Candidate Name	Centre Number	Candidate Number

General Certificate of Secondary Education
former Midland Examining Group syllabus

SCIENCE: DOUBLE AWARD	PAPER 6	**1794/6**
SCIENCE: PHYSICS	PAPER 2	**1782/2**
SCIENCE: PHYSICS (NUFFIELD)	PAPER 2	**1787/2**

HIGHER TIER

Friday **16 JUNE 2000** Afternoon 1 hour 45 minutes

Candidates answer on the question paper.
Additional materials required:
Pencil
Ruler (cm/mm)

TIME 1 hour 45 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

The marks allocated and the spaces provided for your answers are a good indication of the length of answers required.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

This question paper consists of 23 printed pages and 1 blank page.

[Turn over

1 This question is about transferring energy.

Energy can be transferred by **conduction**, **convection**, **evaporation** and **radiation**.

(a) The Sun transfers energy to the Earth.
Before reaching the Earth only one process is involved in this transfer.

State the process and give a reason for your answer.

Process _____

Reason _____

_____ [2]

This marathon runner has been running for more than 23 miles.
He is very hot and sweaty.

(b) Sweating helps the runner to lose energy.
Use your ideas about energy transfer to explain how this happens.

_____

_____

_____

_____

_____

_____

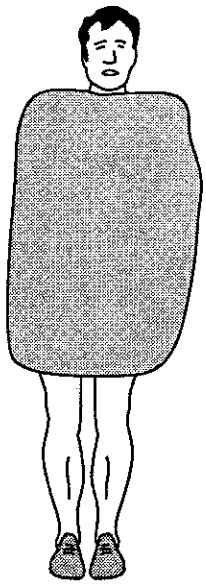
_____

_____ [3]

(c) After the race, the runner is given a **shiny** foil blanket.

This stops him cooling down too quickly.

Use your ideas about energy transfer to explain **two** ways in which this happens.



1. _____

_____

_____

2. _____

_____

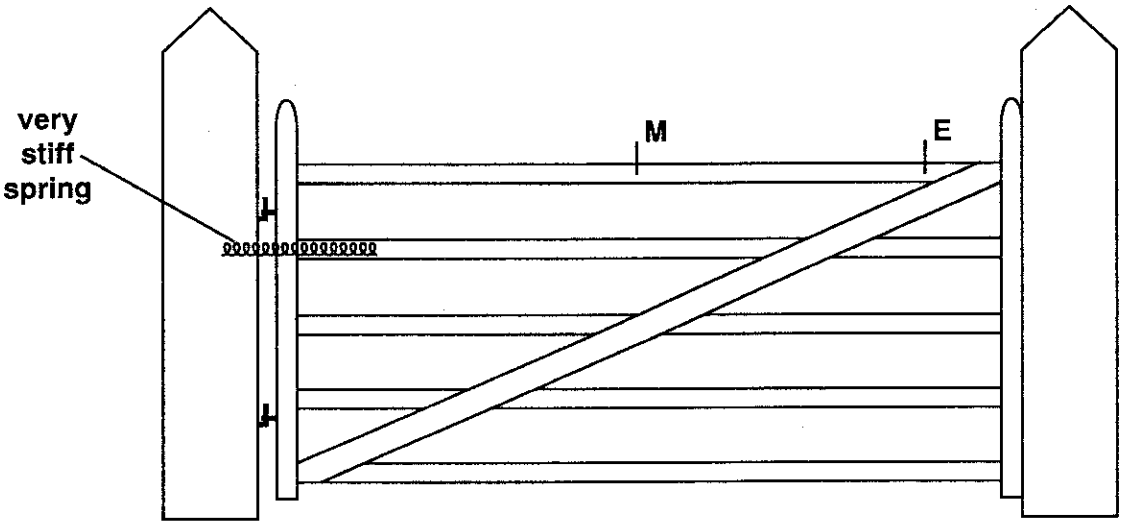
[4]

2 This question is about forces.

Phil lives on a farm.

One of the farm gates has a **very stiff spring** attached between the gate and the gate post.

This **spring** keeps the gate closed.



Phil can open the gate if he pushes it at the end **E**.

He cannot open the gate if he pushes it in the middle **M**.

(a) Use your knowledge of moments to explain this.

_____

_____ [1]

(b) Phil holds open the gate. Ruth starts to drive the tractor through.

The mass of the tractor is 3000 kg.

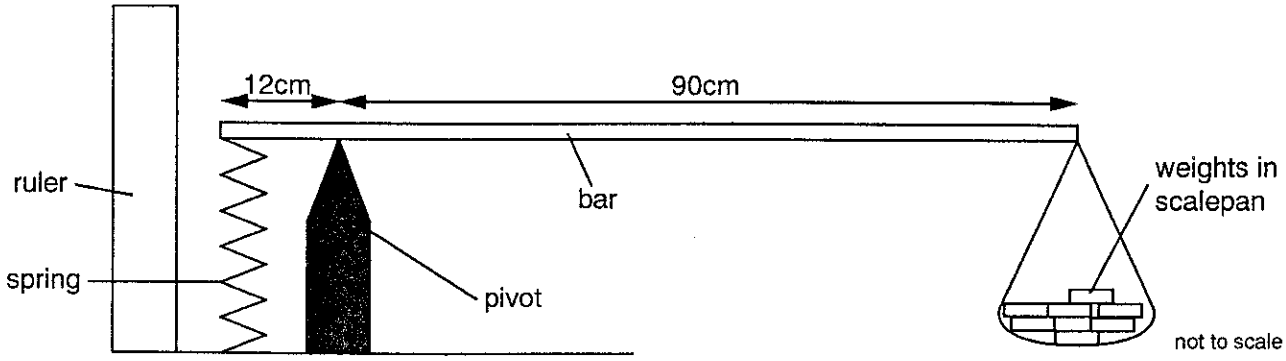
The force causing the tractor to accelerate is 1500 N.

Calculate the acceleration of the tractor.

You **must** show how you work out your answer.

acceleration = _____ unit _____ [4]

At school, Phil stretches a similar spring using this equipment.



(c) He measures the length of the spring as he adds weights to the **scalepan**.

The table shows his results.

load on scalepan in N	length of spring in mm	extension of spring in mm
0	200	0
10	212	12
20	225	25
30	234	34
40	248	48
50	262	62
60	270	70
70	285	85
80	294	94
90	307	107

(i) Plot the points for load and extension on the grid opposite.

