FOR OFFICIAL USE

Presenting Centre No.	Subject No.	Level	Paper No.	Group No.	Marker's No.
	3220				

C

K & U	PS

Total Marks

3220/145

SCOTTISH CERTIFICATE OF EDUCATION 1995

WEDNESDAY, 17 MAY
1.30 PM – 3.15 PM

PHYSICS
STANDARD GRADE
Credit Level

Fill in these boxes and read what is printed below.

Full name of school or college

Town

First name and initials

Surname

Date of birth
Day Month Year

Candidate number

Number of seat

1 All questions should be answered.

2 The questions may be answered in any order but all answers must be written clearly and legibly in this book.

3 Write your answer where indicated by the question or in the space provided after the question.

4 If you change your mind about your answer you may score it out and rewrite it in the space provided at the end of the answer book.

5 Before leaving the examination room you must give this book to the Invigilator. If you do not, you may lose all the marks for this paper.

6 Any necessary data will be found in the **data sheet** on page two.

SCOTTISH EXAMINATION BOARD

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	3000
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*	
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	$= 10^{-9}$

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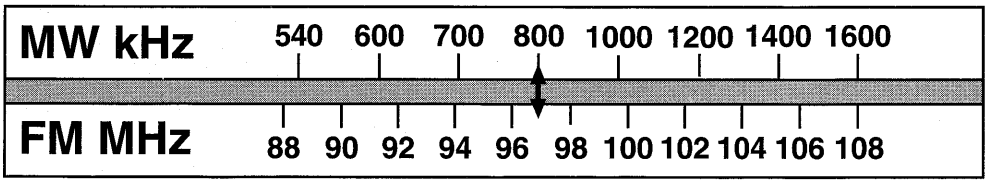
1. (*a*) The diagram below shows the display panel on a radio. The pointer on the display is set so that the radio is tuned to receive a medium wave (MW) broadcast from Radio X.



(i) On which frequency does Radio X broadcast?

..... **(1)**

(ii) Calculate the wavelength of the broadcast from Radio X.

Space for working and answer

(2)

[Turn over

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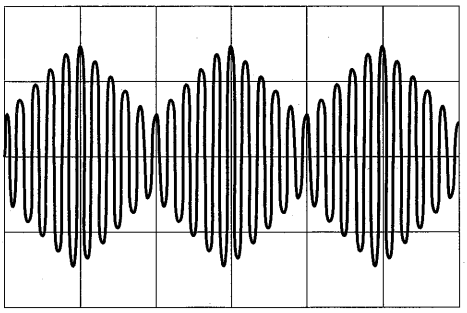
Marks

1. (continued)

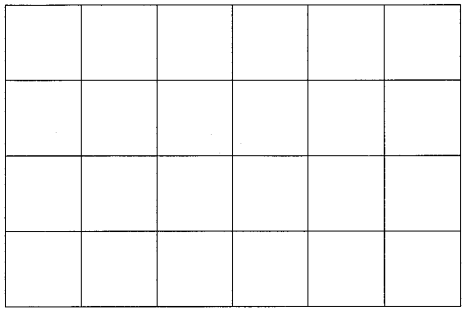
(*b*) An engineer is checking the operation of the transmitter of Radio X. A test audio signal is produced for transmission. The modulated electrical signal in the transmitter is displayed on an oscilloscope as shown in the diagram opposite.



Without adjusting the controls, the engineer uses the oscilloscope to display the traces of the three signals described in parts (i), (ii) and (iii) below.

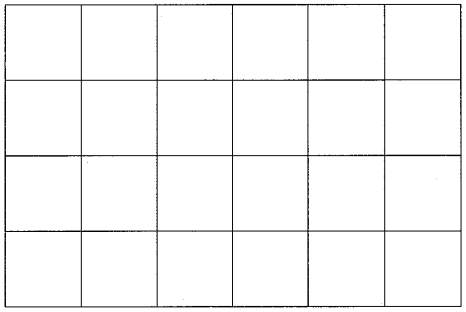
In the spaces provided, draw the trace which would be observed for each signal.

(i) The audio signal only is displayed.



(1)

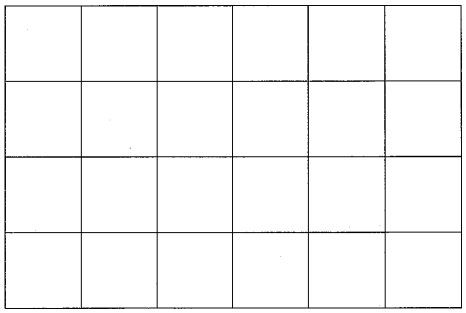
(ii) The unmodulated signal used to produce the radio carrier wave is now displayed.



(1)

(iii) Radio X can also broadcast on the Long Wave (LW) band. The same test audio signal is produced for transmission on LW.

The trace of this modulated signal is displayed.



(2)

(*c*) A person in a cottage, surrounded by hills, wishes to tune in to Radio X.

Which of the wavebands, LW or MW, is likely to provide the better reception? Explain your answer.

.....

