10^{-4} \times P_2$

$P_2 = 1{\cdot}50 \times 10^5\,Pa$

MARKS | DO NOT WRITE IN THIS MARGIN

8. (c) (continued)

(ii) Using the kinetic model, explain what happens to the pressure of the air inside the bottle as the volume of the air increases. 3

There is less pressure because there is less force on the walls because the distance particles move between collisions has increased.

X857750126

MARKS | DO NOT WRITE IN THIS MARGIN

9. A lifeboat crew is made up of local volunteers. When there is an emergency they have to get to the lifeboat quickly.

The lifeboat crew members are alerted to an emergency using a pager.

Text messages are sent to the pager using radio waves.

(a) The radio waves have a frequency of 153 MHz.

Calculate the wavelength of the radio waves. 3

Space for working and answer

$v = f\lambda$

$3 \times 10^8 = 153 \times \lambda$

$\lambda = 1{\cdot}96 \times 10^6$ m

(b) When the pager receives a message it beeps loudly and a light on the pager flashes.

A crew member holding the pager observes the beeps and the flashes happening at the same time.

A second crew member, who is 100 m away from the pager, also observes the beeps and the flashes.

Explain why the second crew member does not observe the beeps and the flashes happening at the same time. 2

$v_{light} \gg v_{sound}$.

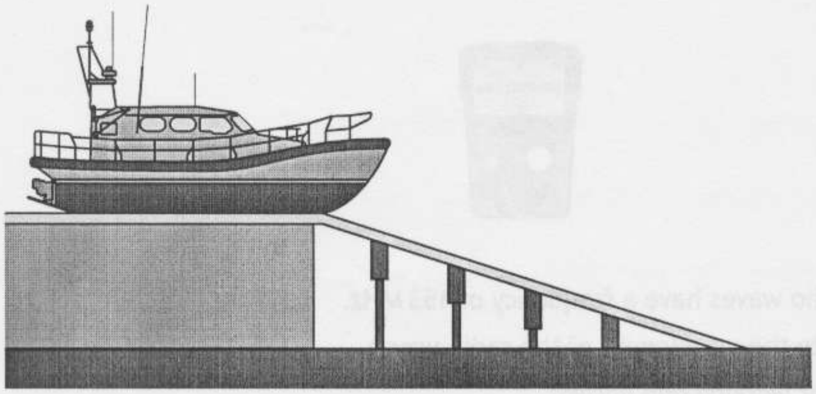
light get there first

X857750128

MARKS | DO NOT WRITE IN THIS MARGIN

9. (continued)

(c) The lifeboat has a mass of 25 000 kg. When it is launched, it loses $4{\cdot}5 \times 10^5$ J of gravitational potential energy before it enters the water.



(i) Calculate the maximum speed of the lifeboat as it enters the water. 3

Space for working and answer

$E_K = \frac{1}{2}mv^2$

$4{\cdot}5 \times 10^5 = \frac{1}{2} \times 25000 \times v$

$v = 6{\cdot}0\ ms^{-1}$

(ii) Explain why, in practice, the speed of the lifeboat as it enters the water is less than calculated in (c) (i). 1

energy is lost as heat as it passes over the rails

X857750129

[Turn over

10. Infrared and gamma rays are both members of a family of waves.

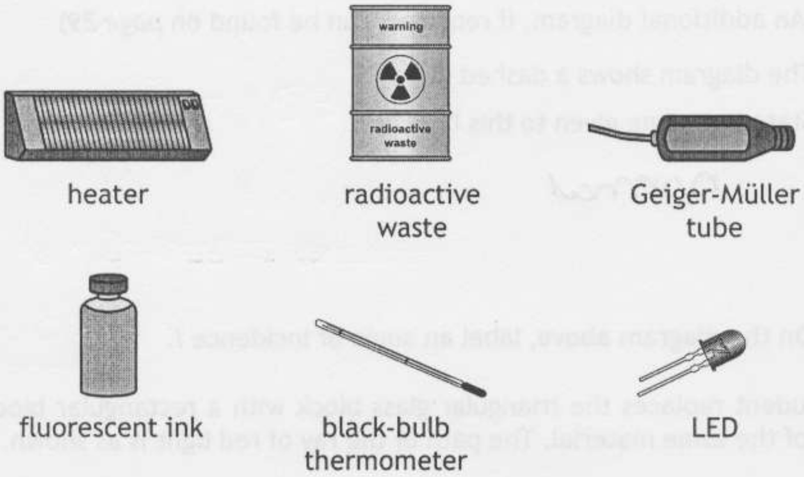
(a) State the name given to this family of waves. **1**

EM spectrum

(b) State how the frequency of infrared compares to the frequency of gamma rays. **1**

gamma higher frequency

(c) Some examples of sources and detectors of waves in this family are shown.



