

X069/201

NATIONAL
QUALIFICATIONS
2004

FRIDAY, 28 MAY
1.00 PM – 3.00 PM

PHYSICS
INTERMEDIATE 2

Read Carefully

- 1 All questions should be attempted.

Section A (questions 1 to 20)

- 2 Check that the answer sheet is for Physics Intermediate 2 (Section A).
- 3 Answer the questions numbered 1 to 20 on the answer sheet provided.
- 4 Fill in the details required on the answer sheet.
- 5 Rough working, if required, should be done only on this question paper, or on the first two pages of the answer book provided—not on the answer sheet.
- 6 For each of the questions 1 to 20 there is only **one** correct answer and each is worth 1 mark.
- 7 Instructions as to how to record your answers to questions 1–20 are given on page two.

Section B (questions 21 to 31)

- 8 Answer the questions numbered 21 to 31 in the answer book provided.
- 9 Fill in the details on the front of the answer book.
- 10 Enter the question number clearly in the margin of the answer book beside each of your answers to questions 21 to 31.
- 11 Care should be taken to give an appropriate number of significant figures in the final answers to calculations.



SECTION A

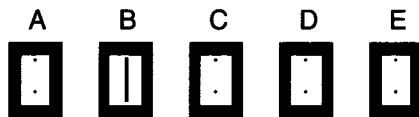
For questions 1 to 20 in this section of the paper, an answer is recorded on the answer sheet by indicating the choice A, B, C, D or E by a stroke made in ink in the appropriate box of the answer sheet—see the example below.

EXAMPLE

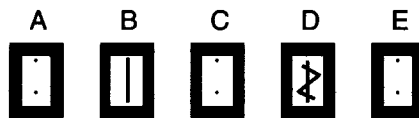
The energy unit measured by the electricity meter in your home is the

- A ampere
- B kilowatt-hour
- C watt
- D coulomb
- E volt.

The correct answer to the question is B—kilowatt-hour. Record your answer by drawing a heavy vertical line joining the two dots in the appropriate box on your answer sheet in the column of boxes headed B. The entry on your answer sheet would now look like this:



If after you have recorded your answer you decide that you have made an error and wish to make a change, you should cancel the original answer and put a vertical stroke in the box you now consider to be correct. Thus, if you want to change an answer D to an answer B, your answer sheet would look like this:



If you want to change back to an answer which has already been scored out, you should enter a tick (✓) to the RIGHT of the box of your choice, thus:



SECTION A

Answer questions 1–20 on the answer sheet.

1. Which of the following shows two physical quantities that have the same unit?

- A Potential energy and work done
- B Momentum and kinetic energy
- C Potential energy and momentum
- D Force and work done
- E Force and mass

2. Near the Earth a mass of 4 kg is falling with a constant velocity.

The air resistance force and the unbalanced force acting on the mass are

	<i>Air resistance force</i>	<i>Unbalanced force</i>
A	10 N upwards	10 N downwards
B	10 N downwards	50 N downwards
C	40 N upwards	0 N
D	40 N upwards	40 N downwards
E	10 N upwards	0 N

3. The table gives information about the velocities of three objects **X**, **Y** and **Z** for a time interval of 3 seconds. Each object is moving in a straight line.

<i>Time (s)</i>	0	1	2	3
<i>Velocity of X (m/s)</i>	2	4	6	8
<i>Velocity of Y (m/s)</i>	0	1	2	3
<i>Velocity of Z (m/s)</i>	0	2	5	9

Which of the following statements is/are correct?

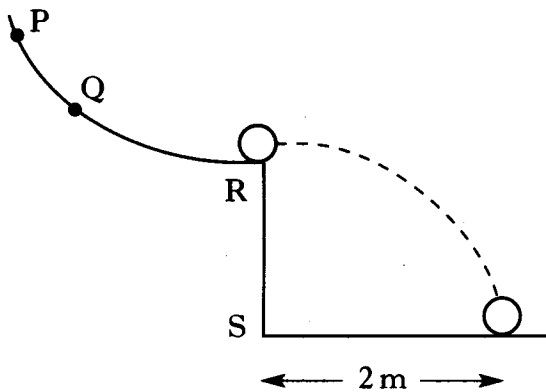
- I X moves with constant velocity.
 - II Y moves with constant acceleration.
 - III Z moves with constant acceleration.
- A I only
 - B II only
 - C I and II only
 - D I and III only
 - E II and III only

4. A mass of 1 kg is pulled along a level bench by a horizontal force of 10 N. The acceleration of the mass is 4 m/s^2 . The frictional force opposing the motion is

- A 0.25 N
- B 0.40 N
- C 2.5 N
- D 4 N
- E 6 N.

[Turn over

5. A ball is released from point **Q** on a curved rail, leaves the rail horizontally at **R** and lands 1 s later.



The ball is now released from point **P**.

Which row describes the motion of the ball after leaving the rail?

	<i>Time to land after leaving rail</i>	<i>Distance from S to landing point</i>
A	1 s	less than 2 m
B	less than 1 s	more than 2 m
C	1 s	more than 2 m
D	less than 1 s	2 m
E	more than 1 s	more than 2 m

6. A student makes the following three statements.

- I Momentum is lost in all collisions.
 II Momentum is mass times velocity.
 III Momentum is a vector quantity.

Which of these statements is/are correct?