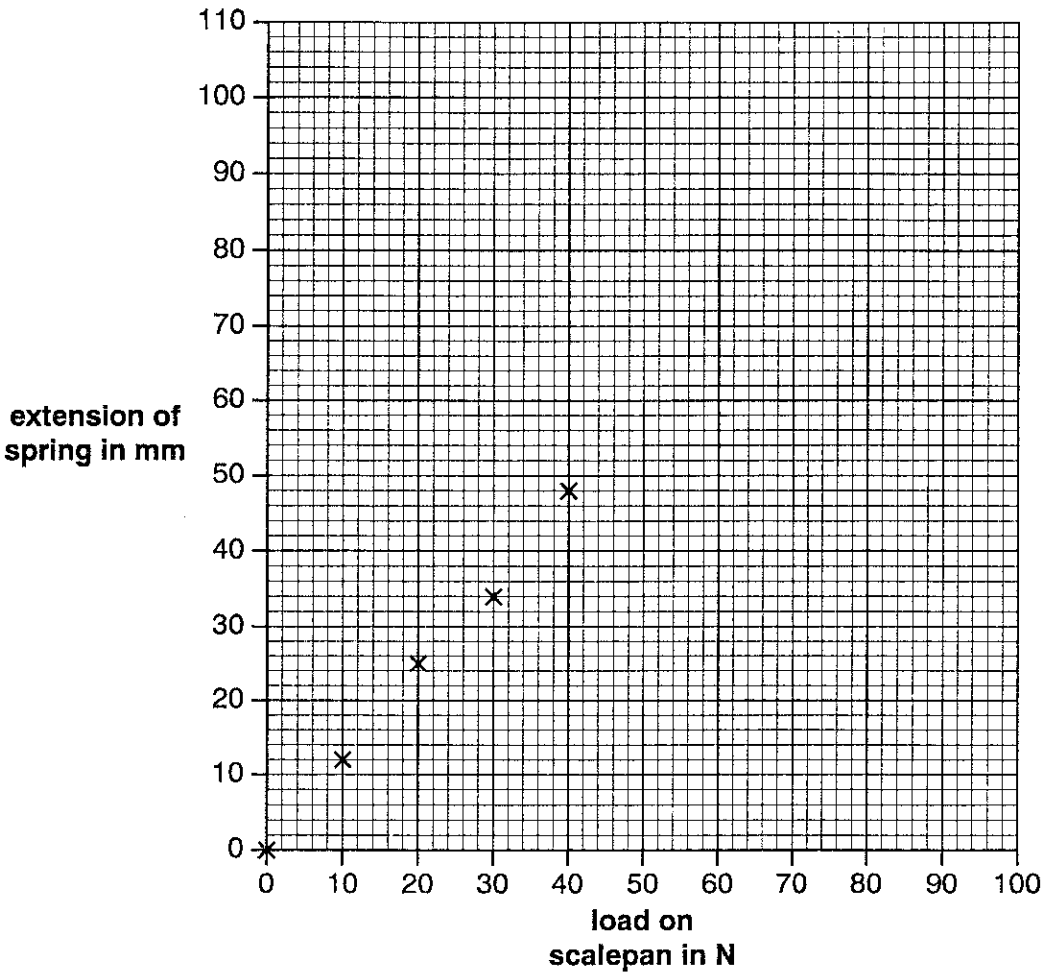
The first five have been done for you. [1]

(ii) Finish the graph by drawing the **best** straight line. [1]

(iii) Use your graph to find the load needed to stretch the spring by 65 mm.

You **must** show clearly, **on the graph**, how you get your answer.

load needed = _____ N [2]



(d) Look back at the diagram of the equipment Phil used.

The distance from the pivot to where the **spring** is attached is 12 cm.

The distance from the pivot to where the **scalepan** is attached is 90 cm.

Calculate the force on the **spring** caused by a load of 80 N in the scalepan.

Use the two equations below. You **must** show how you work out your answer.

moment of a force = force x perpendicular distance to pivot

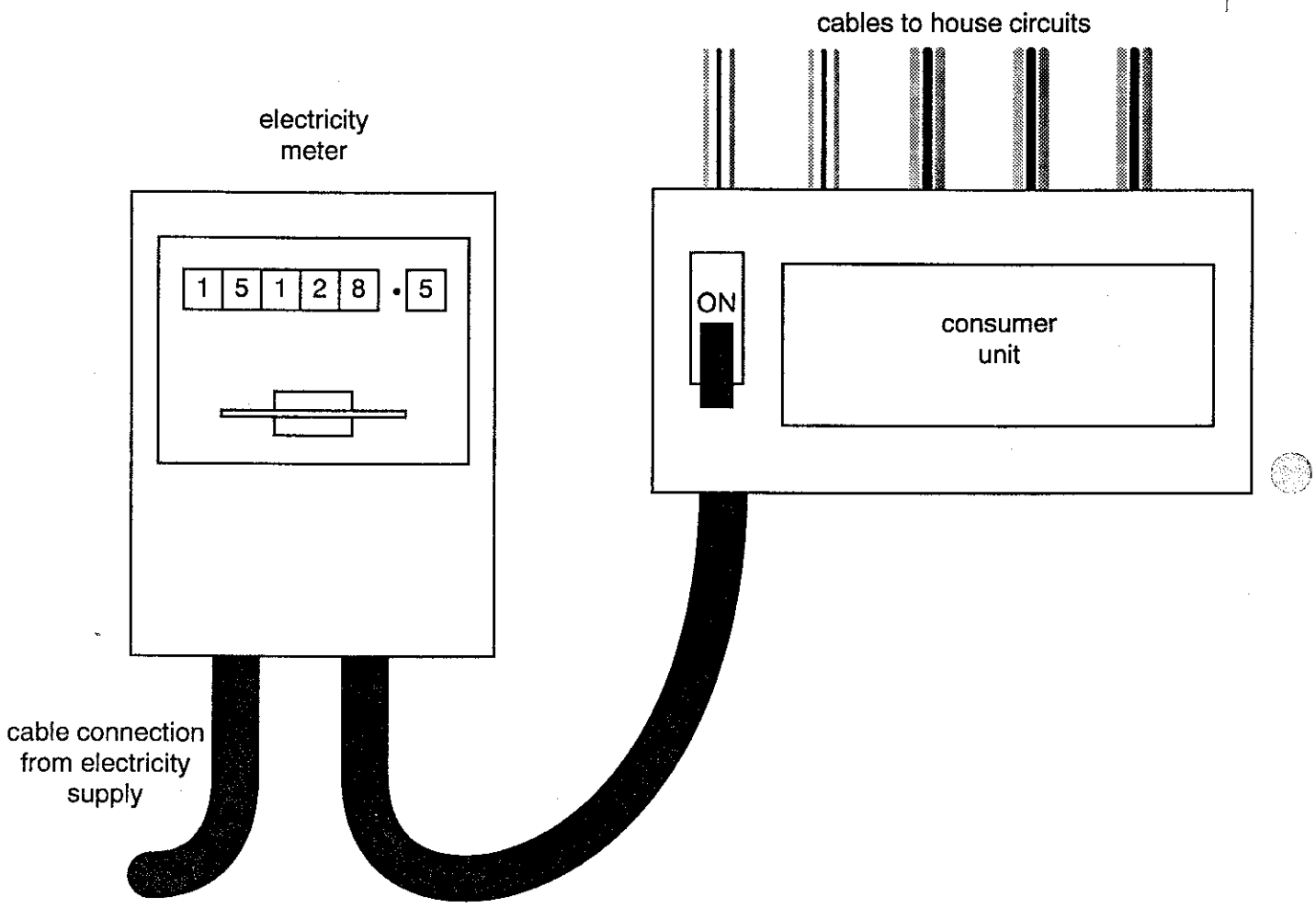
sum of clockwise moments = sum of anticlockwise moments

