X069/201

NATIONAL QUALIFICATIONS 2003

MONDAY, 19 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 30)

8 Answer the questions numbered 21 to 30 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 30.

11 Care should be taken to give an appropriate number of significant figures in the final answers to calculations.

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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

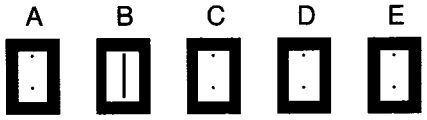
B kilowatt-hour

C watt

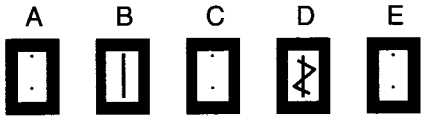
D coulomb

E volt.

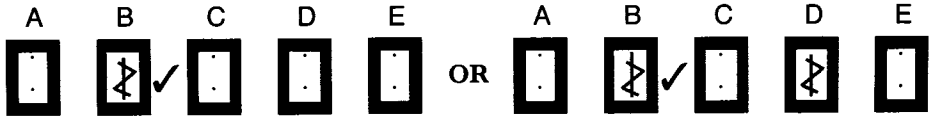
The correct answer to the question is B—kilowatt-hour. Record your answer by drawing a heavy vertical line joining the two dots in the appropriate box on your answer sheet in the column of boxes headed B. The entry on your answer sheet would now look like this:



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:



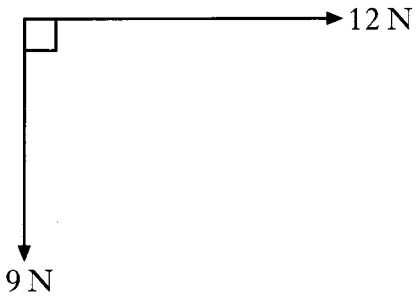
SECTION A

Answer questions 1–20 on the answer sheet.

1. Which row in the table contains only vector quantities?

A	momentum	displacement	force
B	distance	velocity	energy
C	momentum	speed	force
D	force	energy	distance
E	speed	distance	time

2. The diagram represents two forces acting on an object.



The magnitude of the resultant force is

A 3 N

B 10 N

C 11 N

D 15 N

E 21 N.

3. A man of mass 80 kg dives from a diving board which is 10 m above water. Neglecting air friction, the kinetic energy of the diver immediately before he hits the water is

A 14 J

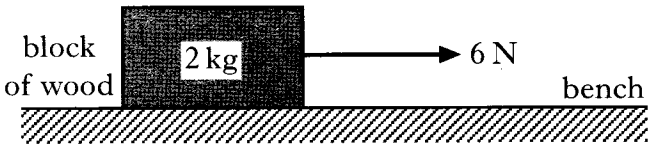
B 800 J

C 1200 J

D 4000 J

E 8000 J.

4. A block of wood of mass 2 kg is pulled along a bench by a horizontal force of 6 N.



A constant frictional force of 2 N acts on the block.

The acceleration of the block is

A $0{\cdot}25\ m/s^2$

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

C $2\ m/s^2$

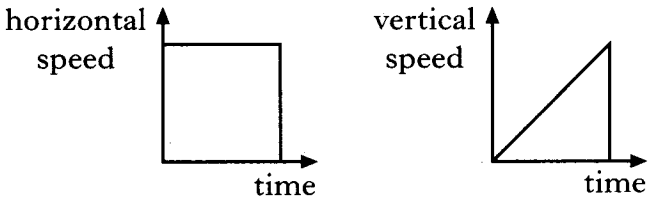
D $3\ m/s^2$

E $4\ m/s^2$.

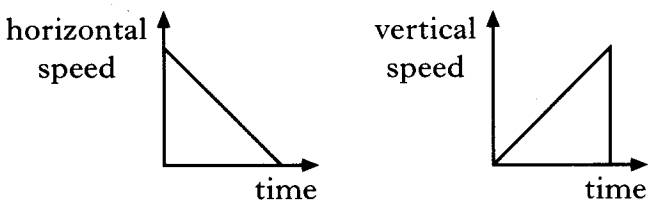
[Turn over

5. A ball is kicked horizontally off the edge of a cliff and lands in the sea. Which pair of graphs shows the horizontal and vertical speeds of the ball during its flight? The effect of air friction should be ignored.