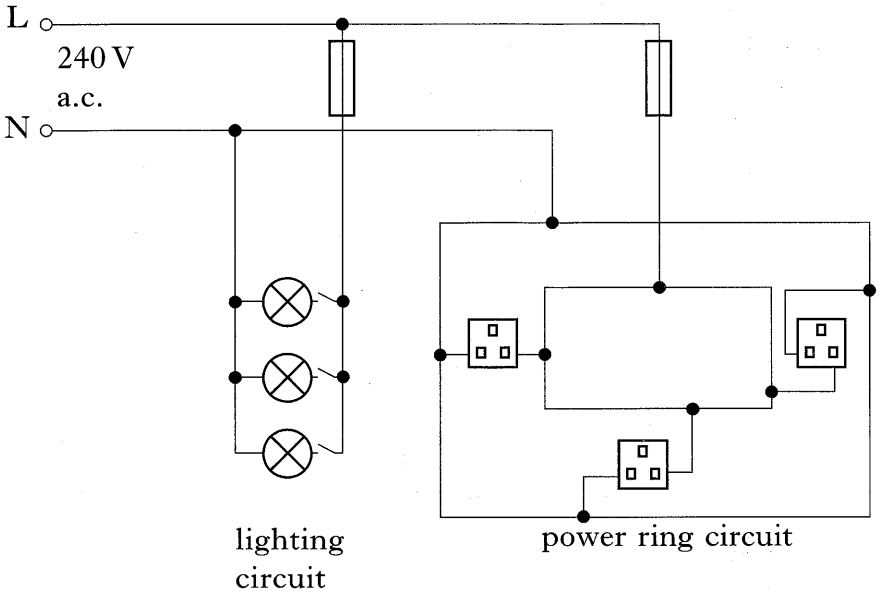
.....

.....

..... **(2)**

Marks

2. The diagram below shows one of the lighting circuits and one of the power ring circuits in a home. The earth wire is not shown in the diagram.



(*a*) In the lighting circuit, the lamps are connected in parallel.

(i) Give **one** advantage of connecting the lamps in parallel rather than in series.

.....

..... **(1)**

(ii) One lamp has a resistance of 900 Ω and each of the other two has a resistance of 600 Ω.

Calculate the resistance of the lighting circuit when all the lamps are switched on.

Space for working and answer

(2)

(*b*) State **one** advantage of connecting the power sockets in a ring circuit.

.....

..... **(1)**

Marks

2. (continued)

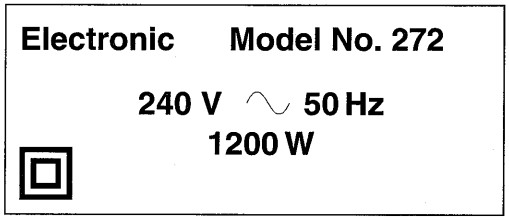
(*c*) The mains fuses protect the wiring in each circuit. A circuit breaker can be used instead of a fuse.

Give **one** reason why a circuit breaker may be preferred to a fuse.

.....

..... **(1)**

3. (*a*) A diagram of a rating plate on a hair drier is shown below.



(i) A suitable flex has to be connected to the hair drier.

(A) Which **one** of the following flexes, P, Q, R and S, is the most appropriate for connection to the hair drier?

Answer ☐ **(1)**

(B) Give **two** reasons for your choice in part (A).

Reason 1: .....

.....

Reason 2: .....

..... **(2)**

(ii) Calculate the resistance of the hair drier when operating at its stated rating.

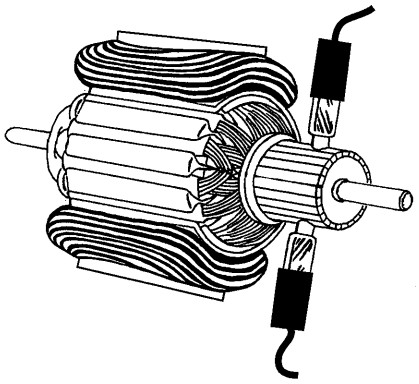
Space for working and answer

(3)

Marks

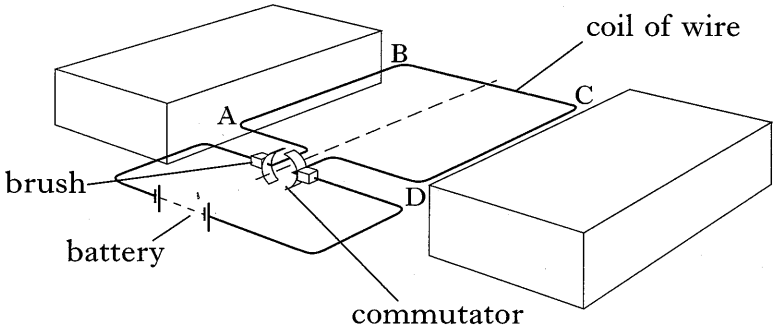
3. (*a*) (continued)

(iii) The hair drier has a fan which is driven by an electric motor. Parts of this motor are shown in the diagram below.



On the diagram, label the field coils. **(1)**

(*b*) A diagram of a simple d.c. electric motor is shown below.



(i) State what is used instead of field coils in this motor.

..... **(1)**

(ii) When there is a current in the coil, a downward force acts on part AB and an upward force on part CD.
What causes these forces to be in opposite directions?

.....