- A I only
 B I and II only
 C I and III only
 D II and III only
 E I, II and III

7. Information about water is shown below.

Specific latent heat of fusion
 $= 3.34 \times 10^5 \text{ J/kg}$

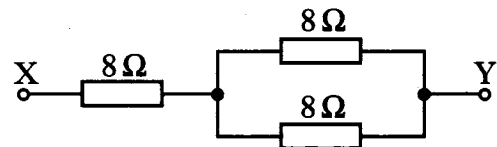
Specific heat capacity
 $= 4.18 \times 10^3 \text{ J/kg}^\circ\text{C}$

Specific latent heat of vaporisation
 $= 2.26 \times 10^6 \text{ J/kg}$

The heat energy required to turn 0.25 kg of water at 100°C into steam at 100°C is

- A $0.25 \times 3.34 \times 10^5 \text{ J}$
 B $0.25 \times 4.18 \times 10^3 \text{ J}$
 C $4.18 \times 10^3 \times 0.25 \times 100 \text{ J}$
 D $2.26 \times 10^6 \times 0.25 \times 100 \text{ J}$
 E $0.25 \times 2.26 \times 10^6 \text{ J}$.

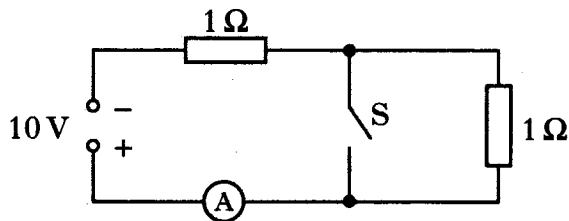
8. Three resistors are connected as shown.



The total resistance between X and Y is

- A 4Ω
 B 8Ω
 C 12Ω
 D 16Ω
 E 24Ω .

9. In the circuit shown, switch S is initially open.

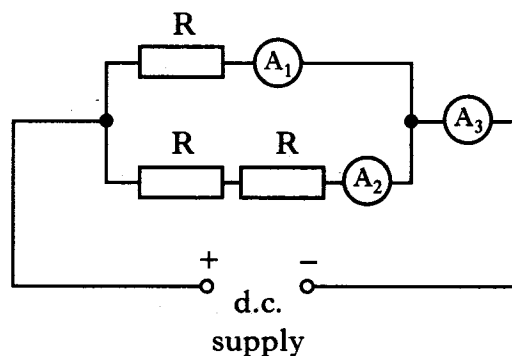


Switch S is now closed.

Which row in the table shows the current with S open and the current with S closed?

	<i>Current with S open</i>	<i>Current with S closed</i>
A	0.1 A	0.2 A
B	0.2 A	0.1 A
C	5 A	2.5 A
D	5 A	10 A
E	10 A	5 A

10. Three identical resistors are connected with three ammeters to a d.c. supply as shown.

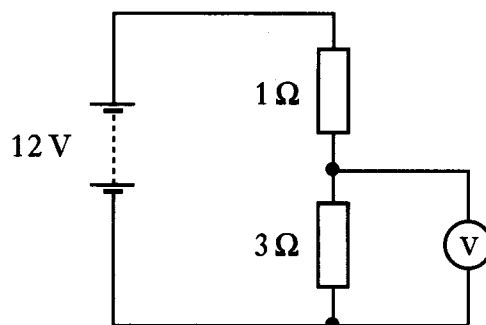


The reading on A_3 is 0.6 A.

Which row shows the readings on A_1 and A_2 ?

	<i>Ammeter A_1</i>	<i>Ammeter A_2</i>
A	0.2 A	0.4 A
B	0.3 A	0.3 A
C	0.4 A	0.2 A
D	0.6 A	0.3 A
E	0.6 A	0.6 A

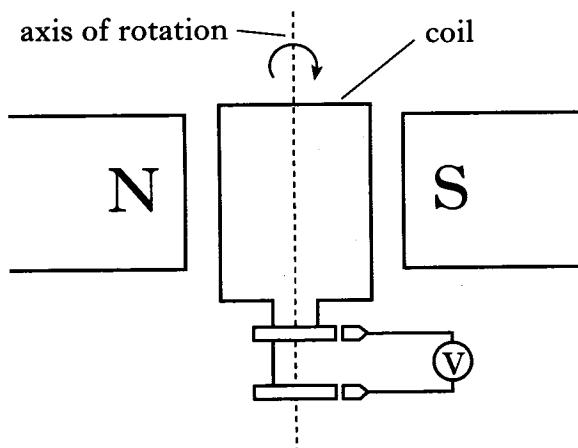
11. Consider the following circuit.



The reading on the voltmeter is

- A 3 V
- B 4 V
- C 8 V
- D 9 V
- E 12 V.

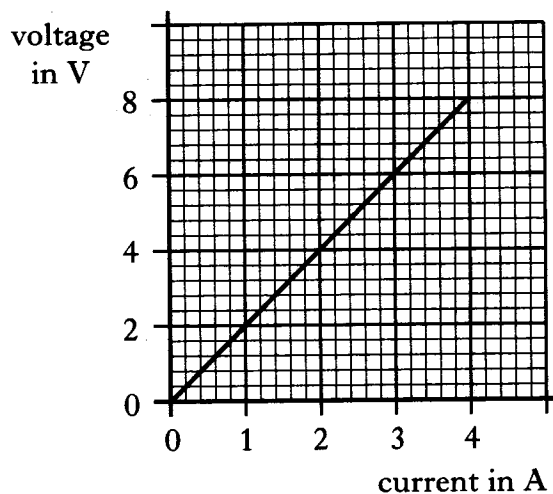
12. A voltage is induced in a coil when it is rotated in a magnetic field.



Which of the following combinations of changes produces the greatest increase in the induced voltage?