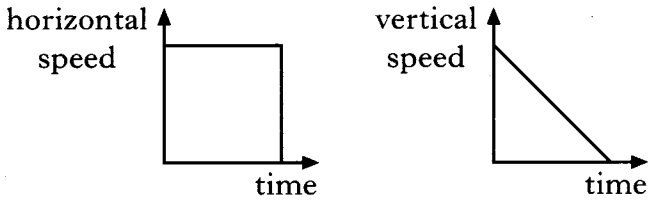
A



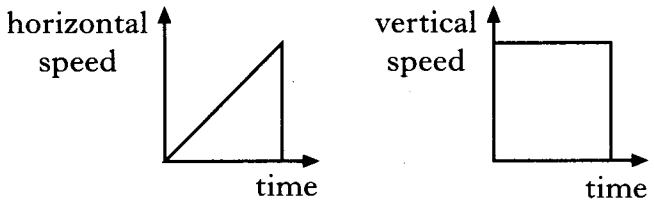
B



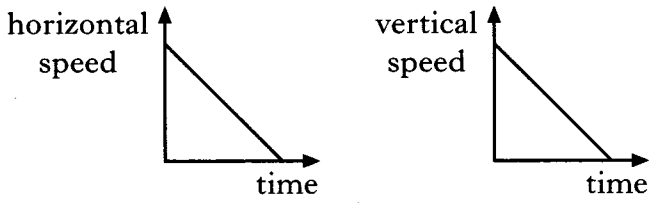
C



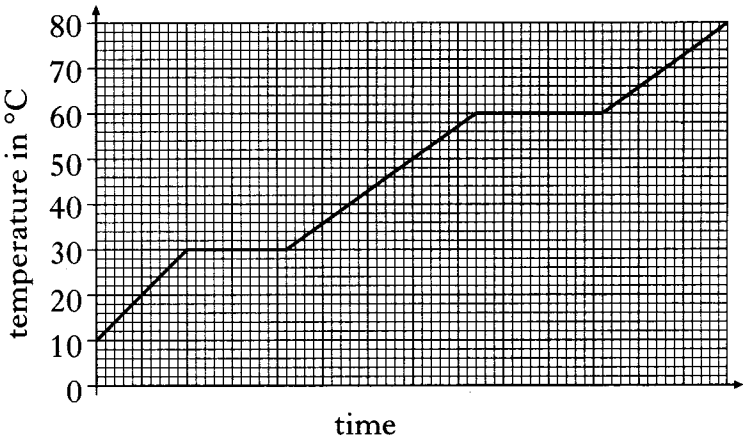
D



E



6. A block of wax, initially in the solid state, is heated. The graph below shows how the temperature of the wax changes with time.



At what temperature does the wax melt?

A 0 °C

B 10 °C

C 30 °C

D 60 °C

E 80 °C

7. A motor has an efficiency of 60%. The input energy to this motor is 200 J. The output energy of the motor is

A $\frac{200}{100 \times 60}$ J

B $\frac{200}{60}$ J

C $\frac{200 \times 60}{100}$ J

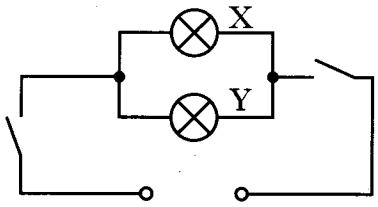
D $\frac{200 \times 100}{60}$ J

E 60×200 J.

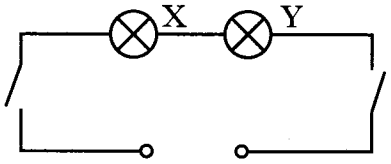
8. A room in a house has two lamps X and Y. With different switch positions, either lamp X or lamp Y or both lamps X and Y can be lit.

Which circuit allows the lamps to operate in this way?

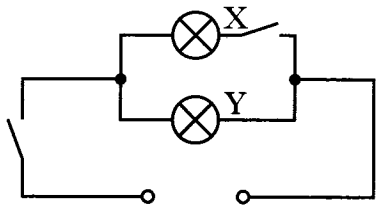
A



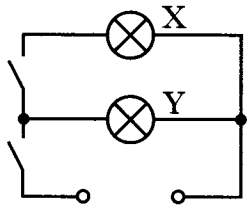
B



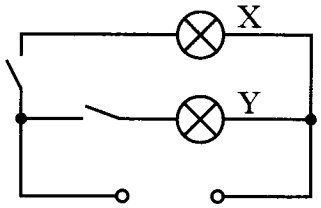
C



D



E



9. The information shown applies to an electric iron.

ELECTRIC IRON	
Operating voltage	230 V
Power	2·3 kW
Resistance	23 Ω

The iron is switched on for 10 minutes. How much electrical energy is converted to heat energy during this time?

A 5290 J

B 529 000 J

C 717 600 J

D 1 380 000 J

E 2 116 000 J

10. The frequency of the mains supply is

A 0·02 Hz

B 5 Hz

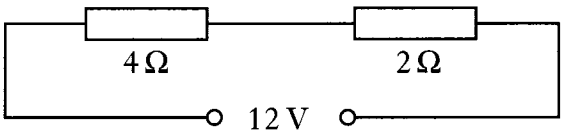
C 50 Hz

D 230 Hz

E 240 Hz.

[Turn over

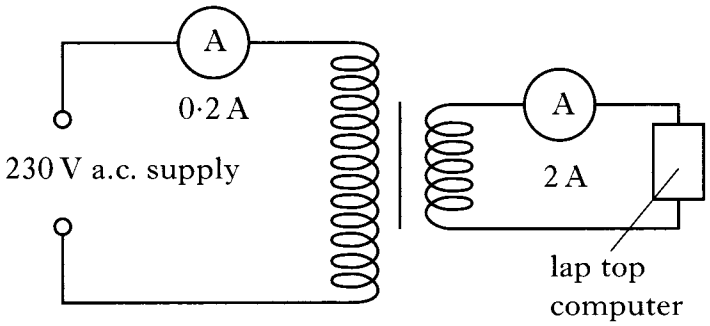
11. Two resistors are connected in series with a 12 volt d.c. supply.



The current in the 2 Ω resistor is 2 A. Which row of the table gives the current in the 4 Ω resistor and the voltage across the 4 Ω resistor?