(i) From the examples shown, identify

(A) the detector of infrared **1**

black bulb thermometer

(B) the source of gamma rays. **1**

radioactive waste

(ii) Suggest one application for the waves that are detected using fluorescent ink. **1**

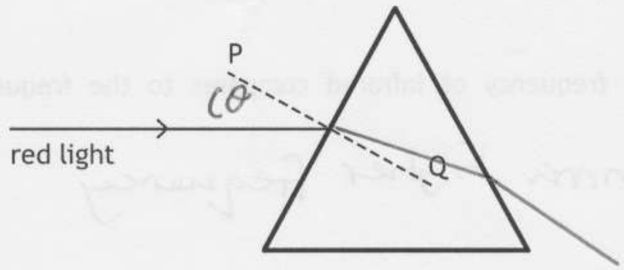
detecting forged bank notes

* X 8 5 7 7 5 0 1 3 0 *

MARKS | DO NOT WRITE IN THIS MARGIN

11. A student carries out an experiment to investigate the effect of different shaped glass blocks on the path of a ray of light.

(a) The student directs a ray of red light at a triangular glass block as shown.



(i) Complete the diagram above to show the path of the ray of red light through and out of the glass block. **2**

(An additional diagram, if required, can be found on *page 39*)

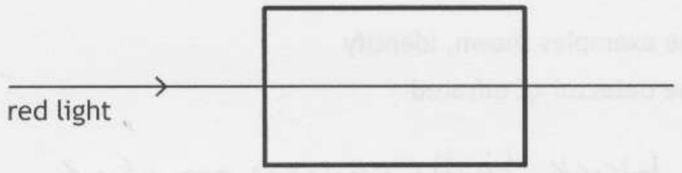
(ii) The diagram shows a dashed line PQ.

State the name given to this line. **1**

normal

(iii) **On the diagram above,** label an angle of incidence *i*. **1**

(b) The student replaces the triangular glass block with a rectangular block made of the same material. The path of the ray of red light is as shown.



State whether the wavelength of the red light in this block is less than, the same as, or greater than the wavelength of the red light in the triangular glass block in (a).

Justify your answer. **2**

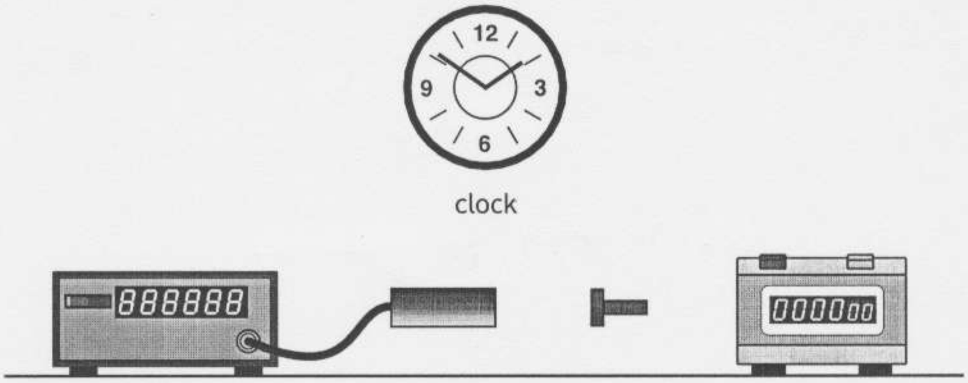
Same as the light goes straught through

X857750131

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

12. A technician carries out an experiment, using the apparatus shown, to determine the half-life of a radioactive source.



