X069/201

NATIONAL QUALIFICATIONS 2002

WEDNESDAY, 22 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.

12 A separate Worksheet is provided for use in answering Question 29.

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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

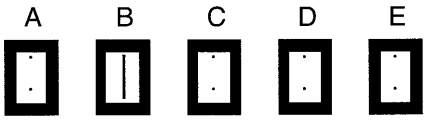
B kilowatt-hour

C watt

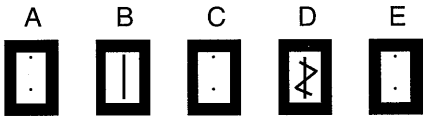
D coulomb

E volt.

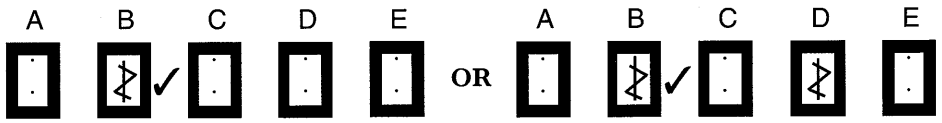
The correct answer to the question is B—kilowatt-hour. Record your answer by drawing a heavy vertical line joining the two dots in the appropriate box on your answer sheet in the column of boxes headed B. The entry on your answer sheet would now look like this:



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. A car accelerates from 4·0 m/s to 20 m/s in 5·0 s. The acceleration of the car is

A $0{\cdot}5\ m/s^2$

B $3{\cdot}2\ m/s^2$

C $4{\cdot}0\ m/s^2$

D $4{\cdot}8\ m/s^2$

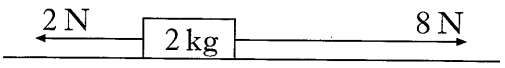
E $16\ m/s^2$.

2. An athlete runs 30 m East and then 40 m West.

Which row correctly shows the distance gone and the displacement from the starting point?

	Distance	*Displacement*
A	10 m	10 m East
B	10 m	10 m West
C	10 m	70 m East
D	70 m	10 m West
E	70 m	10 m East

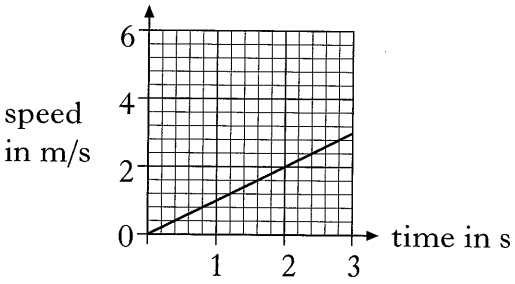
3. Two forces act on a block of mass 2 kg as shown.



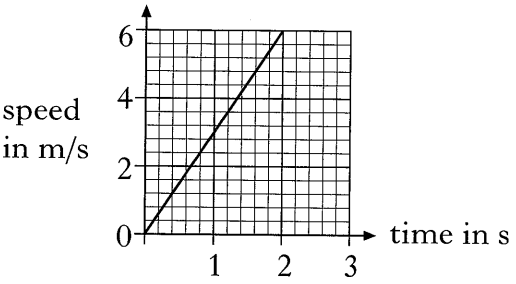
The block is initially at rest.

The speed-time graph for the block is

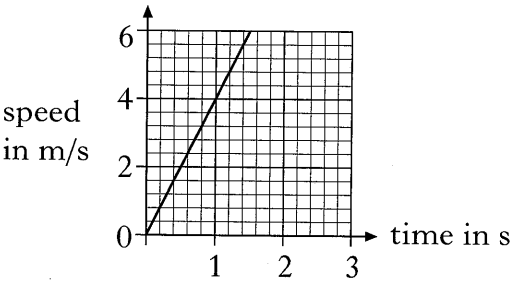
A



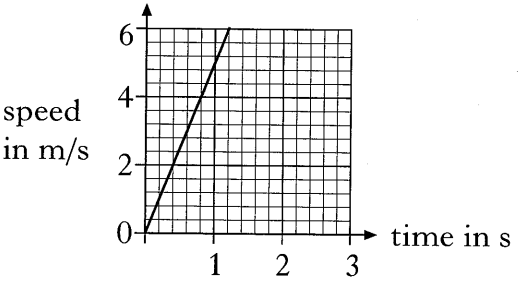
B



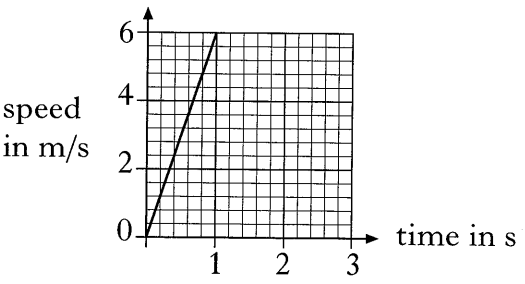
C



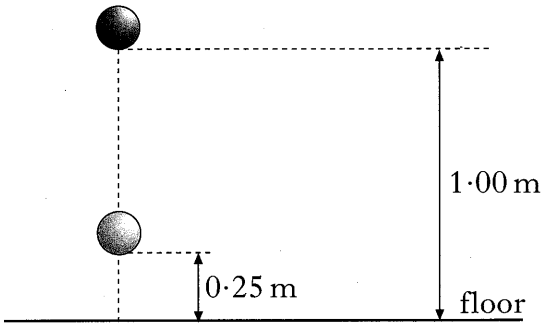
D



E



4. A ball of mass 0·50 kg is released from a height of 1·00 m.



When the ball is 0·25 m from the floor, the gravitational potential energy and the kinetic energy of the ball are