	<i>Strength of magnetic field</i>	<i>Number of turns in the coil</i>	<i>Speed of rotation of the coil</i>
A	decrease	increase	increase
B	increase	decrease	increase
C	increase	increase	decrease
D	decrease	decrease	decrease
E	increase	increase	increase

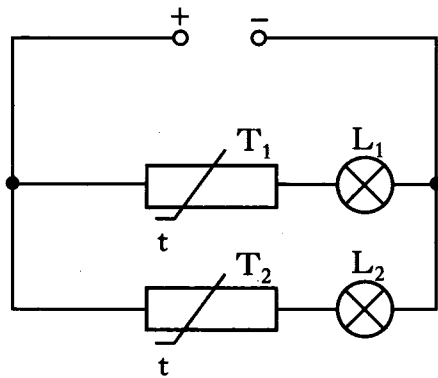
13. The graph shows the relationship between the voltage across a resistor and the current in the resistor.



The resistance of the resistor is

- A 0.5Ω
- B 2Ω
- C 4Ω
- D 12Ω
- E 32Ω .

14. Identical thermistors T_1 and T_2 are connected with lamps L_1 and L_2 as shown.



The resistance of these thermistors falls when their temperature rises.

T_1 is heated, T_2 is not heated.

What happens to the brightness of the lamps?

	<i>Brightness of L_1</i>	<i>Brightness of L_2</i>
A	gets dimmer	stays the same
B	stays the same	stays the same
C	gets brighter	gets brighter
D	gets dimmer	gets brighter
E	gets brighter	stays the same

15. The diagram shows part of the electromagnetic spectrum.

P	Visible light	Q	X-rays
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The radiations in regions P and Q are

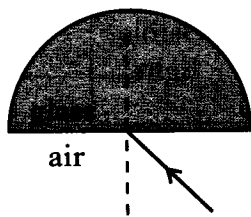
	<i>Region P</i>	<i>Region Q</i>
A	infrared	ultraviolet
B	ultraviolet	microwaves
C	ultraviolet	infrared
D	infrared	microwaves
E	microwaves	ultraviolet

16. Which of the following is a longitudinal wave?

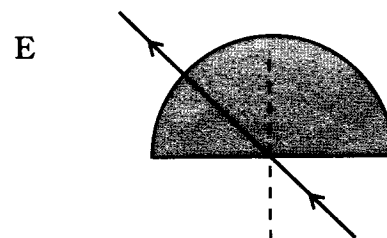
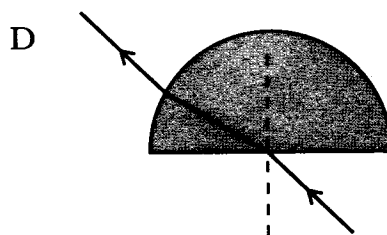
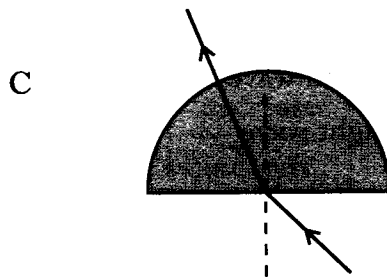
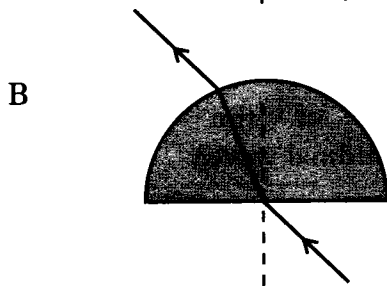
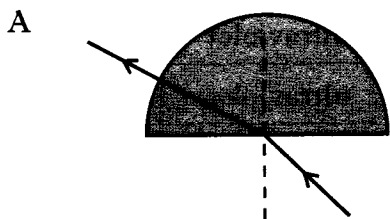
- A Water wave
- B Radio wave
- C Gamma ray
- D Sound wave
- E Light wave

[Turn over

17. The diagram shows a ray of light incident on the centre of the straight edge of a semicircular glass block.



Which diagram shows the path of the ray through the block?



18. An alpha particle has
- A the same mass as a helium nucleus, positive charge and is strongly ionising
 - B the same mass as an electron, negative charge and is weakly ionising
 - C the same mass as a helium nucleus, negative charge and is weakly ionising
 - D the same mass as an electron, negative charge and is strongly ionising
 - E the same mass as a helium nucleus, positive charge and is weakly ionising.

19. A patient's thyroid gland is exposed to radiation. Information about the radiation and the dose received by the gland is shown.

$$\text{Absorbed dose} = 500 \mu\text{Gy}$$

$$\text{Energy absorbed} = 15 \mu\text{J}$$

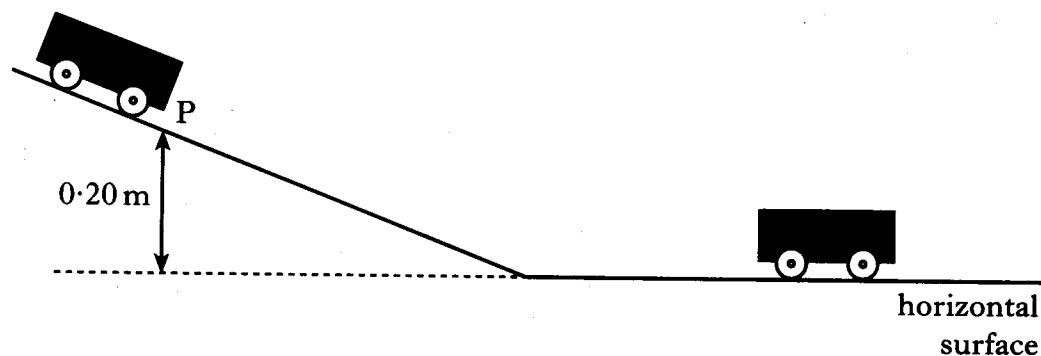
$$\text{Quality factor} = 20$$

The mass of the thyroid gland is

- A 0.01 kg
 - B 0.03 kg
 - C 0.04 kg
 - D 0.33 kg
 - E 0.75 kg.
20. The activity of a sample of a radioactive substance is 80 Bq. The half-life of the substance is 4 hours. The time for the activity to fall to 10 Bq is
- A 4 hours
 - B 6 hours
 - C 8 hours
 - D 12 hours
 - E 20 hours.