force on spring = _____ N [3]

For Examiner's Use

3 This question is about the supply of electricity to the home.

The diagram shows how the electricity supply is connected to the house circuits.



(a) An **alternating** current passes through the cables.

Use your knowledge of particles and how they move to describe this current.

1. Name of particles _____

2. How they move _____

_____ [2]

For Examiner's Use

(b) The circuit to the immersion heater has thicker wires than the lighting circuit.

Suggest why.

_____

_____

_____ [2]

(c) James writes down information about the appliances used in his home between 6 p.m. and 7 p.m.

This is what he wrote.

appliance	power rating in kW	time switched on in hours	energy used in kWh
fan heater	1.0	1.0	1.0
TV and video	0.1	1.0	
kettle	2.0	0.1	
water heater	3.5	0.2	
all lights	0.5	1.0	

(i) Finish the table by calculating the energy used by each appliance.

The first one has been done for you. [2]

(ii) Which appliance has cost the **most** to use between 6 p.m. and 7 p.m.?

_____ [1]

(iii) The meter reading was **15128.5** kWh at 6 p.m.

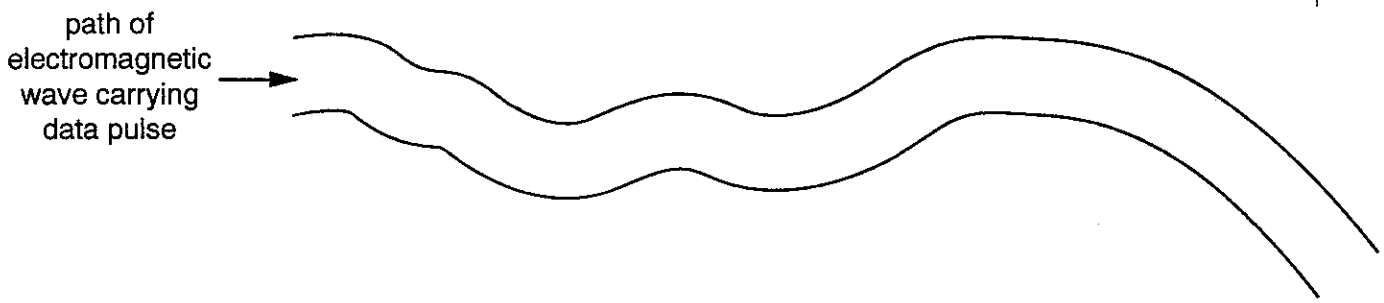
What is the new meter reading at 7 p.m.?

You **must** show how you work out your answer.

new meter reading _____ [2]

4 This question is about optical fibres.

(a) The diagram shows part of an optical fibre.



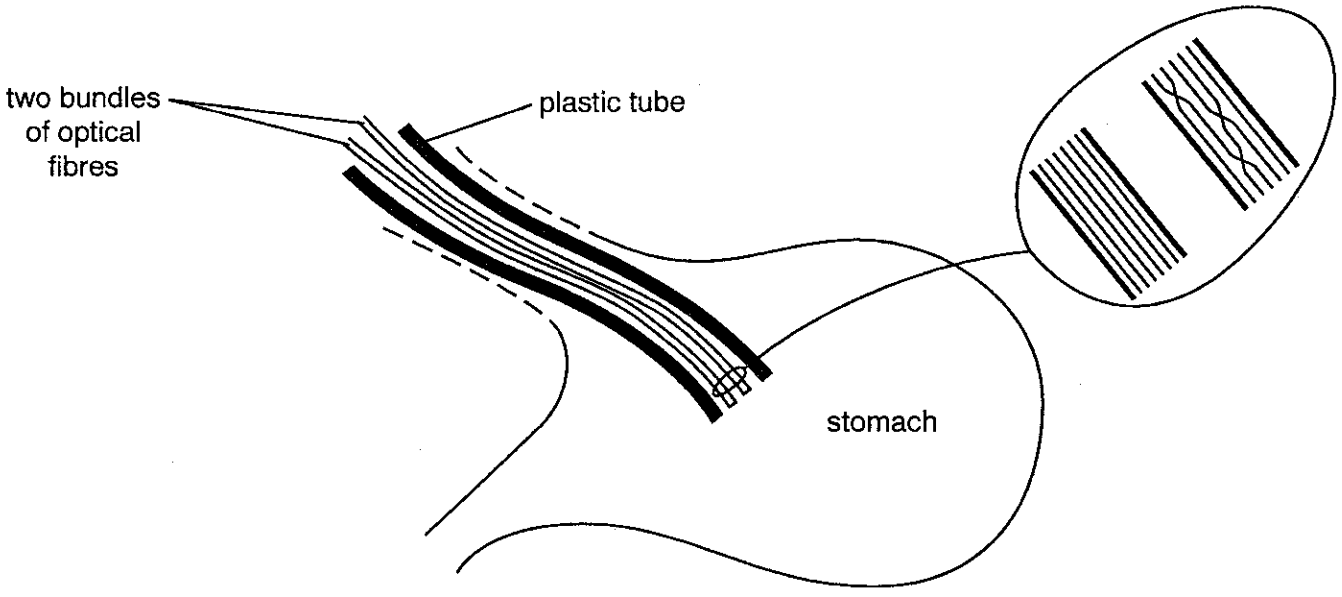
Describe and explain the path of the electromagnetic wave passing along the fibre.

You may add to the diagram or draw other diagrams to help your answer.

[3]

(b) Doctors use endoscopes (fibrescopes) to see inside a patient's stomach.