	Gravitational potential energy (J)	*Kinetic energy* (J)
A	0·125	0·125
B	1·25	1·25
C	1·25	3·75
D	3·75	1·25
E	5·00	1·25

5. The unit of momentum is

A kg m/s

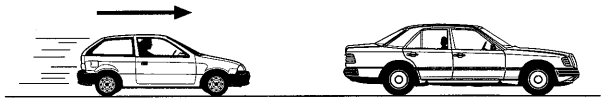
B kg m/s^2

C J

D N m

E N/kg.

6. A vehicle of mass 600 kg travelling at 12 m/s hits a stationary vehicle of mass 1200 kg.



The vehicles lock together.

The velocity of the vehicles immediately after the collision is

A 3·0 m/s

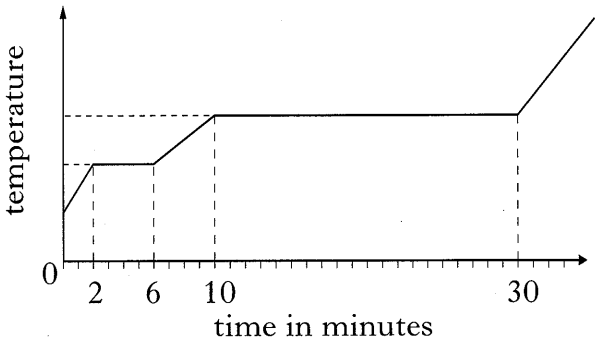
B 4·0 m/s

C 6·0 m/s

D 8·0 m/s

E 12 m/s.

7. A solid is placed in an insulated flask and heated continuously with an immersion heater. The sketch graph below shows how the temperature of the contents of the flask changes with time.



After 5 minutes the contents of the flask are

A in the solid state

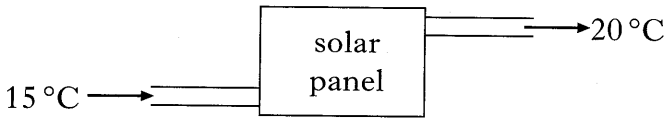
B in the liquid state

C a mixture of solid and liquid

D in the gaseous state

E a mixture of liquid and gas.

8. Water enters a solar panel at 15 °C and leaves at 20 °C.



The specific heat capacity of water is 4200 J/kg °C.

4 kg of water passes through the panel every minute.

The heat energy gained by the water in 1 minute is

A 16 800 J

B 84 000 J

C 252 000 J

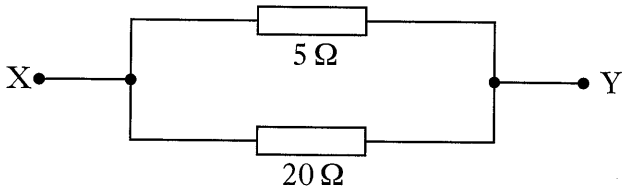
D 336 000 J

E 1 000 800 J.

9. Which row correctly shows the units of charge, current and power?

	Charge	*Current*	*Power*
A	coulomb	ampere	watt
B	coulomb	ampere	joule
C	volt	ampere	watt
D	volt	ampere	joule
E	volt	coulomb	watt

10. A 5 Ω and a 20 Ω resistor are connected in parallel.



The resistance between X and Y is

A 0·25 Ω

B 4·0 Ω

C 12·5 Ω

D 15 Ω

E 25 Ω.

11. A kettle is rated at 230 V, 2300 W.

The charge passing through the element of the kettle in 200 s is

A 20 C

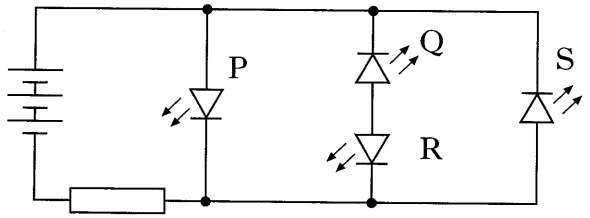
B 2000 C

C 46 000 C

D 460 000 C

E 529 000 C.

12. A circuit contains a battery, a resistor and four LEDs P, Q, R and S.



Which LED(s) is/are lit?

A P only

B S only

C P and R only

D Q and S only

E P and S only

13. An electric motor connected to a 12 V supply draws a current of 0·5 A. The energy supplied to the motor in 30 s is

A 6 J

B 15 J

C 180 J

D 360 J

E 720 J.

14. Which of the following equations can be used to find the power supplied to a resistor?

I $P = VI$

II $P = I^2R$

III $P = \frac{V^2}{R}$

A I only

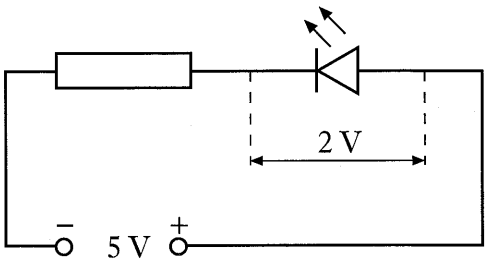
B II only

C III only

D I and II only

E I, II and III

15. A resistor and LED are connected in series across a 5 V d.c. supply.



The current in the LED is 20 mA. The voltage across the LED is 2 V.