Write your answers to questions 21–31 in the answer book.

21. A cart A of mass 1.2 kg is held at point P on a slope. P is 0.20 m above a horizontal surface. A second cart B of mass 2.8 kg is placed close to the bottom of the slope as shown.



Cart A is released, runs down the slope and collides with cart B. The carts stick together and move off along the horizontal surface.

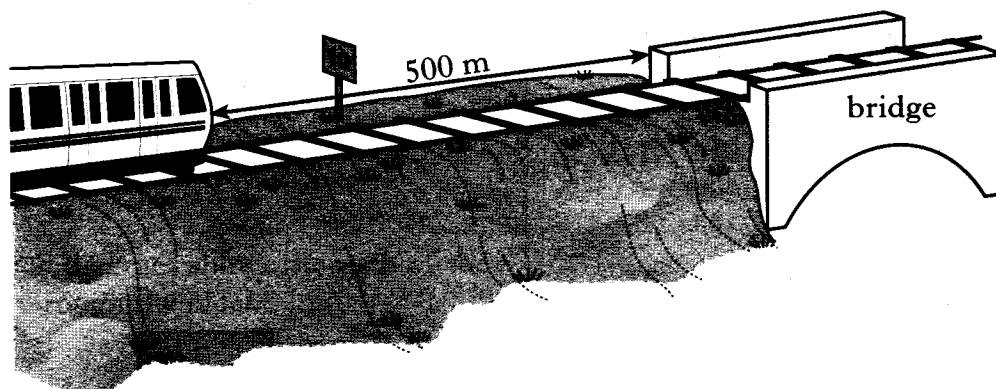
- (a) Calculate the change in gravitational potential energy of cart A from point P to the bottom of the slope. 2
- (b) Assuming no energy losses, show that the speed of cart A at the bottom of the slope is 2.0 m/s . 2
- (c) Calculate the speed of the carts just after the collision. 2
- (d) Describe how the instantaneous speed of the carts immediately after the collision can be measured.

List any apparatus required and state all the measurements that should be taken.

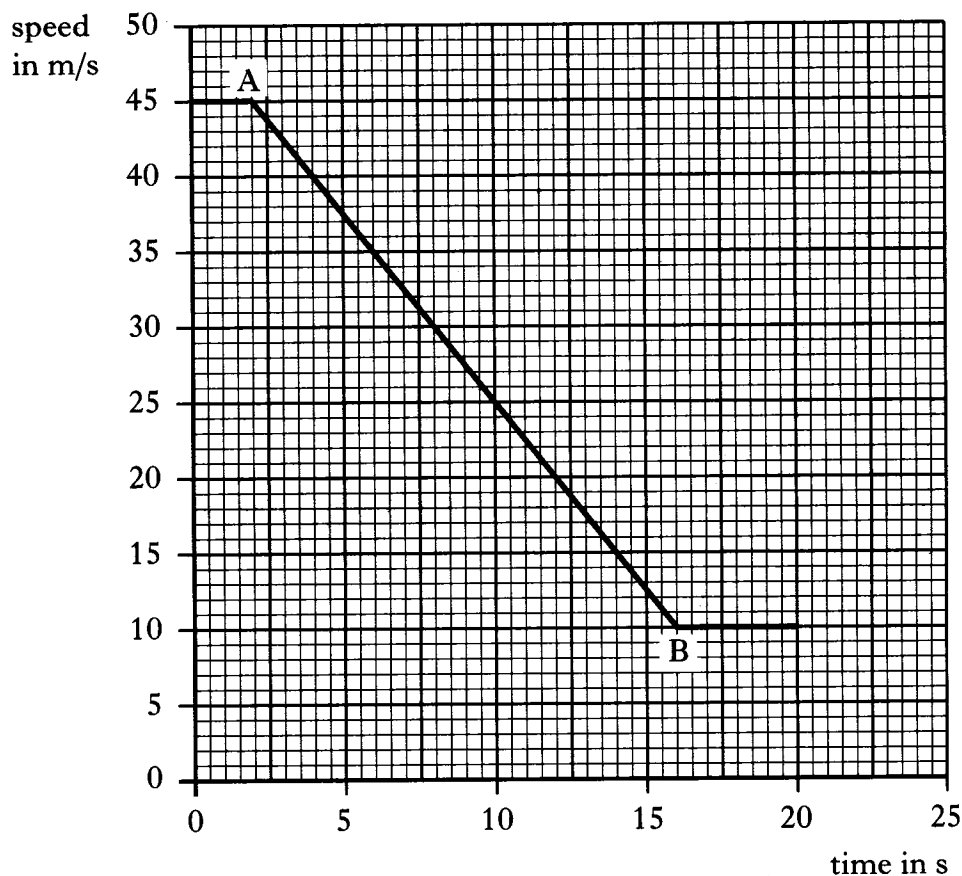
3
(9)

[Turn over

22. The driver of a train travelling at 45 m/s sees a sign indicating that there is a speed limit of 10 m/s on a bridge on the track ahead. At this point the distance from the train to the bridge is 500 m.