	Current in A	*Voltage in* V
A	1	4
B	1	12
C	2	8
D	2	12
E	4	8

12. A lap top computer is connected to the output of a transformer as shown.



The transformer is 100% efficient. The resistance of the lap top computer is

A 4·6 Ω

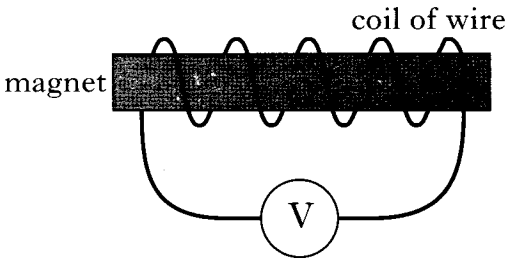
B 11·5 Ω

C 46 Ω

D 115 Ω

E 1150 Ω.

13. A magnet is placed inside a coil of wire connected to a voltmeter as shown below.



The magnet can be moved either to the left or to the right.

The coil of wire can also be moved to the left or to the right.

Which of the following produces a reading of zero on the meter?

	Movement of magnet	*Movement of coil*
A	to the right at 0·2 m/s	to the right at 0·2 m/s
B	to the left at 0·2 m/s	to the right at 0·2 m/s
C	to the left at 0·2m/s	stationary
D	to the right at 0·2 m/s	to the left at 0·2 m/s
E	to the right at 0·2 m/s	to the right at 0·4 m/s

14. A signal of voltage 2 V and frequency 100 Hz is applied to the input of an amplifier. The output of the amplifier has a voltage of 10 V. The output frequency of the amplifier is

A 5 Hz

B 20 Hz

C 50 Hz

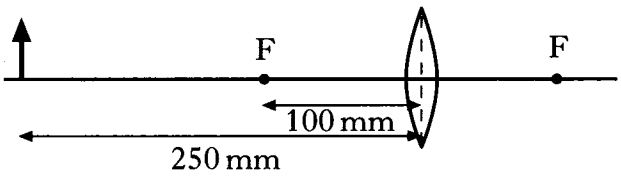
D 100 Hz

E 500 Hz.

15. Which row in the table correctly shows input and output devices?

	Input device	*Output devices*
A	microphone	loudspeaker LED
B	solar cell	thermocouple LED
C	loudspeaker	microphone relay
D	LED	loudspeaker solar cell
E	thermocouple	microphone LED

16. A student places an object 250 mm from a converging lens of focal length of 100 mm.



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.

17. In a water tank, 10 waves pass a point in 2 seconds. The speed of the waves is 0·4 m/s. The wavelength of the waves is

A 0·005 m

B 0·02 m

C 0·04 m

D 0·08 m

E 2 m.

18. Sound is a longitudinal wave. When a sound wave travels through air the particles of air

A move continuously away from the source

B move continuously towards the source

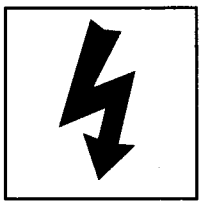
C vibrate at random

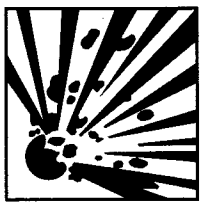
D vibrate at 90° to the wave direction

E vibrate along the wave direction.

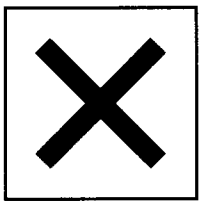
[Turn over

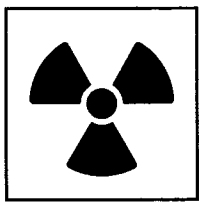
19. Which sign is used to indicate the presence of radioactive material?

A 

B 

C 

D 

E 

20. A student writes the following statements.

I Alpha radiation is part of the electromagnetic spectrum.

II Alpha radiation is more ionising than beta or gamma radiation.

III Alpha radiation is more penetrating than beta or gamma radiation.

Which of the statements is/are true?

A I only

B II only

C III only

D I and II only

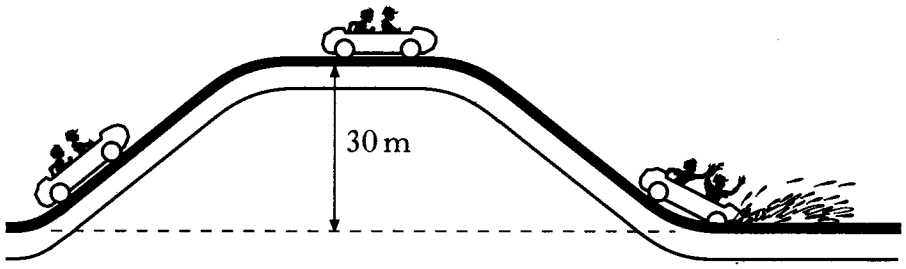
E I and III only

SECTION B

Marks

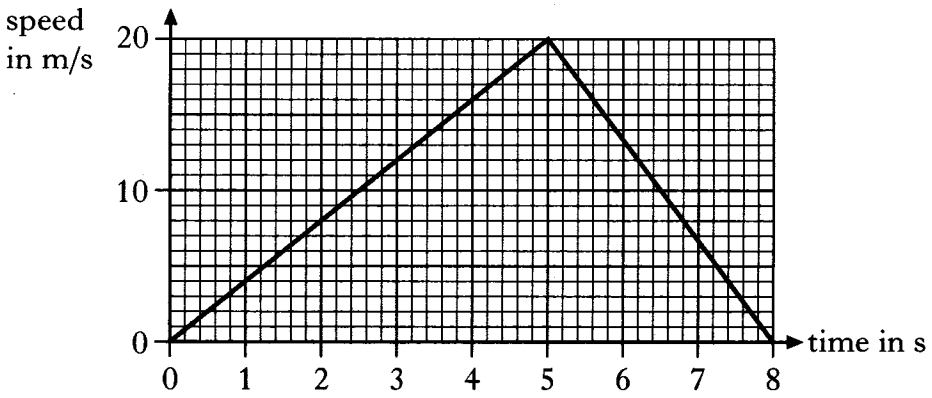
Write your answers to questions 21–30 in the answer book.