..... **(1)**

(iii) Describe how the commutator and the brushes allow the coil to keep spinning.

.....

.....

.....

..... **(2)**

Marks

4. A patient is examined to find out if his kidneys are working properly. A liquid containing some gamma emitting radioactive material is injected into the patient's bloodstream. This radioactive material and other impurities should be absorbed by the kidney and then passed to the patient's bladder. A gamma camera is used to detect the radiation coming from the patient's kidneys. The gamma camera produces images of the patient's left and right kidneys on a monitor as shown below.

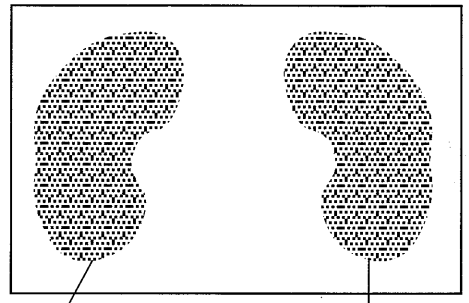


figure 1

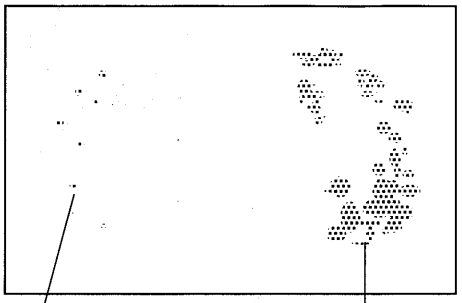


figure 2

Figure 1 shows the image produced 2 minutes after the injection and figure 2 shows the image 10 minutes after the injection.

(*a*) Which kidney is not working properly? Explain your answer.

.....

.....

.....

..... **(2)**

(*b*) The half-lives of four gamma emitters W, X, Y and Z are listed in the table below.

Gamma emitter	*Half life*
W	1 minute
X	5 minutes
Y	5 hours
Z	5 days

The examination of the patient lasts for 15 minutes.

Which one of the above gamma emitters would be most suitable for use in the examination?

..... **(1)**

K&U	PS

Marks

4. (continued)

(*c*) Alpha emitting materials are never injected into the body in order to obtain images of parts of the body.

State **two** reasons why alpha emitting materials are unsuitable.

Reason 1: .....

.....

Reason 2: .....

..... **(2)**

[Turn over

Marks

5. (*a*) X-ray machines, as shown in figure 1, are used to destroy cancerous tissue in the body of a patient. The X-rays produced by the machine reach the patient from different directions by rotating the machine around the patient's body.

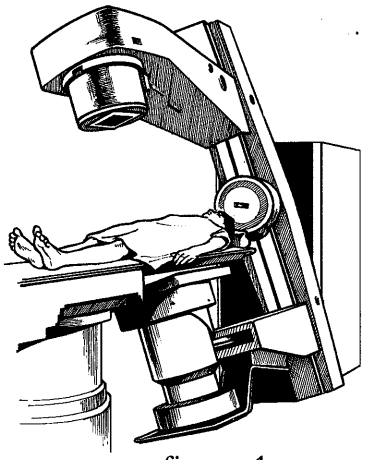


figure 1

In this treatment, the X-rays are not fired continuously in one direction. The different paths of the X-rays through the patient's body are shown in figure 2.

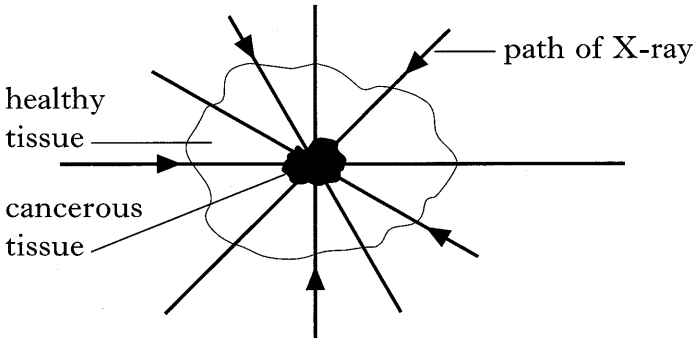


figure 2

(i) Explain why rotating the X-ray machine provides a safer way of ensuring that the cancerous tissue receives the maximum dose.

.....

.....

.....

..... **(2)**

(ii) Why is it important that the patient keeps still during the treatment?

.....

..... **(1)**

K&U	PS

Marks

5. (continued)

(*b*) After using the X-ray machine, an optical fibre is used to view the tissue inside the patient's body. Figure 3 shows the path of a ray of light as it passes along part of the optical fibre.

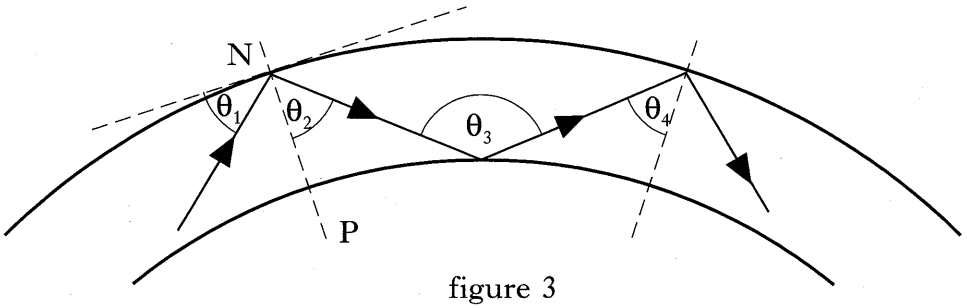


figure 3

(i) Which of the angles, θ_1, θ_2, θ_3, and θ_4, marked on the diagram, is an angle of incidence?