The diagram shows part of the endoscope. It shows **two** bundles of optical fibres inside a plastic tube.



(i) Explain why endoscopes must have **two** bundles of optical fibres.

[2]

(ii) The fibres in one of the bundles must be arranged in the same pattern at both ends. Explain why.

_____

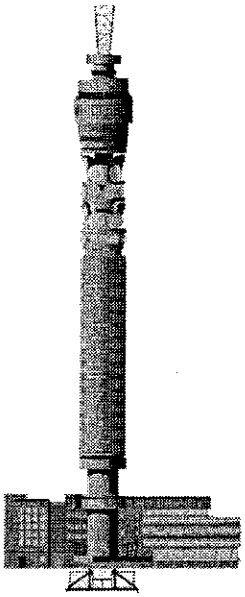
_____ [1]

(iii) How does using an endoscope help a doctor to study a patient's stomach?

_____

_____ [1]

5 This question is about telecommunications.



The BT (Telecom) Tower in London has many dishes which receive and transmit signals using microwaves.

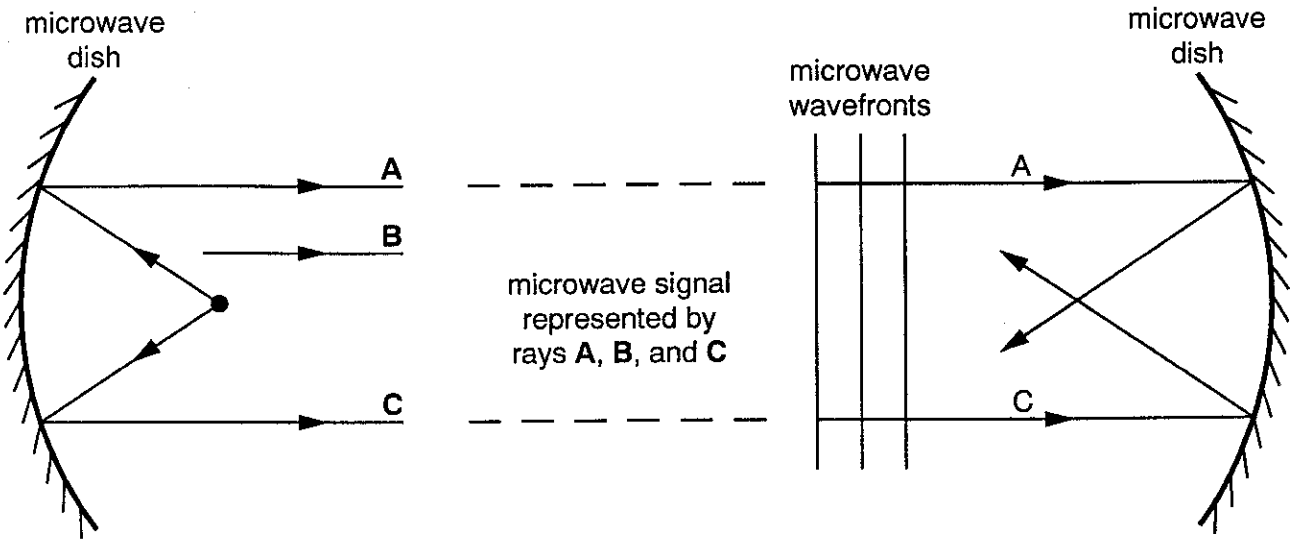
(a) The signal received from another transmitter is very weak.

Suggest a way of overcoming this problem.

_____

_____ [1]

(b) The diagram shows how two concave microwave dishes transmit and receive signals. The microwave signal is represented by rays **A**, **B** and **C**.



(i) Write a **T** on the diagram to show the **exact** position of the transmitter. [1]

(ii) Write an **R** on the diagram to show the **exact** position of the receiver. [1]

(iii) The paths taken by the rays **A** and **C** from the transmitter to the receiver are shown.

Part of the path of ray **B** is shown on the diagram.

Complete the path of ray **B** from the transmitter to the receiver. [2]

(iv) Three microwave wavefronts are shown on the diagram.

Draw on the diagram these three wavefronts after they have been reflected by the concave microwave dish. [3]

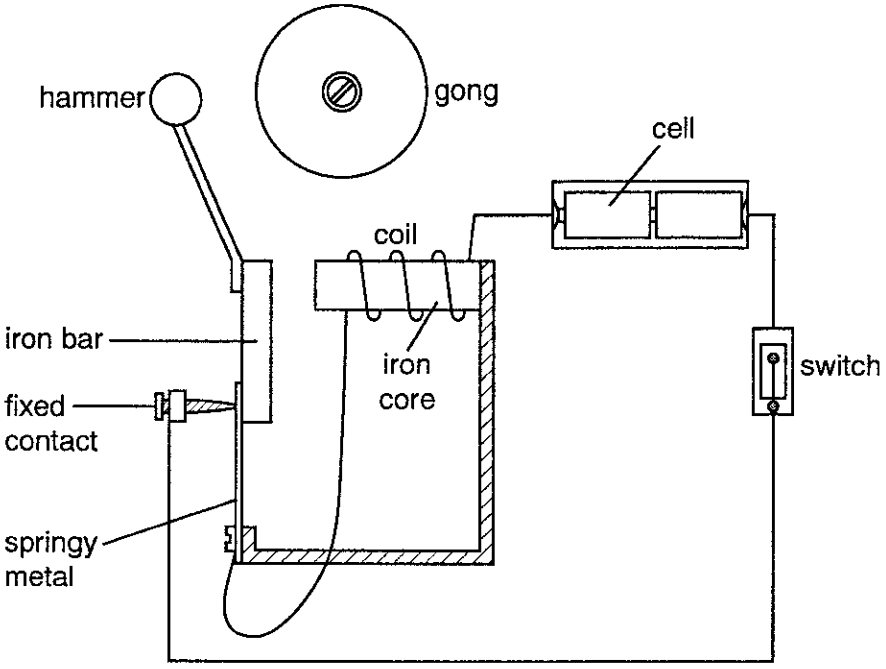
(c) Why are microwaves preferred to radiowaves for transmitting signals in **narrow beams**?

_____

_____ [2]

6 This question is about electromagnetism.

(a) Graham makes a simple electric bell.



He closes the switch.

(i) The hammer moves to the right and hits the gong.

Explain why.

_____

_____

_____ [2]

(ii) The hammer now moves back to the left.

Explain why.

_____

_____

_____ [2]

(b) Graham wants the hammer to hit the gong harder.

Alex says 'Why not replace the iron core with a permanent bar magnet?'

(i) Why is this **not** a good idea?