21. A theme park has a water splash ride. A carriage loaded with passengers is raised through a height of 30 m to the top of the ride. The combined mass of the carriage and the passengers is 1400 kg.



(*a*) Calculate the gain in gravitational potential energy of the carriage and passengers when it is taken to the top of the ride. **2**

(*b*) The carriage and passengers stop briefly before being released at the top of the ride. A speed-time graph of the motion of the carriage from the top of the ride is shown below.



(i) Calculate the acceleration of the carriage from the top of the ride to the point where it reaches the water. **2**

(ii) Calculate the distance travelled by the carriage from the top of the ride to the point where it comes to rest. **2**

(iii) A test run is carried out without any water in the ride. The carriage travels a longer distance before it comes to rest. Explain why this happens. **1**

(7)

[Turn over

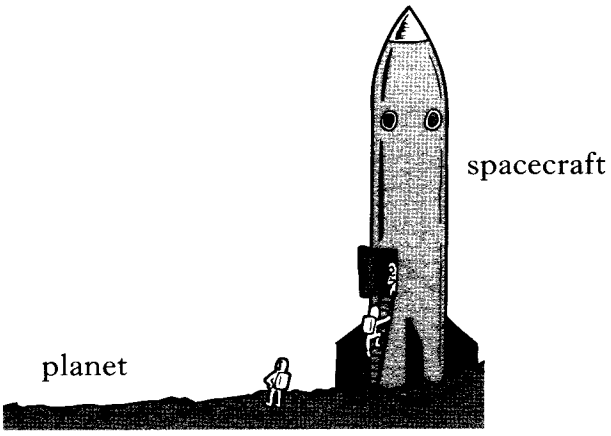
Marks

22. A spacecraft travels through space between planet X and planet Y. Information on these planets is shown in the table below.

	planet X	*planet Y*
Gravitational field strength on surface	8·4 N/kg	13 N/kg
Surface temperature	17·0 °C	9·0 °C
Atmosphere	No	Yes
Period of rotation	48 hours	17 hours

The spacecraft has a total mass of $2{\cdot}5 \times 10^6$ kg.

The spacecraft engines produce a total force of $3{\cdot}8 \times 10^7$ N.



(*a*) The spacecraft is initially on planet X.

(i) Calculate the weight of the spacecraft when it is on the surface of planet X. **2**

(ii) Sketch a diagram showing the forces acting on the spacecraft just as it lifts off from planet X. You must name these forces and show their directions. **2**

(iii) Calculate the acceleration of the spacecraft as it lifts off from planet X. **3**

(*b*) On another occasion, the spacecraft lifts off from planet Y. The mass and engine force of the spacecraft are the same as before. Is the acceleration as it lifts off from planet Y less than, more than or equal to the acceleration as it lifts off from planet X?

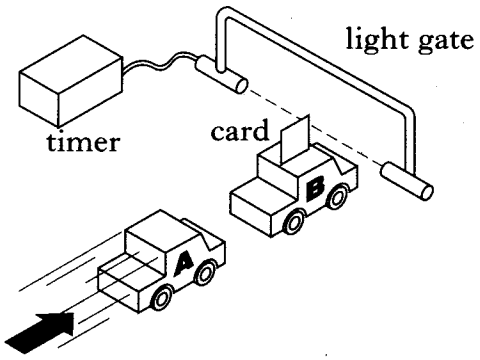
You **must** give a reason for your answer using information contained in the table above. **2**

(9)

Marks

23. A student investigates collisions using model cars A and B.

Car B is fitted with a piece of card and the edge of the card is placed close to a light gate attached to a timer as shown.



(*a*) In one experiment car A is moving directly towards car B which is stationary. The cars collide and stick together. After the collision the card passes through the light gate.

The student records the following measurements.

Mass of car A	= 1·6 kg
Mass of car B	= 1·0 kg
Speed of car B before collision	= 0 m/s
Length of card	= 100 mm
Time on timer	= 0·05 s

(i) Calculate the speed of the cars **after** the collision. **2**

(ii) Use your answer for part (i), and information contained in the student's measurements, to calculate the speed of car A immediately before the collision. **2**

(*b*) In a second experiment car A is moving with a different speed directly towards stationary car B. The cars again collide and stick together. The cars have a speed of 4 m/s after the collision.