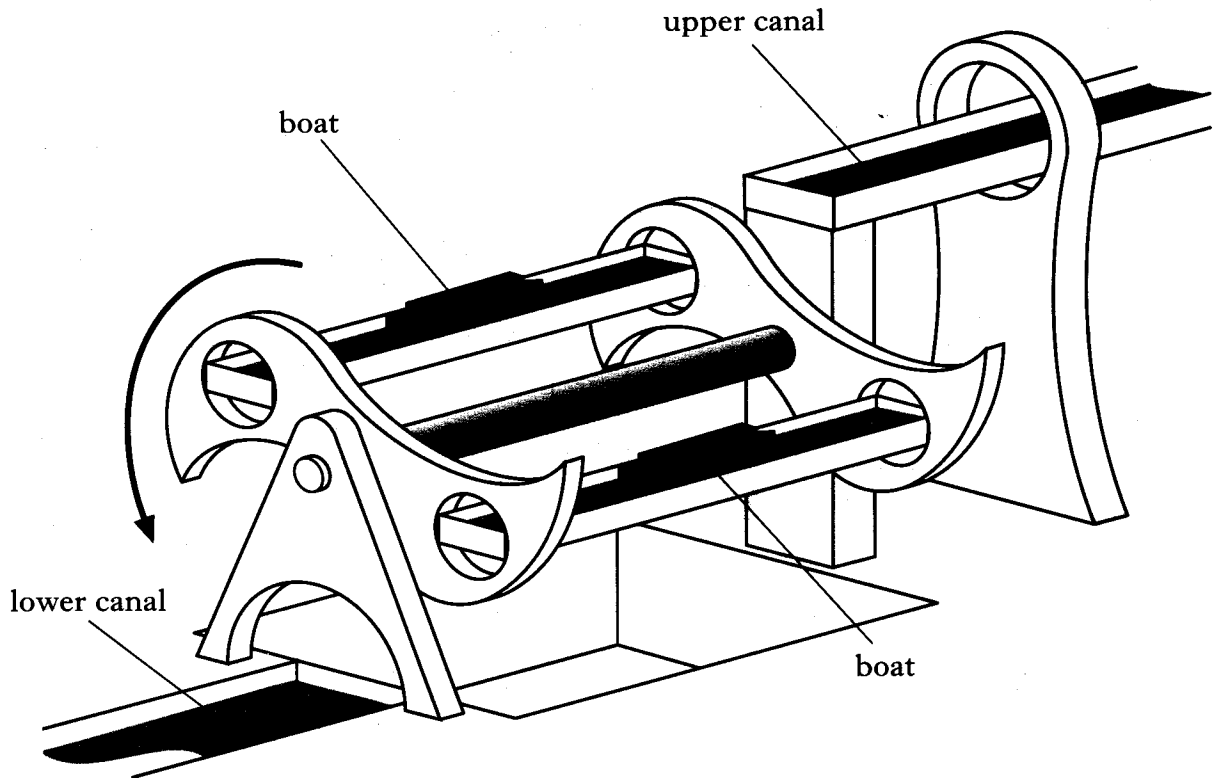


The speed-time graph of the train's motion, from the moment the driver sees the sign, is shown below.



- (a) (i) State the time at which the driver starts to apply the brakes. 1
- (ii) Explain your answer. 1
- (b) Calculate the acceleration of the train between A and B. 2
- (c) Is the train travelling at 10 m/s when it reaches the bridge?
You **must** justify your answer by calculation. 3
- (7)**

23. A boat lift is used to move boats between two canals at different heights as shown.



The lift rotates, lowering a boat on one side while raising a boat on the other side.

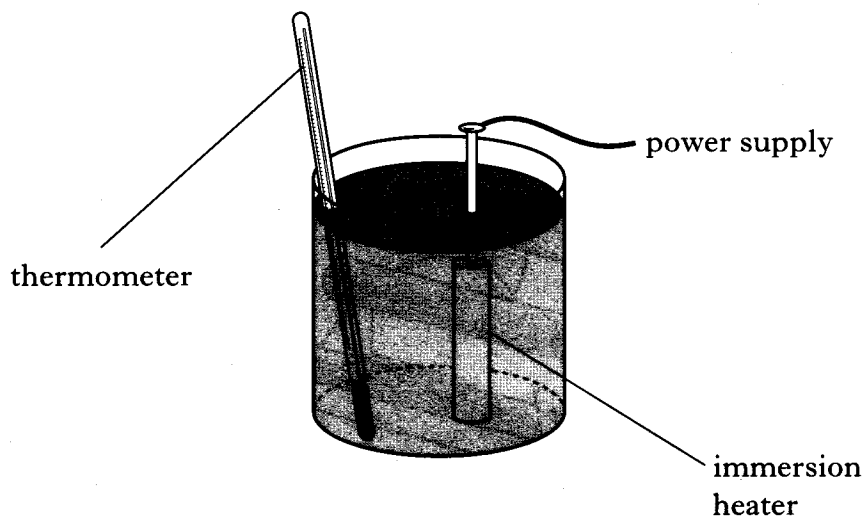
The system is balanced. The motor rotating the lift has to overcome only frictional forces. Information about the lifting process is shown below.

Frictional force	= 84 000 N
Distance through which force acts	= 12 m
Time for lifting process to be completed	= 4 minutes

- (a) Show that the power required to operate the lift is 4.2 kW. 3
- (b) The motor operates at 400 V and draws a current of 16 A.
Calculate the input electrical power. 2
- (c) Calculate the efficiency of the motor. 2
- (d) State whether the power required to start the lift moving is greater than, less than or equal to 4.2 kW. You must explain your answer. 2
- (9)**

[Turn over

24. A heater immersed in 0.40 kg of a liquid is switched on for 4 minutes. The temperature of the liquid rises by 5 °C in this time. The specific heat capacity of the liquid is 2400 J/kg °C.