The resistance of the resistor is

A 0·10 Ω

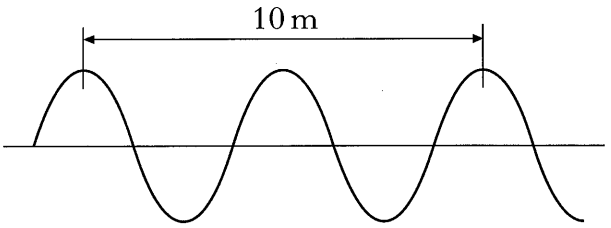
B 0·15 Ω

C 100 Ω

D 150 Ω

E 250 Ω.

16. A water wave is shown below.



The speed of the wave is 2·0 m/s.

The frequency of the wave is

A 0·2 Hz

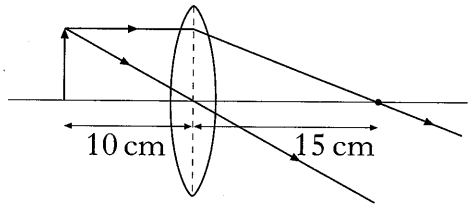
B 0·4 Hz

C 2·5 Hz

D 10 Hz

E 20 Hz.

17. An object is placed 10 cm from a converging lens of focal length 15 cm.



The image formed by the lens is

A inverted and the same size as the object

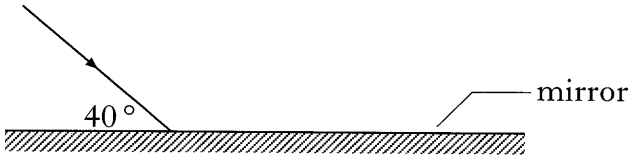
B inverted and smaller than the object

C inverted and larger than the object

D upright and smaller than the object

E upright and larger than the object.

18. A ray of light strikes a plane mirror at an angle of 40 ° to the mirror surface.



Which row shows the correct values of angle of incidence and angle of reflection for this ray?

	Angle of incidence in degrees	*Angle of reflection in degrees*
A	40	40
B	40	50
C	40	140
D	50	40
E	50	50

19. A student makes the following three statements.

I Alpha particles produce much greater ionisation density than beta particles or gamma rays.

II Alpha particles are fast moving electrons.

III Alpha particles can be stopped by a piece of paper.

Which of these statements is/are correct?

A I only

B II only

C III only

D I and III only

E I, II and III

20. Measurements are made of the absorbed dose and dose equivalent received by workers in the nuclear industry. The relationship between absorbed dose and dose equivalent is

A $Q = DH$

B $D = HQ$

C $H = DQ$

D $H = \frac{Q}{D}$

E $H = \frac{D}{Q}$.

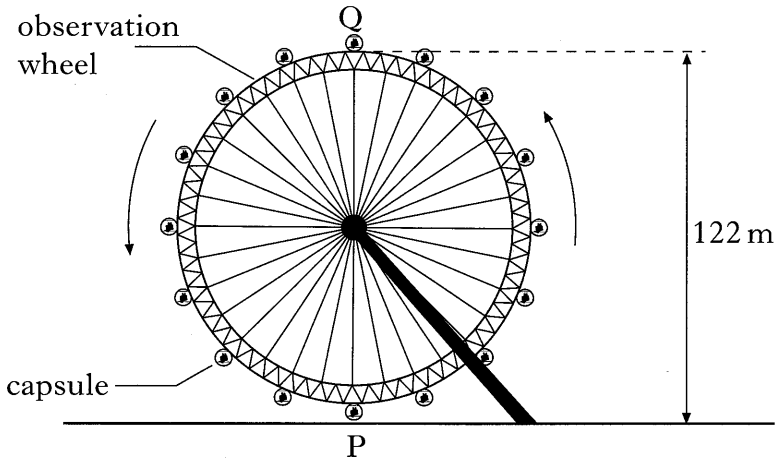
[Turn over

SECTION B

Marks

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

21. An observation wheel rotates slowly and raises passengers to a height where they can see across a large city. The passengers are carried in capsules.

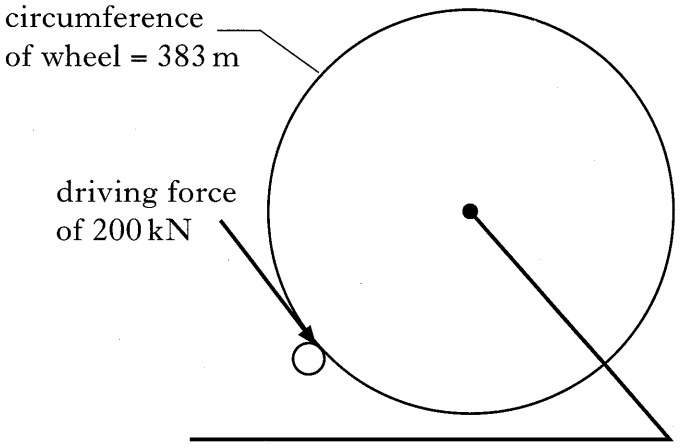


(*a*) Each capsule is raised through a height of 122 m as it moves from P to Q.