_____

_____

_____ [1]

(ii) Suggest **two** ways Graham could make the hammer hit the gong harder.

1. _____

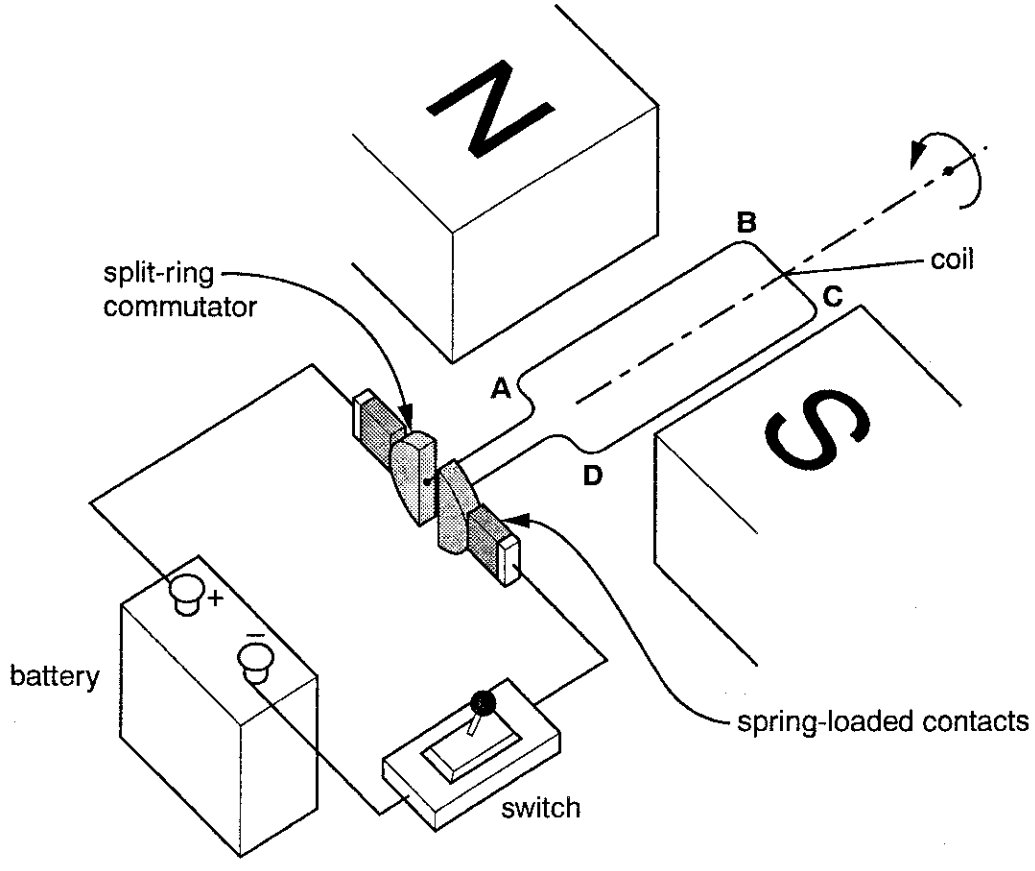
_____

2. _____

_____ [2]

(c) The diagram shows a simplified view of a model electric motor.

The coil is between the poles of a permanent magnet.



For Examiner's Use

When the switch is closed the coil **ABCD** starts to spin.

(i) Use your ideas about forces on conductors in magnetic fields to explain why it **starts** to spin.

Drawing on the diagram may help your answer.

_____

_____

_____

_____ [3]

(ii) What will happen if the battery terminals are reversed?

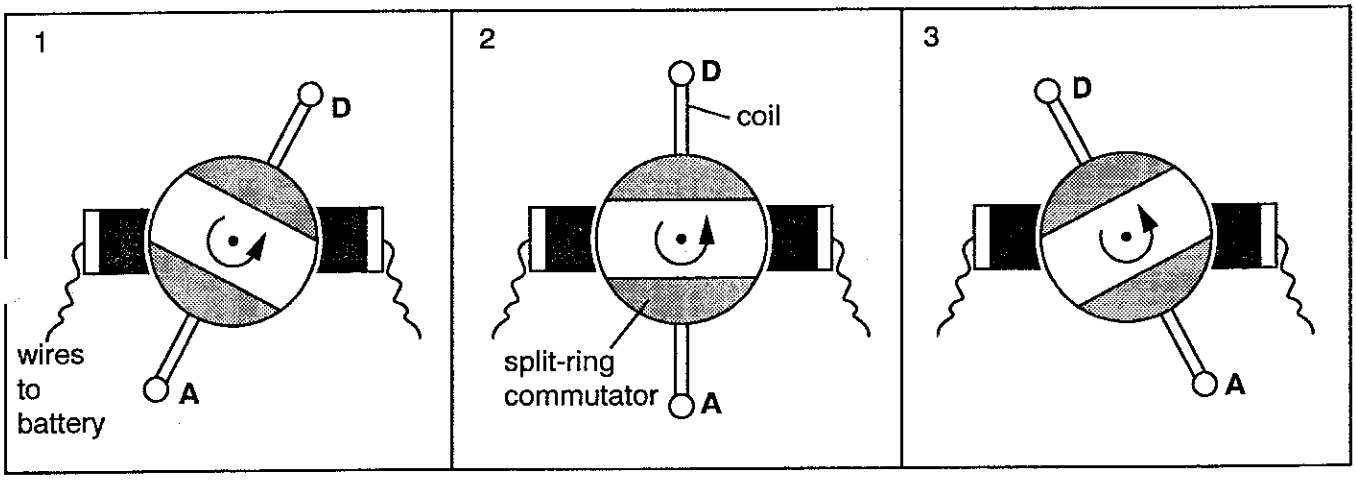
_____

Explain why.

_____

_____ [2]

(iii) The diagrams show the split-ring commutator as the coil of the motor spins through the vertical position.



Explain how the split-ring commutator allows the motor to **continue** to spin.

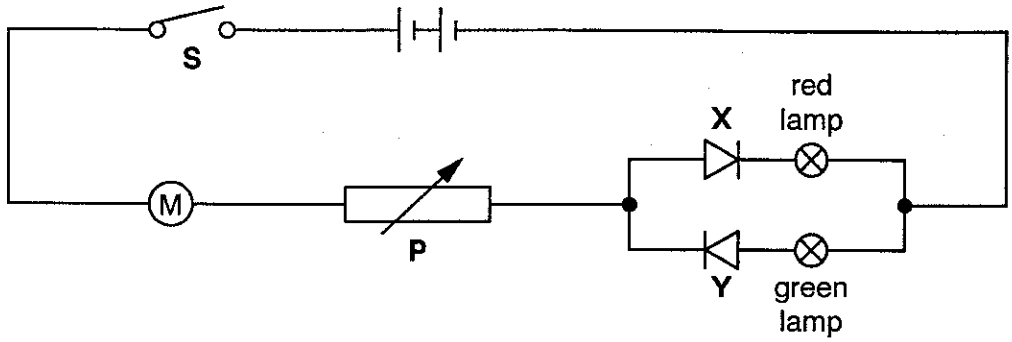
Drawing forces on the diagram may help your answer.