(a) Describe how the apparatus can be used to determine the half-life of the radioactive source. 3

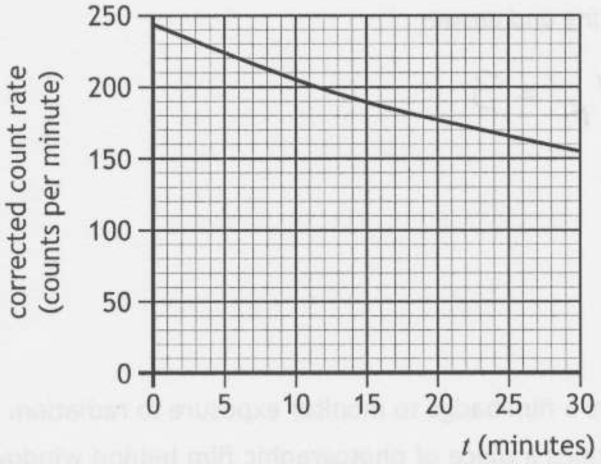
Find background count
A count on the counter for 1 min
without the source.
Bring out the source put it close
to the GM tube at take a count reading of
~~of the~~
on the counter for a set time
period. Repeat this over a long
period of time.
Subtract the background count
from the source counts if taken
over the same time period

[Turn over

X857750133

12. (continued)

(b) The technician carries out the experiment over a period of 30 minutes, and displays the data obtained in a graph as shown.



Suggest an improvement that the technician could make to the procedure to more easily determine a value for the half-life of this source. 1

Do the experiment for over an hour

(c) In a second experiment, the technician absorbs $1{\cdot}2\,\mu J$ of energy throughout their body from a radioactive source.

The mass of the technician is $80{\cdot}0$ kg.

(i) Calculate the absorbed dose received by the technician. 3

Space for working and answer

$D = E/m$

$D = \frac{1{\cdot}2\mu}{80}$

$D = 15\,nGy$

MARKS | DO NOT WRITE IN THIS MARGIN

12. (c) (continued)

(ii) During the experiment, the technician receives an equivalent dose of $4{\cdot}5 \times 10^{-8}$ Sv.

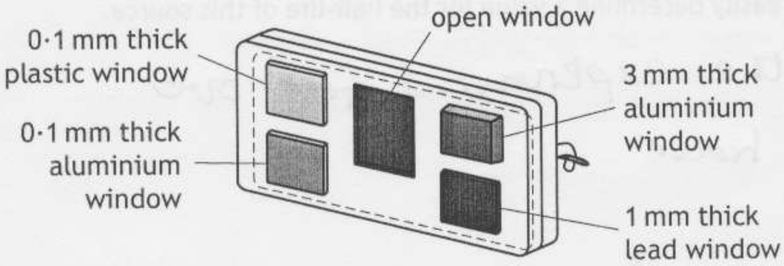
Calculate the radiation weighting factor of this source. **3**

Space for working and answer

$W_R = 3$

(d) The technician wears a film badge to monitor exposure to radiation.

The film badge contains a piece of photographic film behind windows of different materials.



Explain how this badge is used to determine the type of radiation the technician has been exposed to. **2**

These are outdated no one uses these any more. They used electronic Personal dosimeters but if you want me to answer this

sorry bird dropping'

Different types of radiation are absorbed by different types + thicknesses of materials. If they penetrate they will ~~[illegible]~~ fog the photographic film so seeing which films go cloudy and comparing tells you the type of radiation

[Turn over for next question

* X 8 5 7 7 5 0 1 3 5 *

MARKS | DO NOT WRITE IN THIS MARGIN

13. A physics teacher makes the following statement.

'Instead of nuclear fission, perhaps one day nuclear fusion will become a practical source of generating energy.'

Using your knowledge of physics, comment on the similarities and/or differences between using nuclear fission and nuclear fusion to generate energy. **3**

Fission	Fusion
← Energy given	off →
1 large nucleus splitting	2 small nuclei joining
less energy per reaction	more E per reaction
contained in radiation shield	Contained by a magnetic field
Has to be started by neutron	Has to overcome repulsive forces
Uses control rods and moderation	No need for control rods or moderator

E → Heat → produces heat in water to turn turbine

Expensive

No greenhouse gases

[END OF QUESTION PAPER]

* X 8 5 7 7 5 0 1 3 6 *