Each capsule with passengers has a total mass of 2750 kg.

Calculate the gravitational potential energy gained by a capsule with passengers. **2**

(*b*) The wheel is rotated by a driving force of 200 kN.



(i) For one revolution, the driving force is applied through the circumference of the wheel, a distance of 383 m.

Calculate the work done by the driving force for one revolution. **2**

(ii) The observation wheel rotates once every 30 minutes.

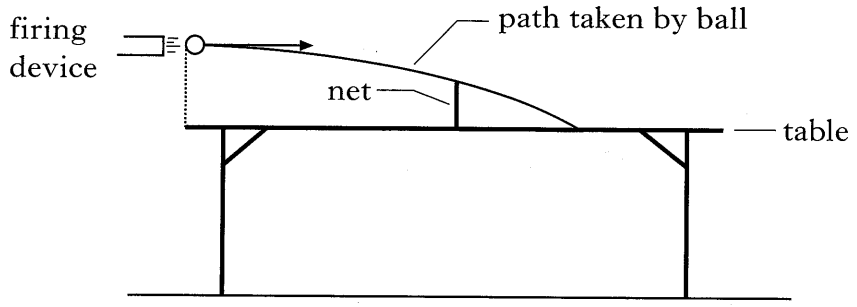
Calculate the power delivered to the wheel. **2**

(*c*) The driving system does not supply all the gravitational potential energy gained by the upward moving capsules. Explain how these capsules gain the additional energy required. **2**

(8)

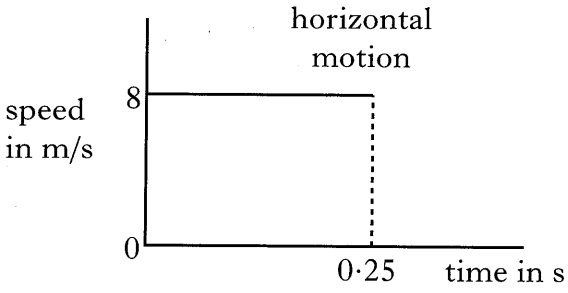
Marks

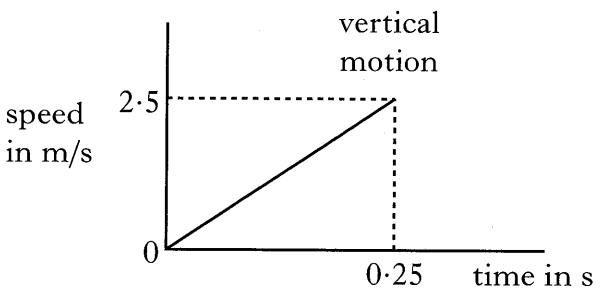
22. Table tennis players can practise using a device which fires balls horizontally.



The following graphs describe the horizontal and vertical motions of a ball from the instant it leaves the device until it bounces on the table 0·25 s later.

The effects of air resistance are assumed to be negligible.





(*a*) Explain why the shape of the path taken by the ball is curved. **2**

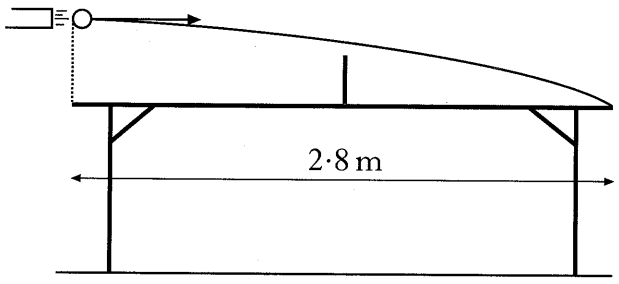
(*b*) (i) What is the instantaneous speed of the ball as it leaves the device? **1**

(ii) Describe a method of measuring the instantaneous speed of the ball as it leaves the device. **3**

(iii) Calculate the height above the table at which the ball is released. **2**

(*c*) The device is adjusted to fire a second ball which lands at the end of the table.

The height and position of the device are not changed.



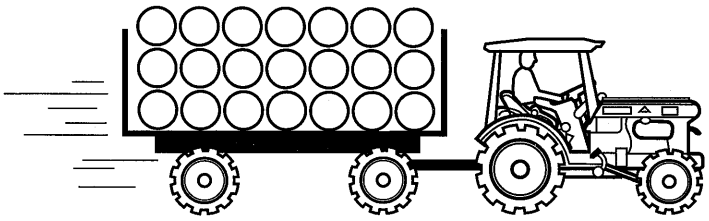
The length of the table is 2·8 m.