_____

_____

_____ [2]

7 Karen wires up this circuit.



(M) is the symbol for an electric motor.

(a) Karen closes **S**. She writes this down.

	• Motor spins
	• Red lamp is on
	• Green lamp is off

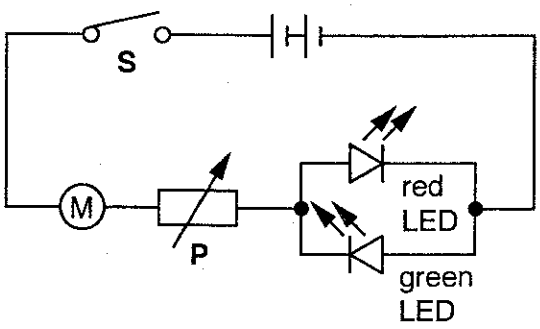
She now reduces the resistance of **P**. What observations will she make about the motor and the lamps now?

motor _____

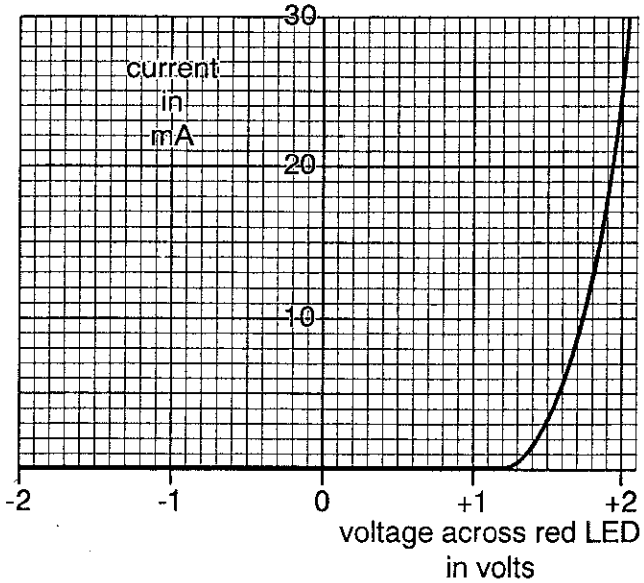
red lamp _____

green lamp _____ [3]

(b) She replaces **X** , **Y** and the lamps with red and green LEDs.



current-voltage graph for a red LED



The graph shows how current varies with voltage across a red LED.

The graph for a green LED is very similar.

(i) Use the graph to find the current through the red LED when the voltage across it is 1.6 V.

You **must** show clearly on the graph how you get your answer.

current = _____ mA [2]

(ii) Calculate the resistance of the red LED when the voltage across it is 1.6 V.

You **must** show how you work out your answer.

resistance = _____ unit _____ [4]

(iii) Use information from the graph to explain how the resistance changes as the voltage increases from zero to 2.0 V.

_____

_____

_____ [2]

(iv) When the voltage across the green LED is 2.0 V, the current through the motor is 25 mA.

Use the graph and your ideas about circuits to explain why.

_____

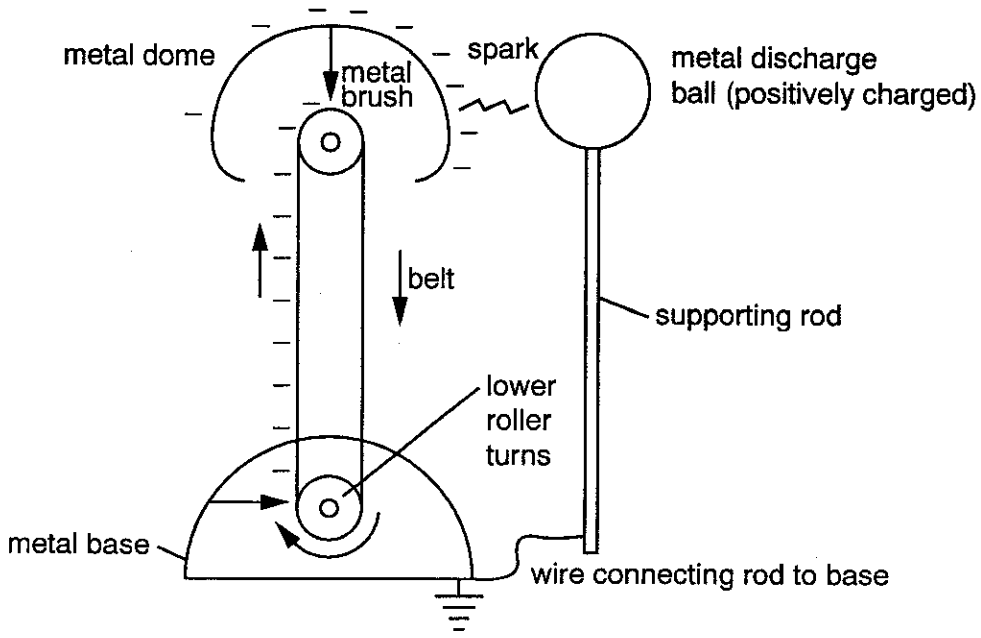
_____

_____

_____ [3]

8 This question is about static electricity.

Frances is using a Van de Graaff generator to make sparks.



The lower roller is turned.

Negative charge is carried by the belt up to the upper roller.

The negative charge is transferred by the brush to the metal dome.

(a) (i) The discharge ball becomes positively charged.

The supporting rod must be conducting for this to happen. Explain why.

_____

_____

_____ [2]

(ii) Write an **X** on the metal discharge ball to show where there is **most** positive charge. [1]

(b) A spark occurs when enough negative charge collects on the metal dome.

The air becomes conducting.

(i) Use your knowledge of particles and how they move to describe the current between the dome and the ball.

_____

_____

_____ [2]

(ii) 0.001 mC of charge is transferred in a spark. 90 mJ of energy is released.

Calculate the voltage between the dome and the ball which causes this transfer.