..... **(1)**

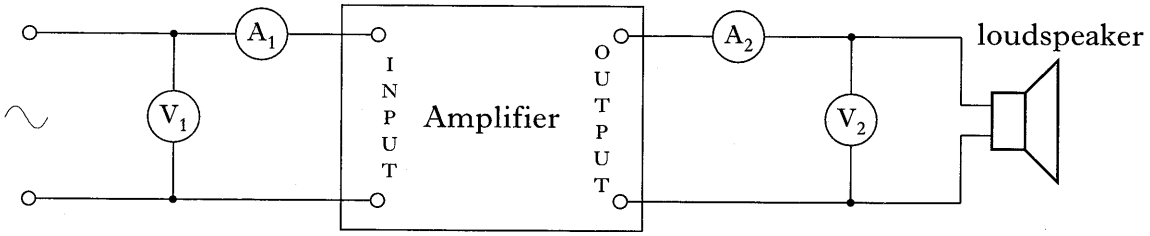
(ii) What name is given to the dotted line NP?

..... **(1)**

[Turn over

Marks

6. A student connects the following circuit in order to find the power gain of an amplifier.



The readings on the meters shown in the circuit diagram are given below.

Reading on V_1 =	**0·2 V**
Reading on A_1 =	**0·005 A**

Reading on V_2 =	**2·0 V**
Reading on A_2 =	**0·04 A**

(*a*) Calculate the power gain of the amplifier.

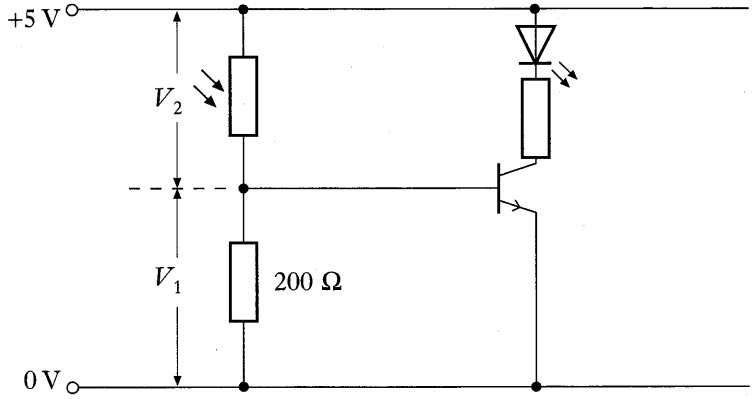
Space for working and answer

(3)

(*b*) The frequency of the input signal is 100 Hz.
What is the frequency of the output signal?

..... **(1)**

7. A pupil builds the following light detecting circuit to sense the level of brightness in a room.



V_1 is the input voltage to the transistor. The transistor switches fully on when V_1 rises above 0·7 V.

(*a*) Initially the level of brightness in the room is very low. At this brightness the resistance of the LDR is 1800 Ω and the LED is off.

(i) Calculate the value of the input voltage V_1.

Space for working and answer

(2)

(ii) What is the value of the voltage V_2 across the LDR?

Space for working and answer

(1)

(*b*) The pupil increases the brightness in the room.

(i) What happens to the resistance of the LDR?

..... **(1)**

(ii) State what happens to the values of V_2 and V_1.

.....

..... **(2)**

(iii) Explain why the LED lights up.

.....

.....

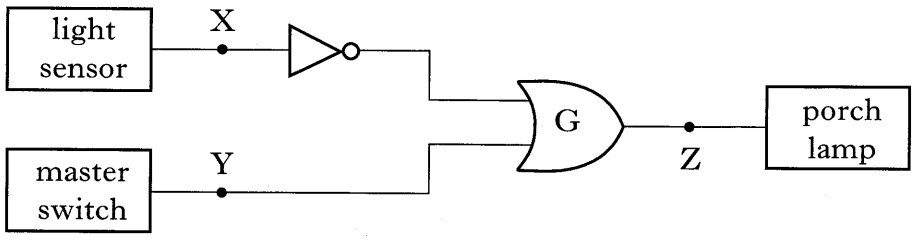
.....

..... **(2)**

K&U	PS

Marks

8. The Smith family want to install a porch lamp which will automatically switch on at night but only if a master switch is closed. The Smiths think that they can design a circuit which uses logic gates to solve the problem. Their first attempt at a design is shown in the diagram below.



When the light sensor goes from being in dark to being in light, the logic level at X changes from logic 0 to logic 1.

When the master switch is turned from off to on, the logic level at Y changes from logic 0 to logic 1.

(*a*) Name the logic gate G used by the Smiths in their design.

..... **(1)**

(*b*) Complete the truth table below to show the logic levels at Z in the above diagram.

X	Y	Z
0	0	
0	1	
1	0	
1	1	

(2)

(*c*) Give **one** reason why the Smiths' design is **not** suitable.