Assuming that the effects of air resistance are negligible, calculate the instantaneous speed of the second ball as it leaves the device. **2**

(10)

Marks

23. A tractor and a loaded trailer have a total mass of 9500 kg.



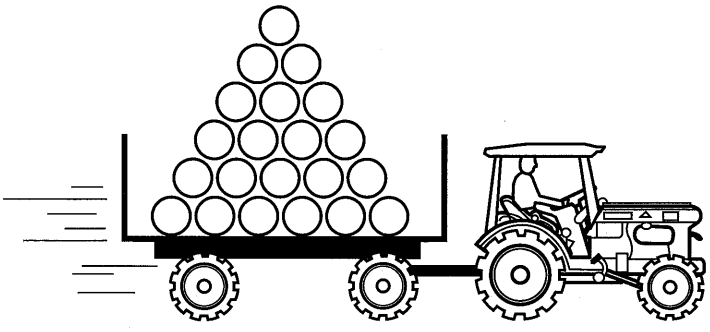
(*a*) The tractor applies a forward force of 15 250 N. At the instant the tractor and trailer move off the total frictional force is 1000 N.

Calculate the initial acceleration of the tractor and trailer. **3**

(*b*) The following graph shows how the speed of the tractor and trailer varies with time.

The tractor continues to apply a forward force of 15 250 N. State the size of the frictional force after 20 s. **1**

(*c*) On a second journey the trailer is loaded in a different way. The total mass of the tractor and trailer is again 9500 kg.



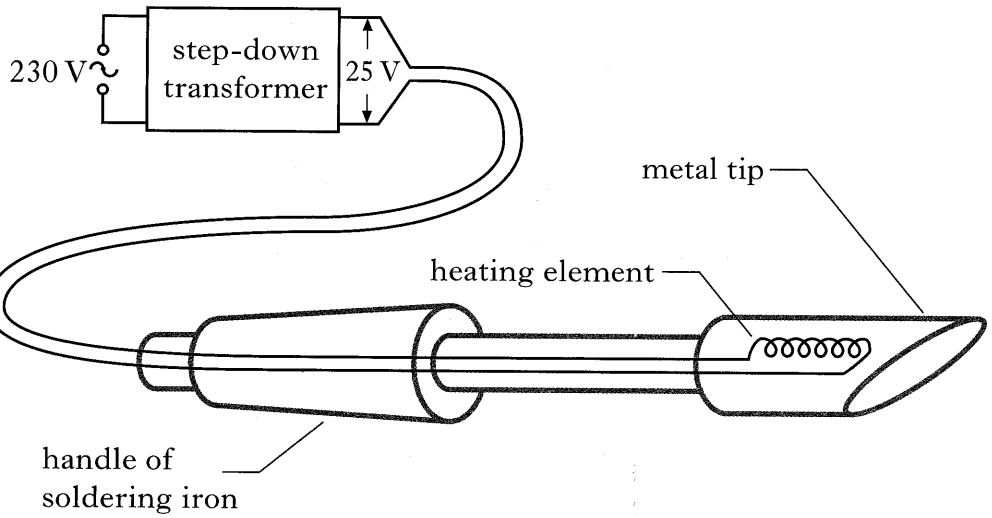
The tractor again applies a forward force of 15 250 N. The maximum speed on this journey is 12 m/s.

Explain, in terms of forces, why the maximum speed on this journey is less than the maximum speed in part (*b*). **2**

(6)

Marks

24. A technician uses the soldering iron shown when connecting electrical components.



The heating element is used to raise the temperature of the metal tip above the melting point of solder. The heating element is rated at 25 V, 90 W.

(*a*) A step-down transformer is used to reduce voltage from the mains value of 230 V to 25 V.

There are 1840 turns on the primary coil of the transformer.

Calculate the number of turns on the secondary coil. **2**

(*b*) The heating element is switched on for 50 s.

Calculate the electrical energy supplied to the element. **2**

(*c*) The metal tip is made of copper and has a mass of 0·03 kg. The temperature of the metal tip rises from 20 °C to 370 °C during the period that the element is switched on.

The specific heat capacity of copper is 386 J/kg °C.

Calculate the heat energy gained by the metal tip. **2**

(*d*) Explain why the heat energy gained by the metal tip is less than the electrical energy supplied to the element. **2**

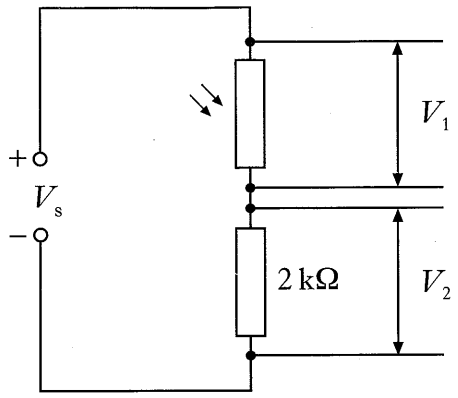
(*e*) A device which uses a thermocouple is used to measure the temperature of the metal tip. State the energy change which takes place in a thermocouple. **1**

(9)