You **must** show how you work out your answer.

voltage = _____ V [3]

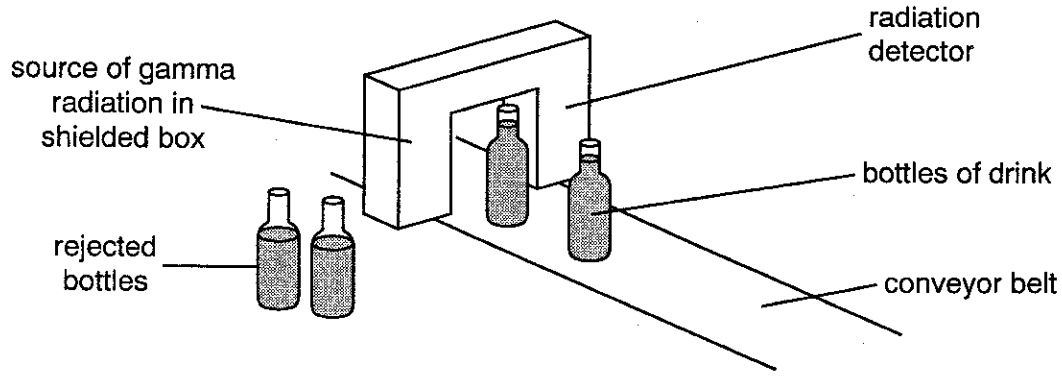
9 This question is about radioactivity and its uses.

Americium-241 ($^{241}_{95}$Am) is a radioactive material which emits gamma radiation.

A brewery uses Americium-241 in its bottling plant.

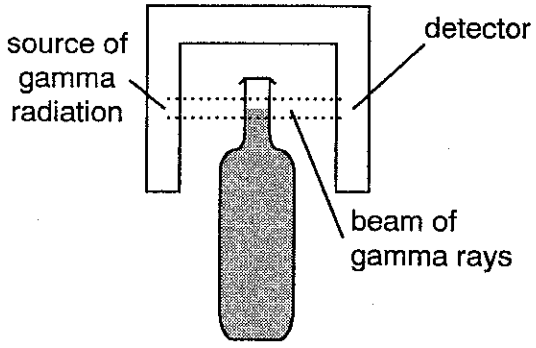
The diagram shows bottles of drink passing through a liquid level detector.

If the bottle is not full enough, the bottle is rejected.

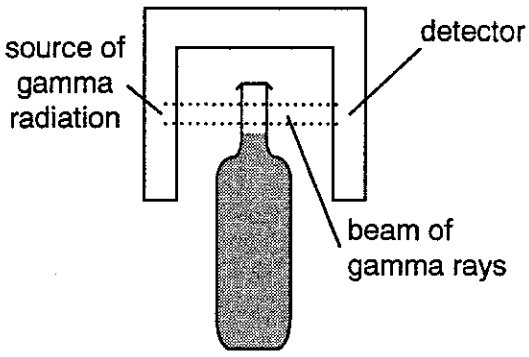


The gamma radiation passes through the bottle and its contents.

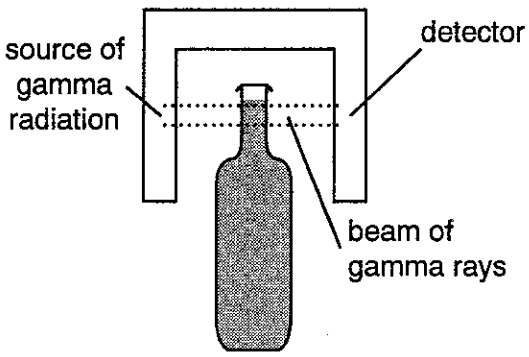
The radiation is detected on the other side.



bottle filled to correct level



bottle not full enough



bottle too full

(a) (i) For this process to work, all of the bottles must be accurately made to be the same thickness.

Suggest why.

_____

_____

_____

_____ [2]

(ii) Why is gamma radiation used instead of alpha radiation?

_____ [1]

(iii) Some modern bottling machines use ultrasound instead of gamma radiation to check the liquid level.

Suggest why ultrasound is used instead of gamma radiation.

_____

_____ [2]

For Examiner's Use

(b) Americium-241 has a half-life of 460 years.

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

_____

_____

_____ [1]

(ii) The machinery at the bottling plant is designed to last for twenty years.

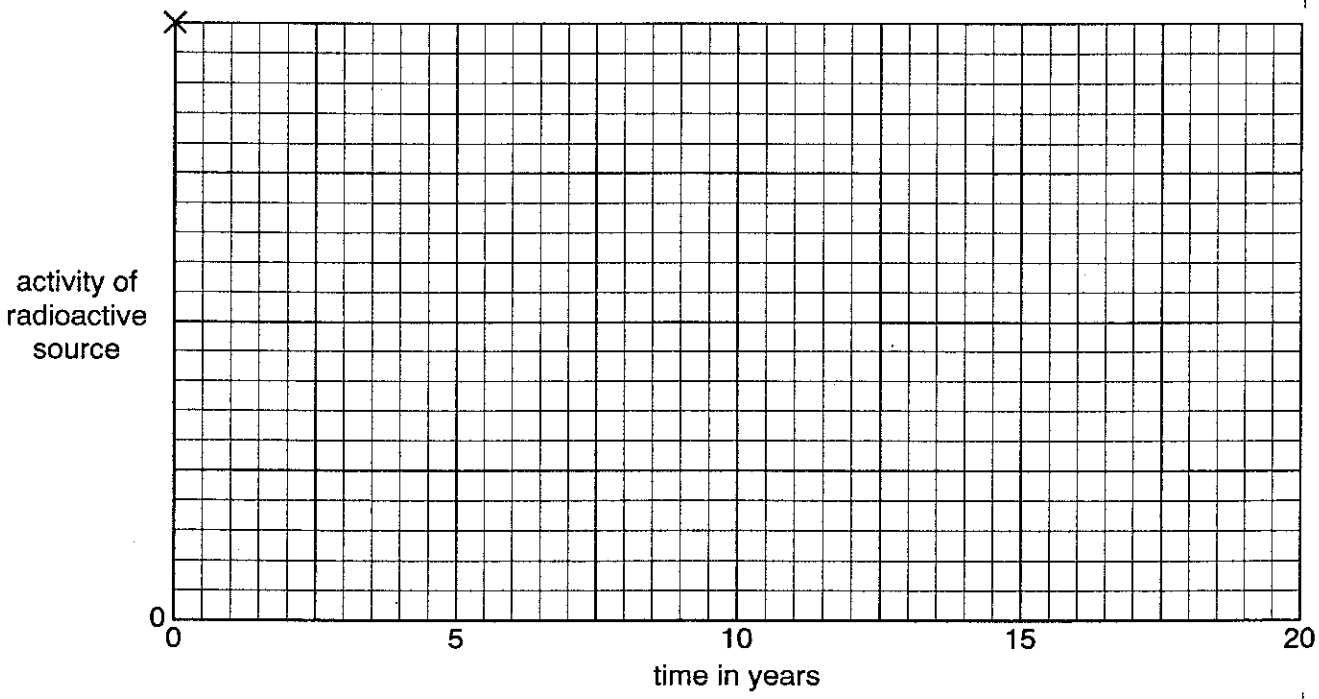
Cobalt-60 is another radioactive material used in industry which emits gamma radiation.