.....

..... **(1)**

(*d*) What alteration could you make to the design so that it will operate as required?

..... **(1)**

K&U	PS

Marks

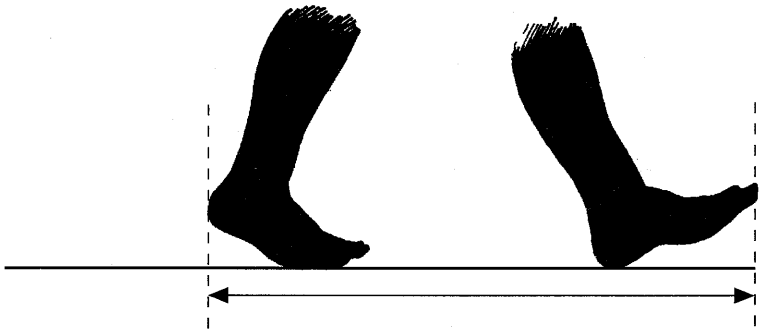
9. A keen walker bought a device called a pedometer to find out how far he walks during his journeys. The instructions ask him to measure the length of his step and enter this information into the pedometer. The pedometer detects and counts the number of steps taken and then uses the information which has been entered to calculate and display the distance walked.

(*a*) After walking for 30 minutes, the pedometer displays a distance of 2520 m. Calculate the walker's average speed, in **kilometres per hour**, during this time.

Space for working and answer

(2)

(*b*) In order to provide the information on the length of step which had to be entered into the pedometer, the walker measured his step from the back of his heel to the front of his toes as shown below.



During his journey, the walker did not change the length of his step. The actual distance walked was not 2520 m as displayed on the pedometer.

State whether the actual distance walked was greater or smaller than 2520 m. Explain your answer.

.....

.....

.....

..... **(2)**

(*c*) What changes would you make to the measurement so that the information entered into the pedometer would allow it to record the actual distance walked?

.....

..... **(1)**

Marks

10. Competitors are taking part in a bobsleigh competition.

(*a*) Figure 1 shows the bobsleigh at point X near the end of its run.

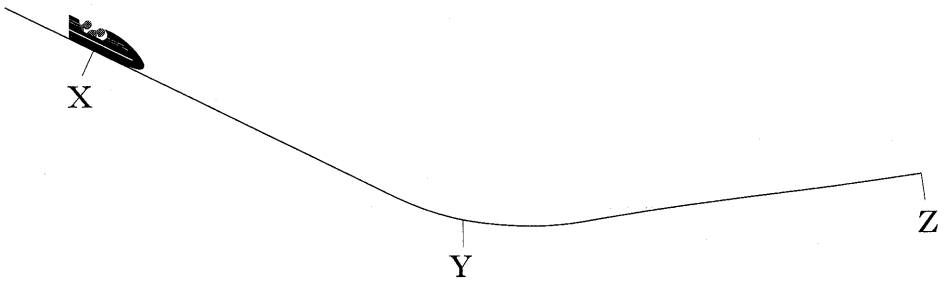


figure 1

When the bobsleigh reaches point Y, the brakes are applied until it comes to rest at point Z.

The speed–time graph of the motion of the bobsleigh from point X to point Z is shown in figure 2.

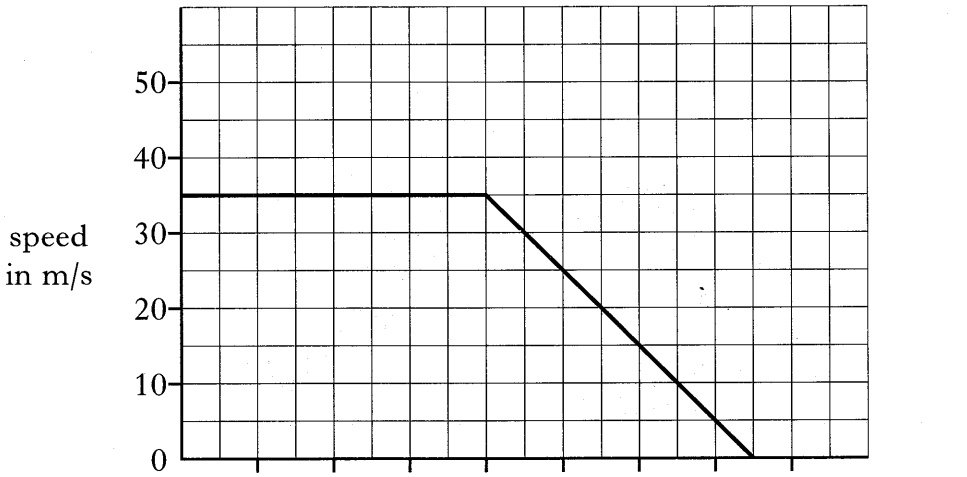


figure 2

(i) What time did the bobsleigh take to travel from X to Y?

(1)

.....

(ii) What was the distance travelled by the bobsleigh from point X until it came to rest?

Space for working and answer

(3)

K&U	PS

Marks

10. (*a*) (continued)

(iii) Calculate the deceleration of the bobsleigh between Y and Z.