[Turn over

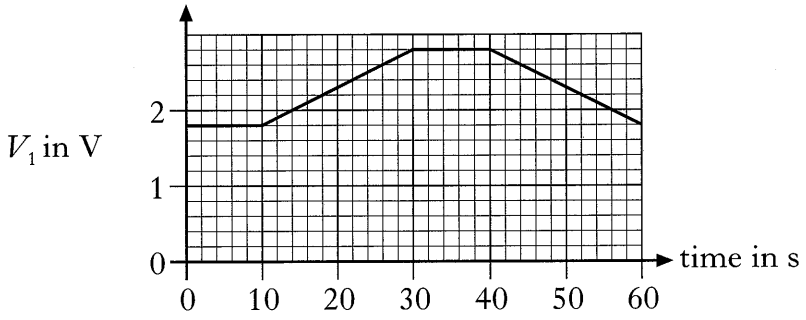
Marks

25. A light dependent resistor and a 2 kΩ resistor are connected in series across a d.c. supply.

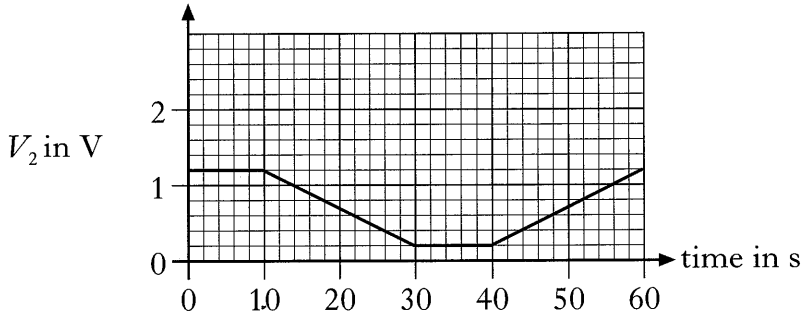


In an experiment the light intensity incident on the LDR is varied during a 60 s period. The voltages across both components are measured over the 60 s period and the following graphs are obtained.

graph 1



graph 2



(*a*) (i) State the values of V_1 and V_2 at the start of the 60 s period. **1**

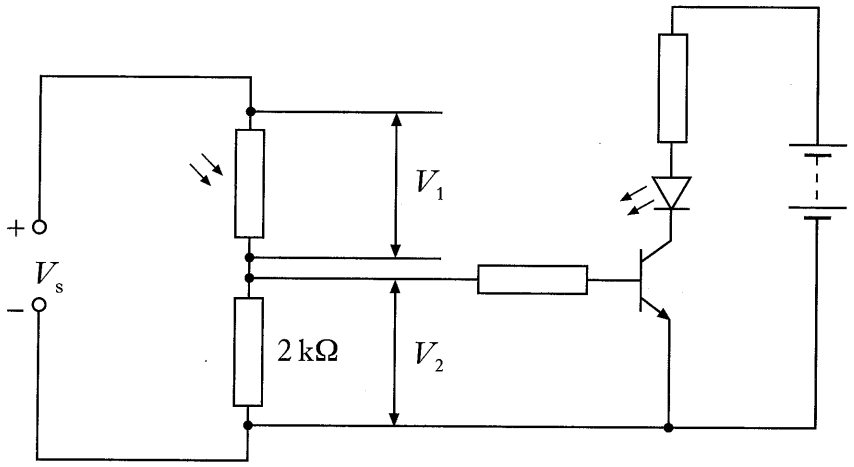
(ii) State the value of the supply voltage V_s. **1**

(*b*) Calculate the resistance of the light dependent resistor at the start of the 60 s period. **2**

(*c*) Is the light intensity incident on the LDR increasing or decreasing during the time interval between 10 s and 30 s? You must explain your answer. **3**

25. (continued)

(*d*) An additional circuit is connected across the 2 kΩ resistor.



The experiment is now repeated and identical graphs are obtained.

A student observes that the LED is lit between 0 s and 20 s, off between 20 s and 50 s and lit between 50 s and 60 s.

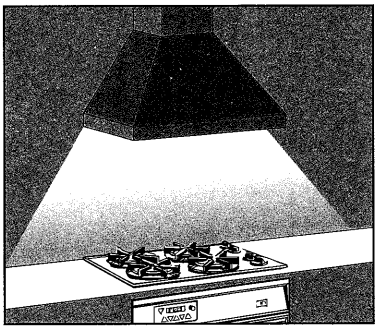
Use graph 2 to explain why the LED is off between 20 s and 50 s. **2**

(9)

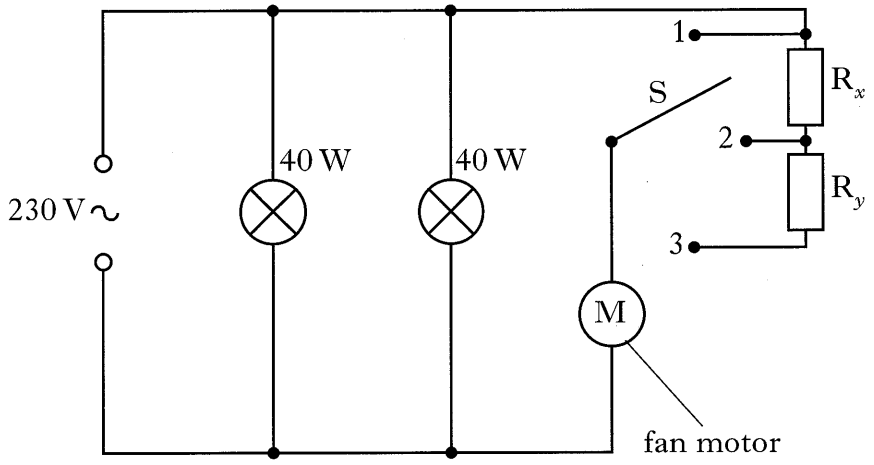
[Turn over

Marks

26. A cooker hood contains two 40 W lamps and an extractor fan.



A circuit diagram for the cooker hood is shown below.