(i) Calculate the total kinetic energy of the cars after the collision. **2**

(ii) After this collision the cars move in a straight line and come to rest. The frictional force acting on the cars is 2·6 N. Calculate the distance travelled by the cars after the collision. **2**

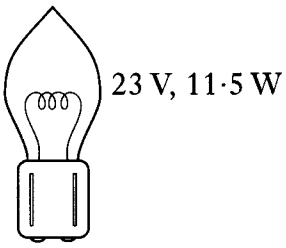
(*c*) In each experiment the edge of card is placed close to the light gate before the collision. Explain why. **1**

(9)

[Turn over

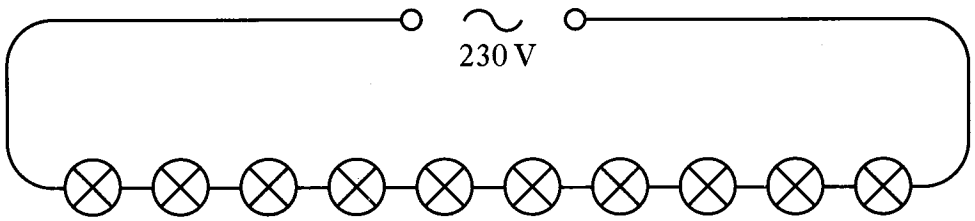
Marks

24. One type of lamp used for Christmas tree sets is rated as follows.



(*a*) Show that the resistance of one lamp is 46 Ω. **2**

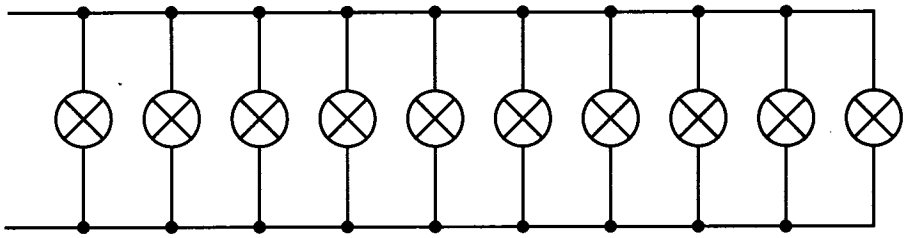
(*b*) In one arrangement, ten of these lamps are connected in series to the mains as shown.



(i) Show that the voltage across each lamp is 23 V. **1**

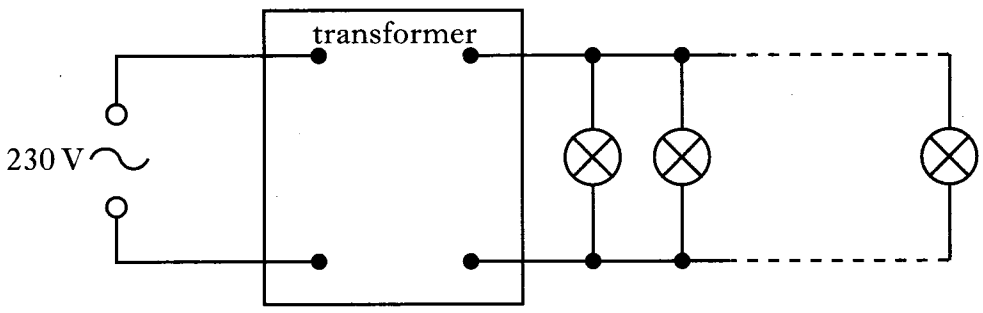
(ii) State **one** disadvantage of wiring lamps in this way. **1**

(*c*) In another arrangement, the ten lamps are connected in parallel as shown.



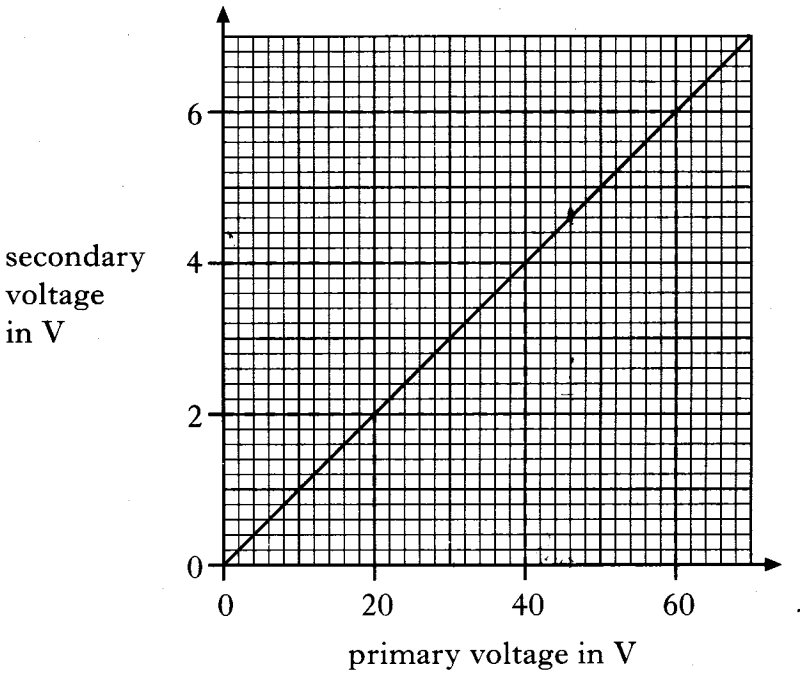
(i) Calculate the total resistance of this arrangement of lamps. **2**

(ii) This arrangement of lamps cannot be connected directly to the mains, but it can be connected to the mains by using a transformer.



24. (*c*) (ii) (continued)

A technician investigates the relationship between the primary voltage and secondary voltage of the transformer. The following graph is obtained from the technician's results.