Space for working and answer

(2)

(iv) The competitors and the bobsleigh have a total mass of 380 kg.
Calculate the force causing the deceleration of the competitors and bobsleigh.

Space for working and answer

(2)

[Turn over

Marks

10. (continued)

(*b*) At the start of a run, at point A in figure 3, both competitors push the empty bobsleigh. At point B, one of the competitors jumps in while the other keeps pushing. At point C, the second competitor jumps in.

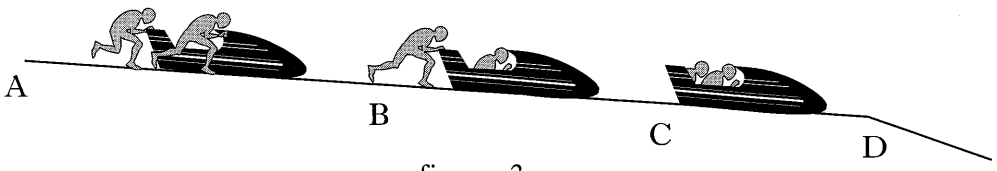


figure 3

The speed–time graph of the motion of the bobsleigh from A to C is shown in figure 4.

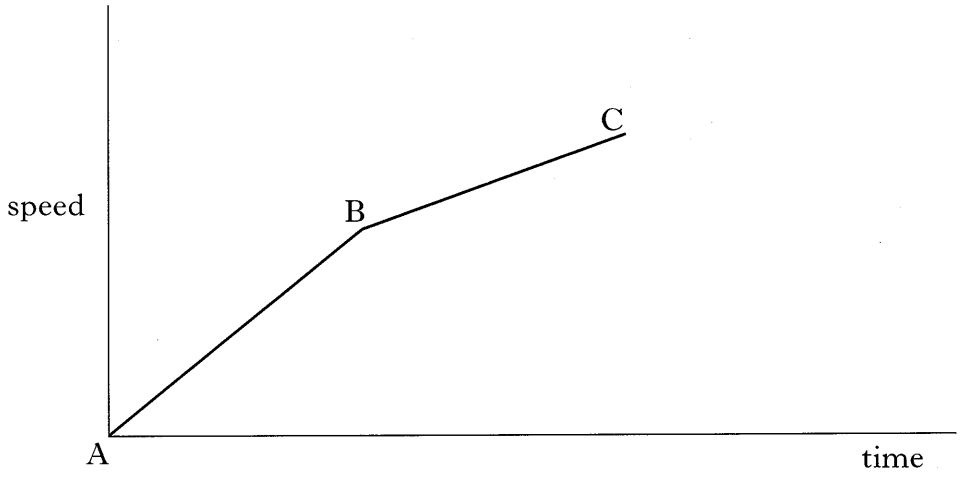


figure 4

(i) Give **two** reasons, in terms of Newton's laws, for the change in the acceleration of the bobsleigh between AB and BC.

Reason 1: .....

.....

Reason 2: .....

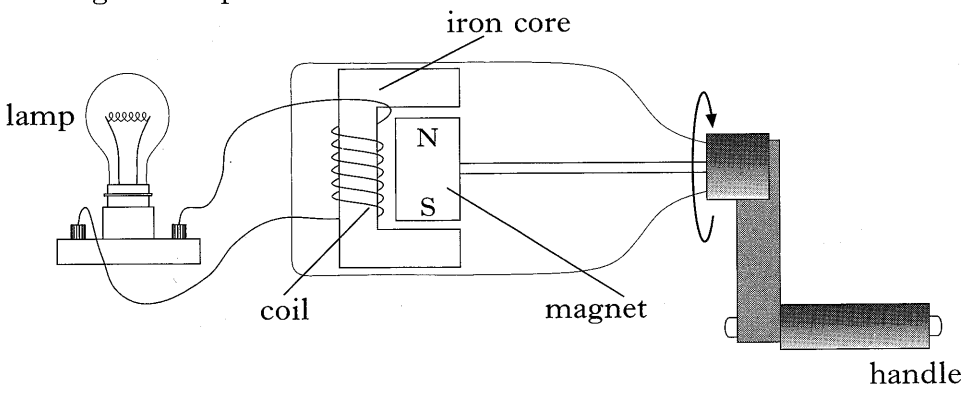
..... **(2)**

(ii) Complete the graph in figure 4 to show how the speed varies with time between **C** and **D** when both competitors are in the bobsleigh. **(1)**

K&U	PS

Marks

11. (*a*) The diagram below shows a simple hand operated generator which is used to light a lamp.



(i) Explain why a voltage is induced across the coil of the generator when the handle is turned.

.....

..... **(1)**

(ii) The induced voltage increases when the handle is rotated faster.
State **two** changes which could be made to the **design** of the generator which would also produce a larger induced voltage.

Change 1: .....