(*a*) Calculate the current drawn by one lamp. **2**

(*b*) Calculate the resistance of one lamp. **2**

(*c*) The speed of the fan motor is varied by moving switch S to position 1, 2 or 3.

State the position of S for maximum speed of the extractor fan motor. You must explain your reason for selecting that position. **2**

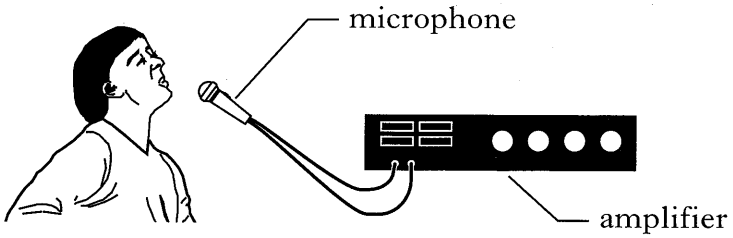
(*d*) When S is in position 2 the voltage across the motor is 180 V and the current through the motor is 0·25 A.

Calculate the resistance of R_x. **3**

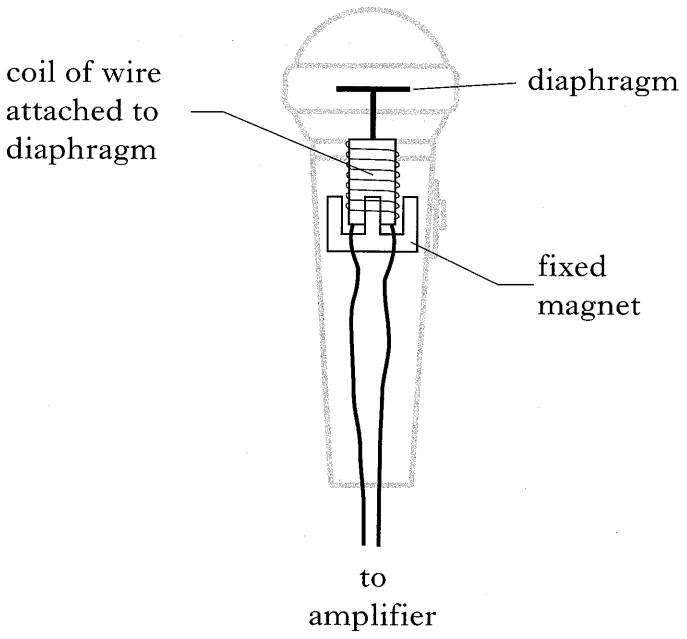
(9)

Marks

27. At a concert a musician sings into a microphone connected to an amplifier.



The sound energy causes a diaphragm in the microphone to move up and down. A coil of wire is attached to the diaphragm so that it moves up and down with the diaphragm.



(*a*) Explain how an a.c. voltage is induced in the coil. **2**

(*b*) State **two** changes in the design of the microphone which would result in a greater induced voltage. **2**

(*c*) A voltage of 2 mV from the microphone is applied to the input terminals of the amplifier. The output voltage of the amplifier is 0·5 V.

Calculate the voltage gain of the amplifier. **2**

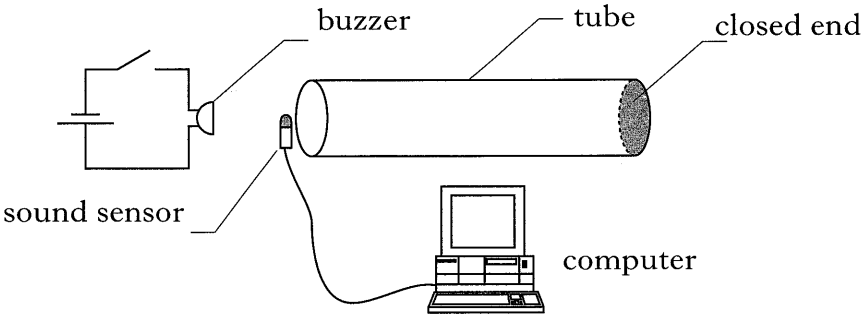
(6)

[Turn over

Marks

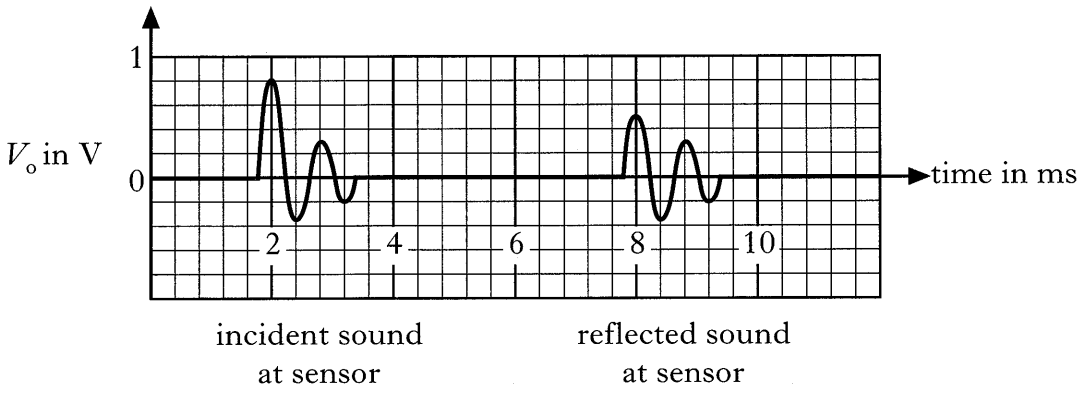
28. A buzzer is placed in front of the open end of a tube. The tube is closed at the other end.