It has a half-life of 5 years.

Plot accurately on the grid the activity of the Cobalt-60 after 5, 10, 15 and 20 years.

The activity at the start has been marked for you (×).

Finish the graph by drawing the best line through the points. [3]



(iii) **Sketch** on the grid how the activity of the Americium-241 (half-life 460 years) changes during the twenty years.
Use the same starting point (×) as before.
Label your line **A**. [1]

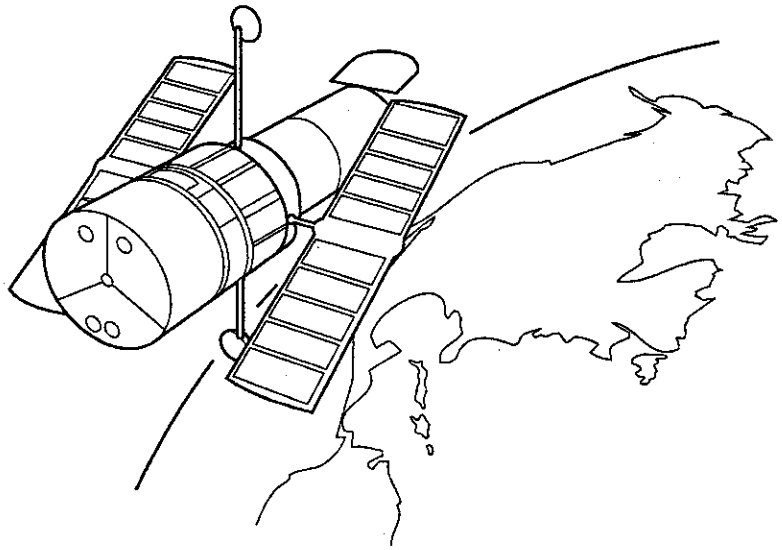
(iv) Use your graph to explain why Cobalt-60 is not a suitable radioactive source to use in the bottling plant.

_____

_____

_____ [2]

10 The Hubble Space Telescope orbits the Earth at a height of 600 km.



(a) Calculate the time it takes for a microwave signal to reach Earth from the satellite.

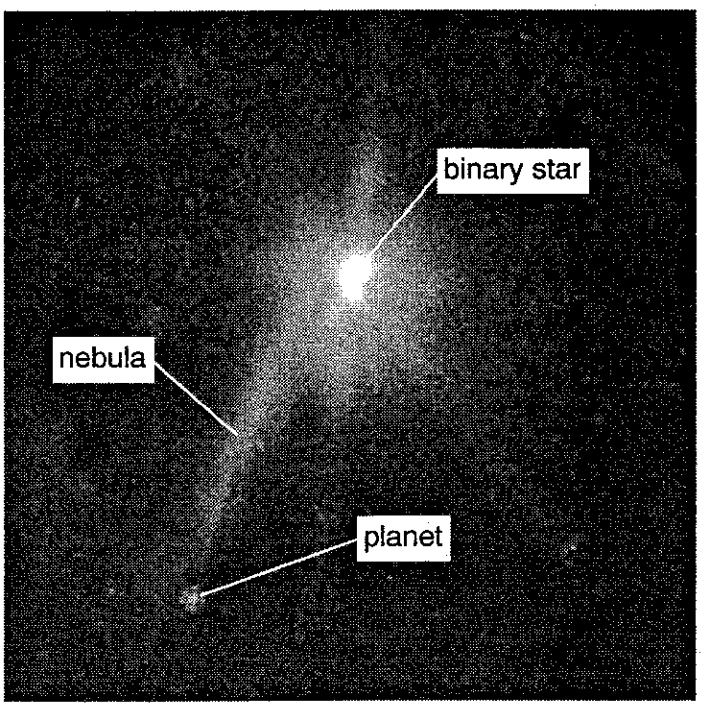
The speed of the microwave signal is 300 000 km/s.

You **must** show how you work out your answer.

time = _____ s [3]

(b) This picture was taken by the Hubble Space Telescope in August 1997.

It shows the birth of binary stars. These are a pair of stars which orbit around each other.



Read the following sentences from the NASA press release.

Then use them to help you answer the questions.

HUBBLE'S FIRST DIRECT LOOK AT POSSIBLE PLANET AROUND ANOTHER STAR

This NASA Hubble Telescope infra-red picture of new-born binary stars shows a long thin nebula pointing towards a faint object. This could be the first planet outside our solar system to be pictured directly.

The brightest objects in the picture are the binary stars. These illuminate a large cloud of gas and dust from which the stars formed. So much dust surrounds these stars that they are almost invisible at optical wavelengths. However, infra-red light penetrates the dust, revealing the new-born stars.

At the bottom left of the picture, there is a point of light many times fainter than the stars. Calculations show that this object is much too dim to be an ordinary star. The brightness of this object suggests it could be a hot planet several times the mass of Jupiter. The planet is 200 billion kilometres from the star (1400 times the Earth's distance from the Sun). A bright streak (nebula) stretches from the star towards the planet. This may suggest that the planet was ejected from the star system.

Present ideas predict that very young giant planets are still warm from being formed by gravitational contraction. Temperatures can be as high as a few thousand degrees Celsius. This makes them relatively bright in infra-red light compared with old giant planets such as Jupiter.

(i) The picture of the star system has been formed using infra-red light rather than visible light.

Use your knowledge of waves to explain the difference between infra-red light and visible light.

_____

_____ [1]

(ii) Why was visible light not used?

_____

_____ [1]

(c) Stars form from clouds of gas and dust. Explain how.

_____

_____ [1]

(d) Calculations show that the object referred to in line 9 is a planet rather than a star.

(i) What information about the planet in the passage supports this?

_____ [1]

(ii) Suggest what process **cannot** be occurring in the planet's core.

_____ [1]

(e) Why would you expect the acceleration due to gravity at the surface of the planet to be much greater than that on the surface of Jupiter?

_____ [1]

(f) What information in the passage suggests it will take many Earth years for the planet to orbit the binary stars?

_____ [1]