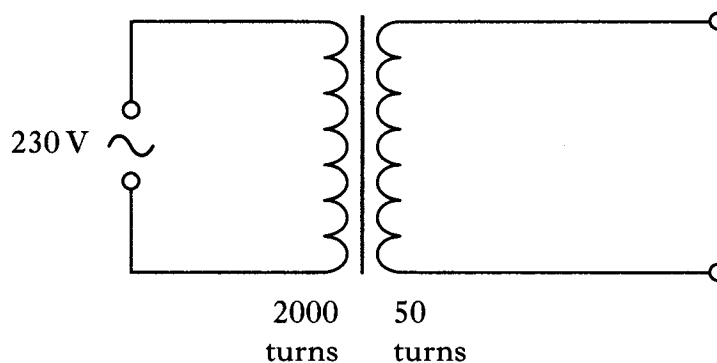


- (a) State the useful energy transformation that takes place in the heater. 1
- (b) State the part of the heater in which the energy transformation takes place. 1
- (c) Calculate the heat energy gained by the liquid. 2
- (d) Calculate the power rating of the heater. 3
- State **one** assumption you have made. (7)

25. A mobile phone charging unit contains a transformer.



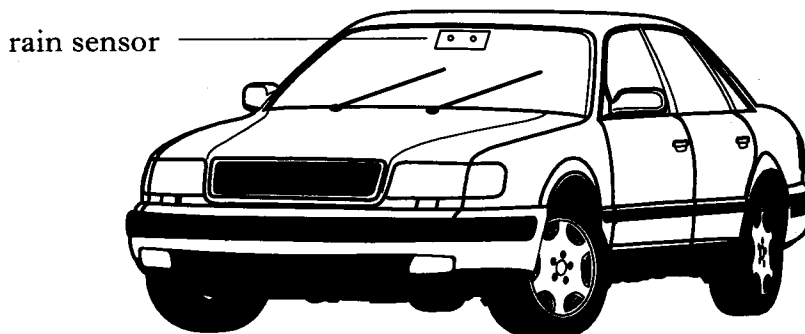
The transformer circuit is shown below.



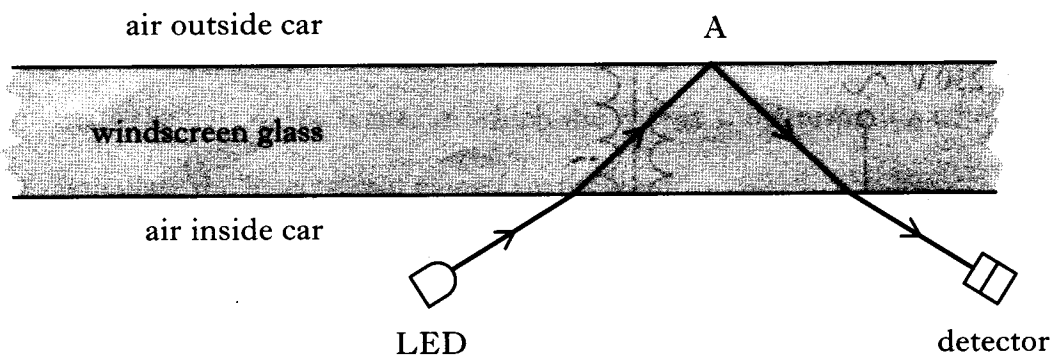
- (a) State the purpose of the transformer. 1
- (b) Calculate the secondary voltage of the transformer. 2
- (c) When the phone is being charged the current in the primary coil of the transformer is 24 mA.
Calculate the current in the secondary coil of the transformer. 2
- (d) The mobile phone transmits microwaves at a frequency of 1800 MHz.
Calculate the wavelength of the microwaves. 3
- (8)**

[Turn over

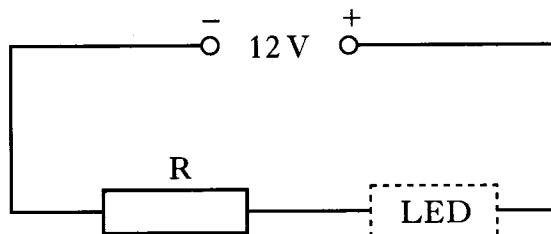
26. A car has a system that switches on the windscreen wipers when rain is detected on the windscreen.



The rain sensor contains an LED which emits a beam of infrared radiation inside the car. In dry conditions this beam travels through the glass and is picked up by a detector as shown below.



- (a) (i) Name the effect on the beam at A. 1
 (ii) Draw the symbol for an LED. 1
 (iii) The LED circuit is shown below.



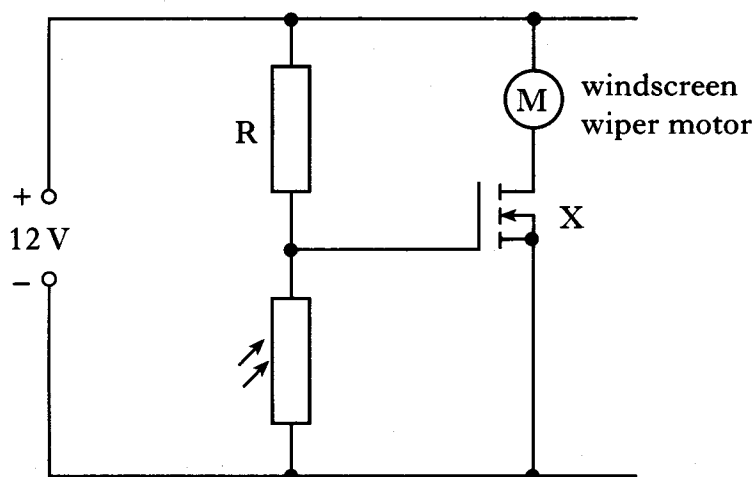
The voltage across the LED is 1.8 V and the current in the LED is 100 mA.