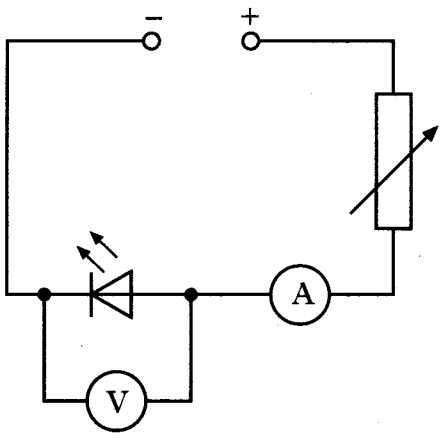
(A) Calculate the output voltage from the transformer when it is attached to the mains supply of 230 V. **2**

(B) The parallel arrangement is connected to the mains through this transformer. **Explain** whether the lamps operate at normal brightness. **1**

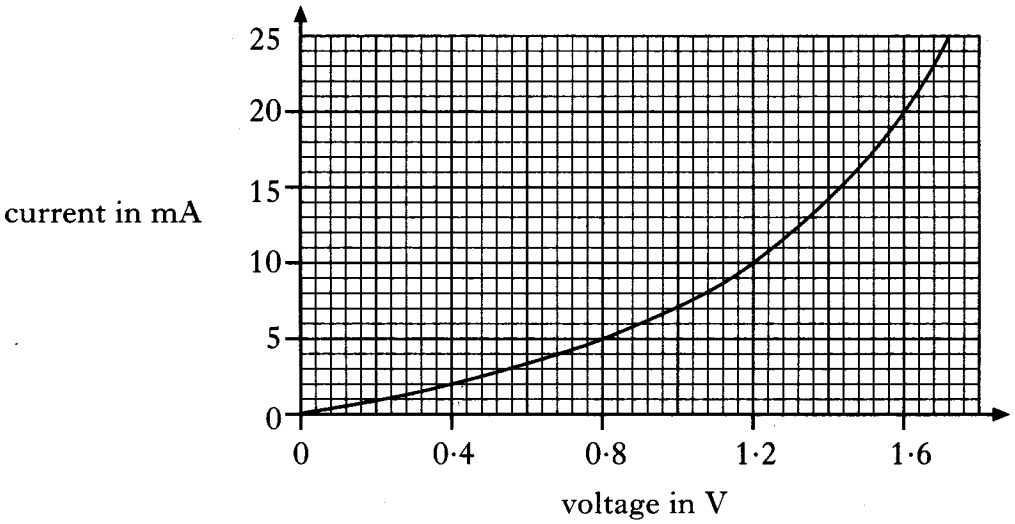
(9)

[Turn over

25. An LED is connected in the circuit shown.



The variable resistor is adjusted and voltmeter and ammeter readings are taken. The following graph is obtained from the experimental results.

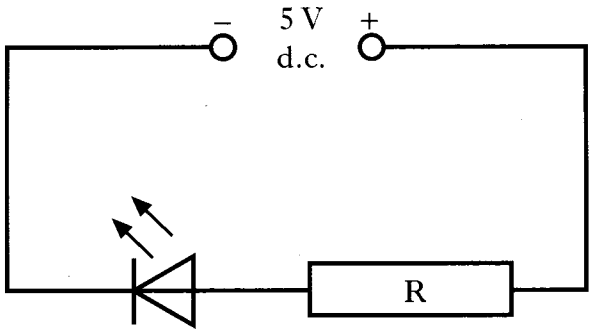


(*a*) Using information from the graph, determine how the resistance of the LED changes as the voltage across it is increased.

You **must** justify your answer by calculation. **3**

25. (continued)

(*b*) The LED is now connected into a circuit with a resistor R as shown.



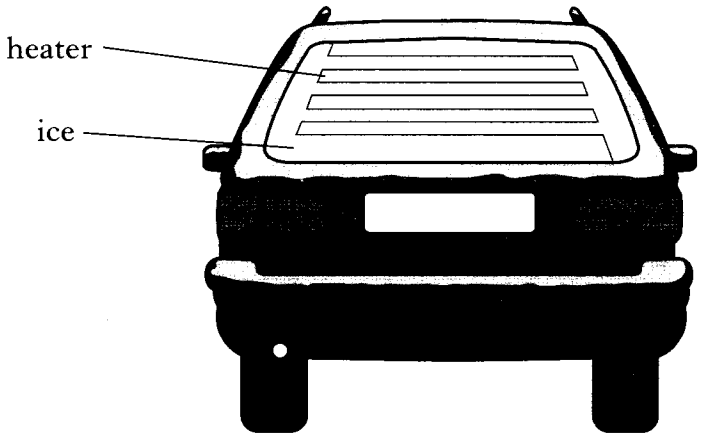
(i) The current in the LED is 20 mA. Using the graph on *Page fourteen*, state the voltage across the LED. **1**

(ii) Calculate the resistance of resistor R. **3**

(7)