A sound sensor linked to a computer is placed at the open end of the tube as shown.



The buzzer produces a short pulse of sound. At the instant the buzzer is operated the computer starts to record the output voltage V_o of the sound sensor.

The following graph of V_o against time is displayed on the computer screen.



(*a*) Explain why the amplitude of the reflected sound is less than the amplitude of the incident sound. **1**

(*b*) State the time between the first peak of the incident sound and the first peak of the reflected sound arriving at the sound sensor. **1**

(*c*) The speed of sound in air is 340 m/s.

Calculate the length of the tube. **3**

(*d*) The frequency of the pulse is 1250 Hz.

Calculate the wavelength of the pulse. **2**

(7)

Marks

29. Rays of light enter glass prisms as shown in diagrams 1 and 2.

diagram 1

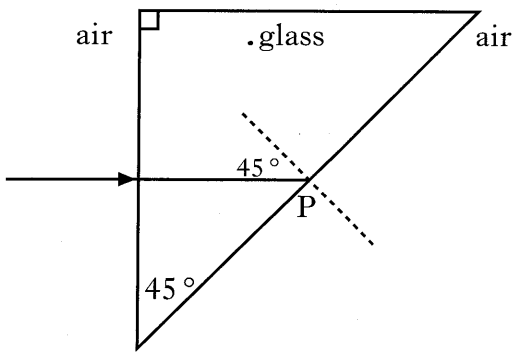
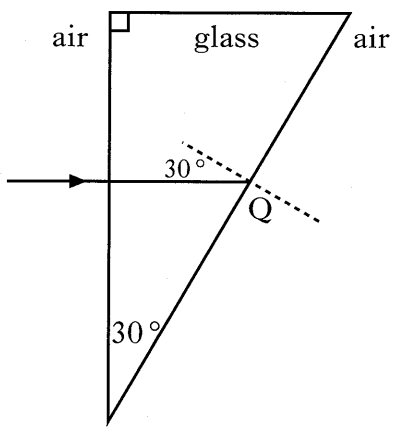


diagram 2



The critical angle for glass is 42°.

(*a*) Using **Worksheet Q29**, complete diagram 1 to show the path of the ray after it strikes point P. **2**

(*b*) Using **Worksheet Q29**, complete diagram 2 to show the path of the ray after it strikes point Q. **2**

(4)

30. The following table contains information about two radioactive sources used in medicine.

Radioactive source	*Activity* (MBq)	*Half-life* (days)
R	1600	8
S	80	74

(*a*) Calculate the number of decays of source R in 30 s. **2**

(*b*) These radioactive sources can be disposed of after their activity has fallen below 40 MBq.

Show, by calculation, which source, R or S, will be the first to reach an activity of 40 MBq. **3**

(*c*) State **two** safety precautions which should be taken when handling radioactive sources. **2**

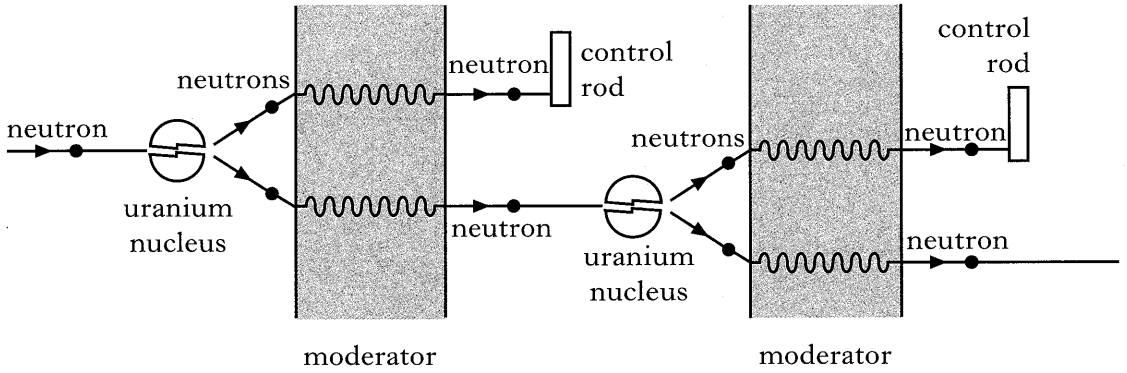
(7)

[Turn over for Question 31 on *Page eighteen*

Marks

31. A simplified model of a controlled chain reaction in a nuclear reactor is shown below.

Controlled Chain Reaction



(*a*) (i) Name the type of nuclear reaction that takes place in the reactor. **1**

(ii) State the purpose of the moderator. **1**

(iii) How could the chain reaction process be stopped? **1**

(*b*) State **one advantage** and **one disadvantage** of using nuclear power for the generation of electricity. **2**

(5)

[END OF QUESTION PAPER]

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