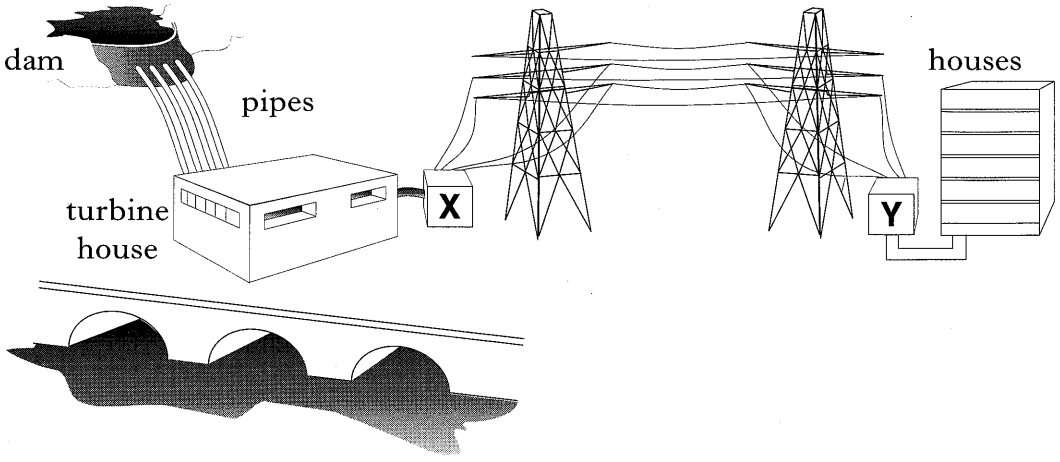
Change 2: ..... **(2)**

[Turn over

Marks

11. (continued)

(*b*) A power station generates electricity by using large a.c. generators. Electricity from the power station is transmitted across country using the National Grid system. Parts of this system are shown in the diagram below.



(i) Name the parts labelled **X** and **Y** and describe the purpose of each.

Part **X**: .....

.....

Part **Y**: .....

..... **(2)**

(ii) A power line in the system has a resistance of 2 Ω for every kilometre length. The power line is 100 km long and carries a current of 200 A.

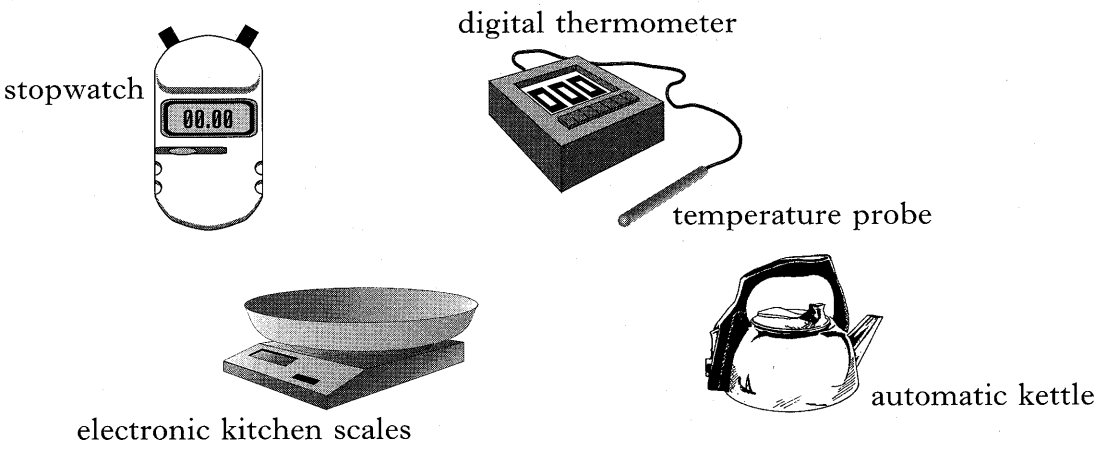
Calculate the electrical power loss in the line.

Space for working and answer

(3)

Marks

12. Marion decides to show her father that she can measure the power of their automatic kettle. She makes use of the equipment shown below.



She measures accurately the mass of some water using electronic kitchen scales and reads the initial temperature of the water using a digital thermometer. All of the water is poured into the kettle and when the kettle is switched on she starts a stopwatch. The water temperature gradually increases and eventually, after the water has been boiling for a short time, the kettle switches off automatically. Marion stops the stopwatch at this point.

Marion's measurements are listed below.

Mass of water	=	*1·52* kg
Initial temperature of water	=	*19·5* °C
Time for which kettle was switched on	=	*325* s

(*a*) Calculate the amount of heat supplied to raise the water temperature to 100 °C.

Space for working and answer

(3)

(*b*) Use the answer to part (*a*) to estimate the power of the kettle.
(Use an appropriate number of figures in your answer.)

Space for working and answer

(2)

K&U	PS

Marks

12. (continued)

(*c*) The rating plate on the kettle indicates that the power rating is 2 kW. Errors in Marion's experimental method cause the calculated value of the power to be different from that shown on the rating plate. One of these errors is due to heat being lost from the water.

(i) Describe **one** other source of error in Marion's method.

.....

..... **(1)**

(ii) How could you improve her method so that this other error is reduced?

.....

.....

.....

..... **(1)**

(*d*) Later, the kettle is switched on again but by mistake the lid is left off. The water reaches boiling point but the autoswitch does not switch off.

If there were no heat losses, how much heat energy would be required to vaporise 0·1 kg of water?