[Turn over

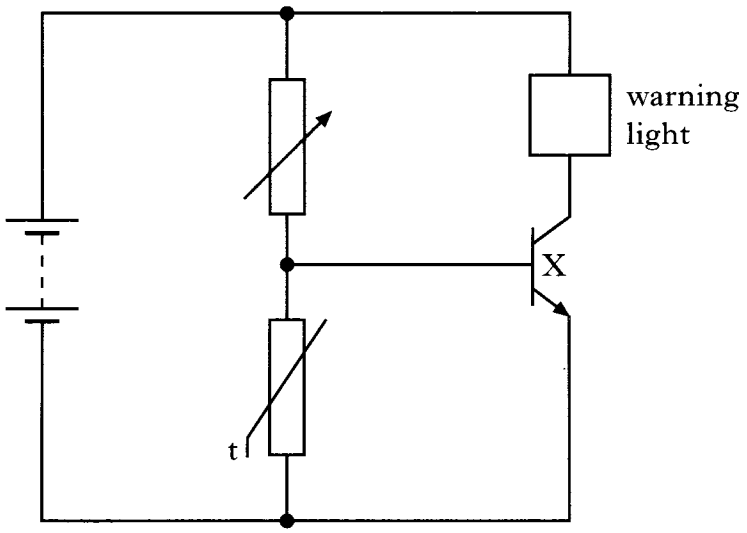
26. (*a*) A heater is used to melt ice on the rear window of a car.



(i) Calculate the heat energy required to melt 0·05 kg of ice.
(Latent heat of fusion of ice = $3{\cdot}34 \times 10^5$ J/kg) **2**

(ii) The heater takes 5 minutes to melt 0·05 kg of ice. Assuming all the energy is used to melt the ice, calculate the output power of the heater. **2**

(*b*) The car has a warning light which comes on when the outside temperature falls below 3 °C. The circuit for the warning light is shown.



(i) Name component X. **1**

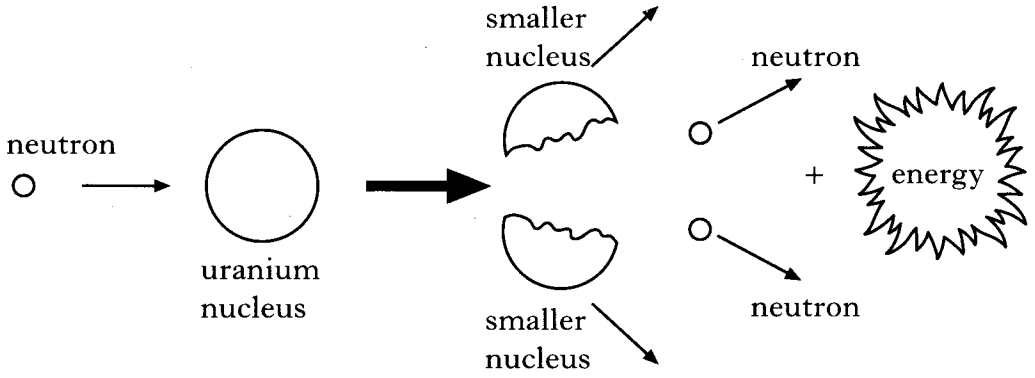
(ii) What happens to the resistance of the thermistor as the temperature falls? **1**

(iii) Explain how the circuit operates so that the warning light comes on when the temperature falls below 3 °C. **2**

(8)

27. A student reads the following article about nuclear power.

"In a nuclear reactor, uranium nuclei in fuel rods are bombarded with neutrons. A uranium nucleus may absorb a neutron and then break up into two smaller nuclei releasing further neutrons and energy."



(*a*) (i) A **nucleus** contains 2 types of particle. Name these particles. **1**

(ii) What is the name given to the process shown in the diagram? **1**

(iii) Explain why fuel rods have to be replaced after a certain time. **1**

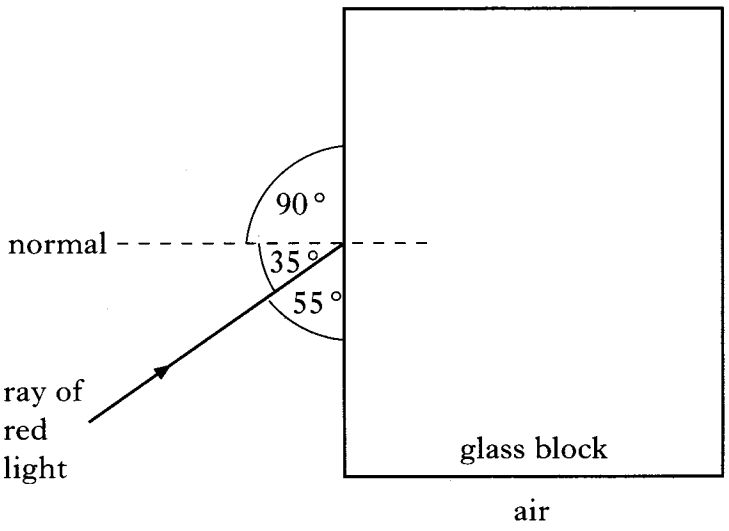
(iv) Explain why the fuel rods that are removed from the reactor are a safety hazard. **1**

(*b*) In a nuclear reactor, 166 MJ of energy is transferred to 2000 kg of coolant. All of this energy is absorbed by the coolant which has a specific heat capacity of 830 J/kg °C. Assuming the coolant does not change state, calculate the rise in temperature of the coolant. **2**

(6)

[Turn over

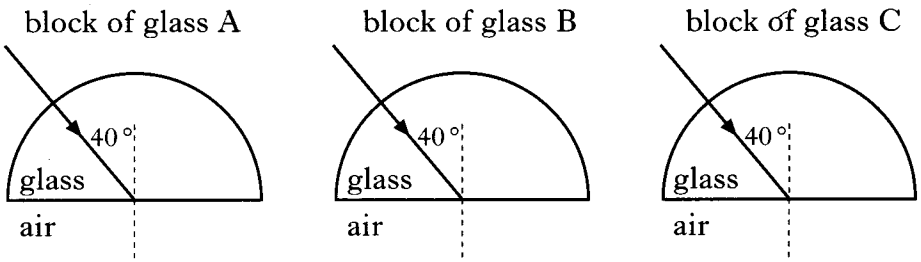
28. (*a*) A ray of red light is incident on a glass block as shown below.