Calculate the resistance of R. 3

26. (continued)

- (b) When rain falls on the windscreen the detector picks up less infrared radiation and the windscreen wipers are switched on.

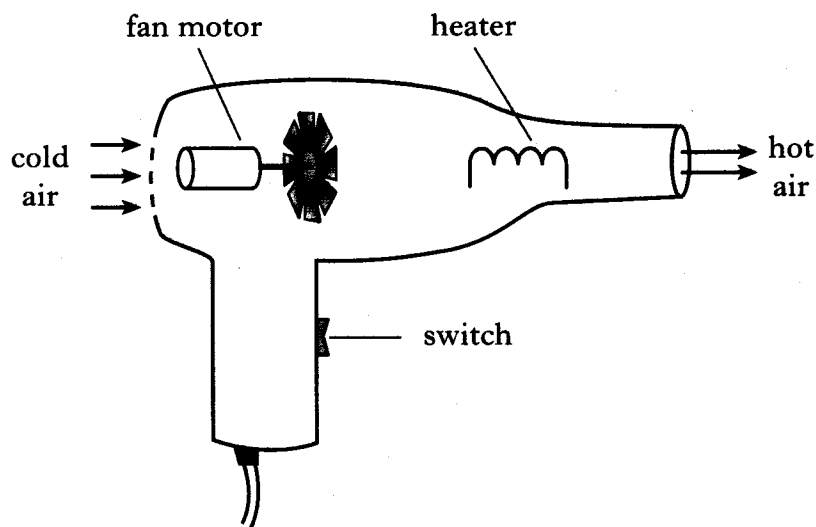
A student builds a model of the system. The model uses an LDR to represent the infrared detector and visible light to represent infrared radiation. The circuit is shown below.



- (i) Name component X. 1
- (ii) Describe how this electronic system operates when less light falls on the LDR. 3
- (9)

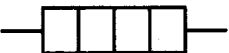

[Turn over

27. A paint stripper contains a heater and a motor which drives a fan.



The heater and the motor both operate at mains voltage, 230 V.

Information about the heater and motor is shown in the table below.

	<i>Heater</i>	<i>Motor</i>
Symbol		
Operating voltage	230 V	230 V
Power	1425 W	575 W

- (a) Calculate the resistance of the motor. 2
- (b) Draw the circuit diagram for the paint stripper. 2
- (c) The heater burns out. What effect, if any, does this have on the speed of the fan motor?

You **must** explain your answer.

2
(6)

28. Radio waves are transmitted between New York and Edinburgh.
 The ionosphere is a layer of charged particles above the Earth.
 Radio waves with frequencies below 40 MHz are reflected by the ionosphere.
 Radio waves with frequencies above 40 MHz pass through the ionosphere.



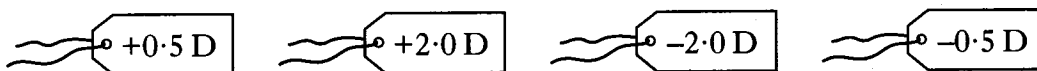
diagram not
to scale



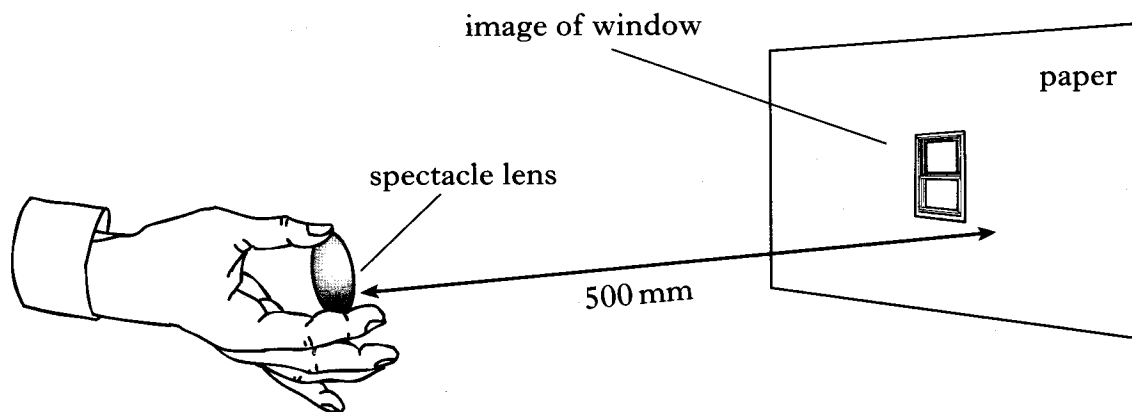
- (a) What is transferred by a radio wave? 1
- (b) An aerial in New York transmits and receives signals of the following frequencies.
- 300 kHz 3 MHz 30 MHz 300 MHz
- Which of these frequencies could be used for communication with Edinburgh by **satellite**? 2
- You **must** give a reason for your answer.
- (c) A satellite is 36 000 km from both transmitting and receiving stations in New York and Edinburgh. 3
- Calculate the minimum time for a signal to pass from New York to Edinburgh using the satellite. (6)

[Turn over

29. (a) An optician wishes to attach labels to spectacles to show the power of their lenses. The following labels are available.