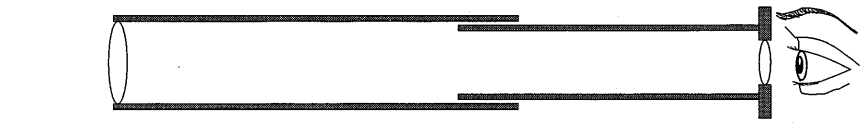
(Specific latent heat of vaporisation of water = $22{\cdot}6 \times 10^5$ J/kg)

Space for working and answer

(2)

Marks

13. (*a*) A telescope may be used to look at distant objects such as stars. A simple refracting telescope is shown below.



(i) A pupil replaces the objective lens in the telescope by one of identical focal length but having a smaller diameter as shown below.

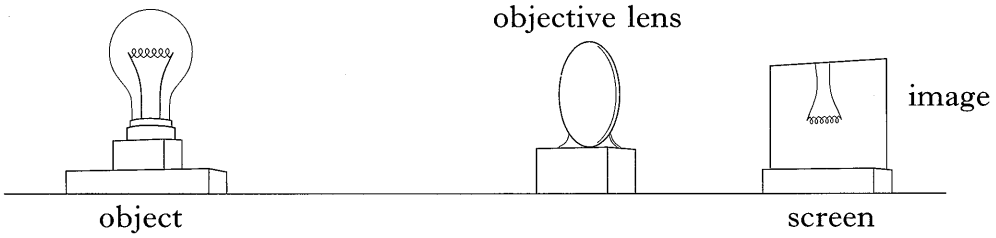
Explain the effect this has on the image of the object seen through the telescope.

.....

.....

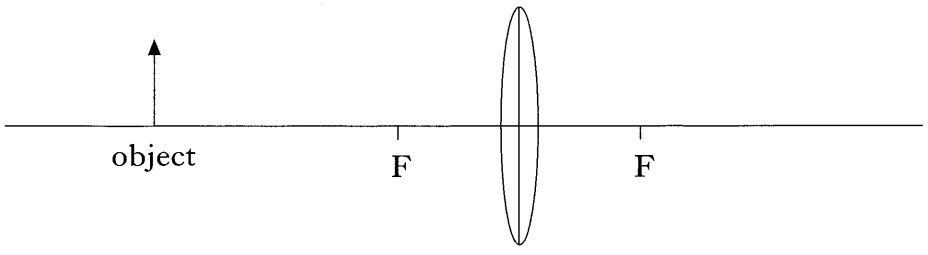
..... **(2)**

(ii) The pupil removes the objective lens from the telescope and uses it to produce an image of an object on a screen.



Complete the diagram below to show how the lens forms an image of the object. Clearly show the position of this image on your diagram.

The points marked F are one focal length from the centre of the lens.

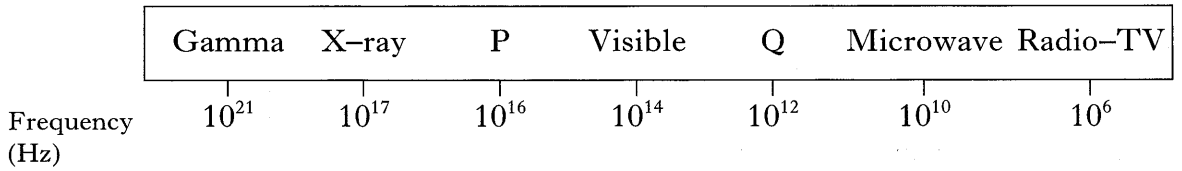


(3)

Marks

13. (continued)

(*b*) The radiation emitted by a star forms part of the electromagnetic spectrum. Part of the electromagnetic spectrum is shown below. Two radiations, P and Q, have not been named.



(i) Name each of the radiations P and Q.

Radiation P: .....

Radiation Q: ..... **(1)**

(ii) One type of radiation in the electromagnetic spectrum has a wavelength of 300 m.

Using information from the data sheet and the electromagnetic spectrum above, determine the name of this radiation.

You **must** show clearly the calculation you used to arrive at your conclusion.

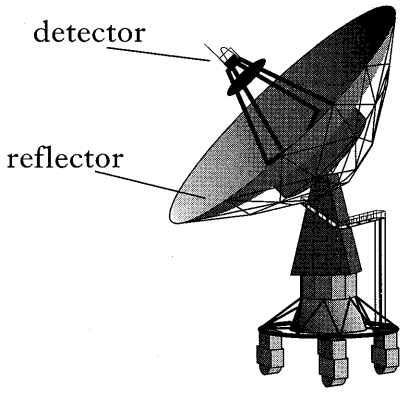
Space for working and answer

(3)

Marks

13. (continued)

(*c*) Radio waves emitted by stars can be detected on Earth using a radio telescope similar to that shown below.



Describe how the curved reflector and the position of the detector on the radio telescope ensure that a strong signal is picked up.

.....

.....

.....

..... **(2)**

14. (*a*) A meteor is a rock which travels through space.

One particular meteor is travelling through space at a speed of 70 000 m/s. The mass of the meteor is 2 kg.

Calculate its kinetic energy.

Space for working and answer

(2)

(*b*) While the meteor travels through space, it is not normally seen from Earth by the naked eye. If, by chance, the meteor enters the Earth's atmosphere, it may be seen as a bright streak of light in the night sky.

Explain why the meteor appears as a streak of light.

.....

.....

..... **(2)**

[END OF QUESTION PAPER]

K&U	PS

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