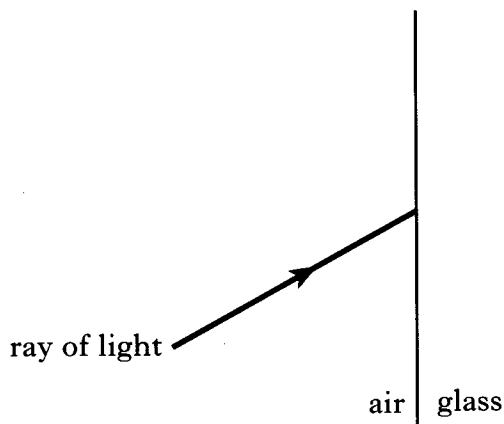
One pair of spectacles has two lenses of the same power. The optician uses one of the lenses to obtain a sharp image of a distant window on a piece of paper as shown below.



- (i) Name this type of lens. 1
- (ii) Which label should be attached to these spectacles? 3

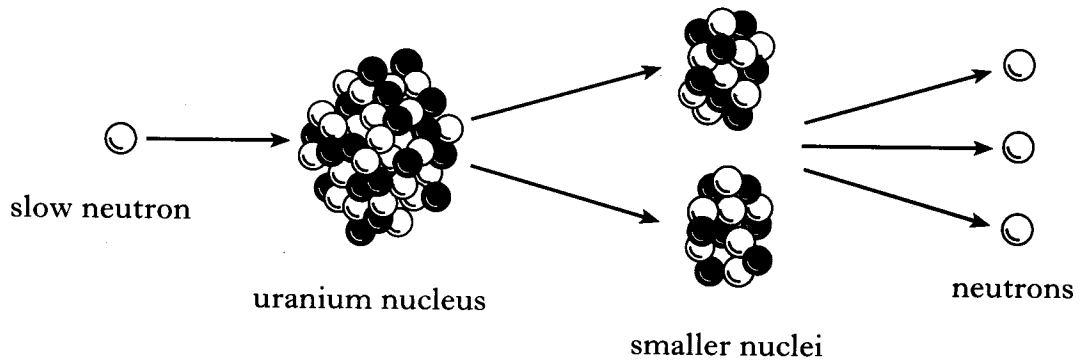
You **must** show clearly the working which leads to your answer.

- (b) The diagram below shows a ray of light incident on a glass surface. Copy the diagram and complete it to show the normal and the refracted ray. On your diagram, label the angle of incidence i and the angle of refraction r . 2



(6)

30. In the reactor of a nuclear power station a uranium nucleus is bombarded by a slow neutron as shown below.



- (a) State the name of this type of nuclear reaction. 1
- (b) In this reaction neutrons are released.
Why are these neutrons important to the operation of the reactor? 1
- (c) The reactor also contains boron control rods.
Explain the purpose of these rods. 1
- (d) A worker in the power station is exposed to the following absorbed doses.
2.0 mGy of slow neutrons
5.0 μ Gy of fast neutrons

The table below gives quality factors of various types of radiations.

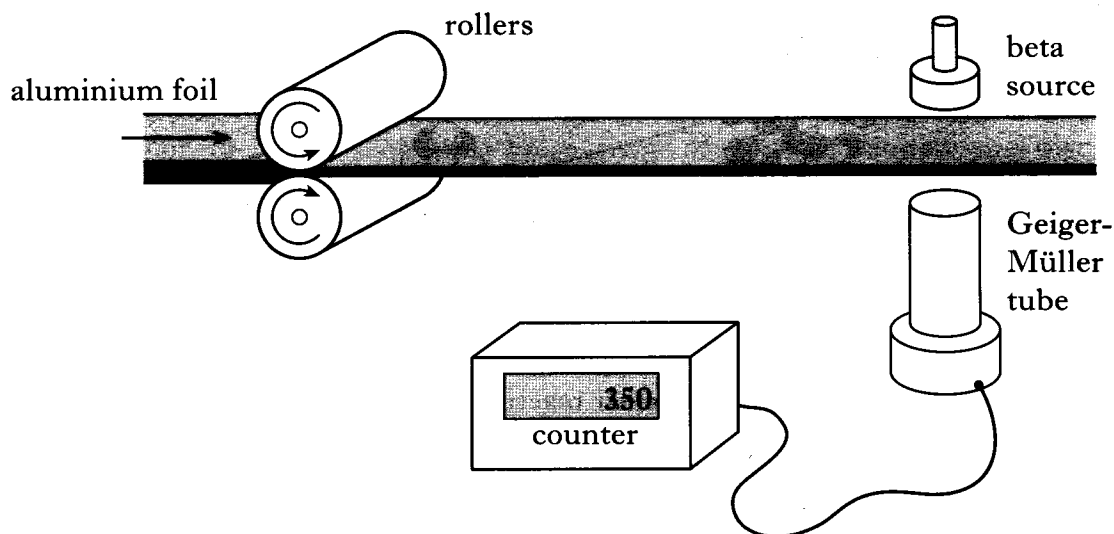
<i>Radiation</i>	<i>Quality factor</i>
X-rays	1
gamma rays	1
slow neutrons	3
fast neutrons	10
alpha particles	20

- Calculate the total dose equivalent received by the worker. 3
- (e) (i) State **one** advantage of using nuclear power for the generation of electricity. 1
- (ii) State **one** disadvantage of using nuclear power for the generation of electricity. 1

(8)

[Turn over for Question 31 on Page twenty

31. A roller mill produces thin sheets of aluminium foil. The thickness of the foil is checked using a source of beta radiation, a Geiger-Müller tube and a counter as shown below.



- (a) What happens to the count rate when the thickness of the foil increases? 1
- (b) Why is an alpha source **not** suitable for this system? 1
- (c) Radioactive sources give off radiations that cause ionisation.
- (i) What is meant by *ionisation*? 1
- (ii) Give **two** precautions that should be taken when handling radioactive sources. 2
- (5)

[END OF QUESTION PAPER]