(i) State the size of the angle of incidence. **1**

(ii) Copy the diagram and complete it to show the path of the ray inside the glass block. **1**

(*b*) In another experiment, rays of red light are incident on three semi-circular blocks of glass as shown. Each block is made of a different type of glass.



The critical angle for each block of glass is given below.

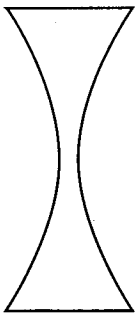
Glass type	*Critical angle*
A	38°
B	42°
C	44°

From which block(s) does a ray of light refract through the straight edge? Explain your answer. **2**

28. (continued)

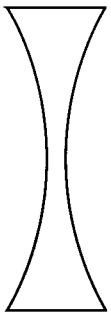
(*c*) One particular **short sighted** person requires a lens with a focal length of 200 mm. Six lenses, each of different type and power, are available.

lens P



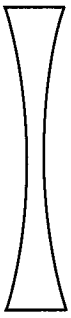
power −20 D

lens Q



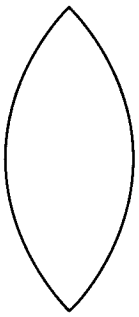
power −5 D

lens R



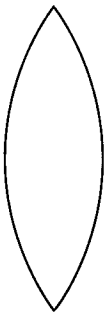
power −0·2 D

lens S



power +20 D

lens T



power +5 D

lens U

power +0·2 D

(i) Name the type of lens used to correct for short sight. **1**

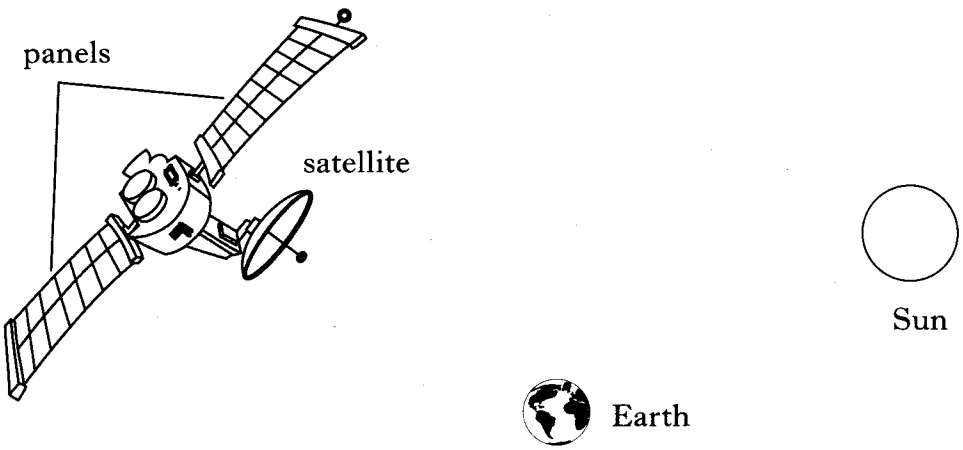
(ii) From the lenses shown, choose the one that corrects for the short sight of the above person.

You must justify your answer by calculation. **2**

(7)

[Turn over

29. A satellite orbiting the earth has large panels as shown.

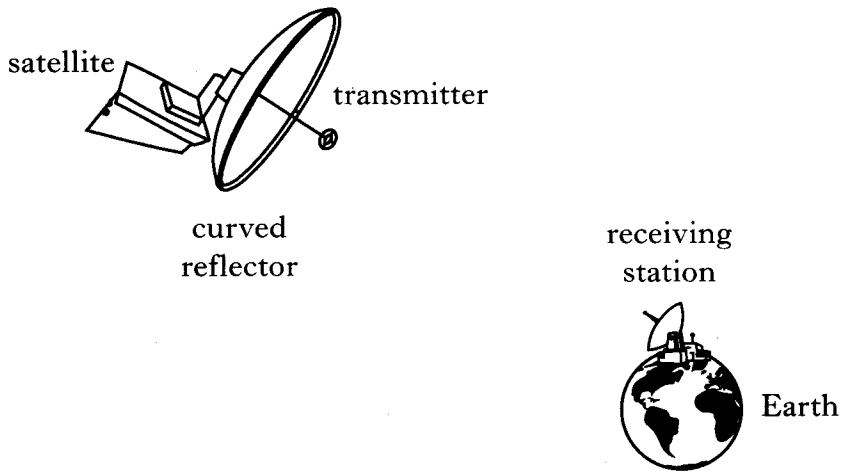


The panels absorb light energy from the sun and change it to electrical energy.

(*a*) (i) Name a device which can change light energy to electrical energy. **1**

(ii) The panels produce a current of 4·5 A for 5 minutes.
Calculate the charge moved in this time. **2**

(*b*) The satellite uses electrical energy to generate microwaves which are transmitted to a receiving station on earth.

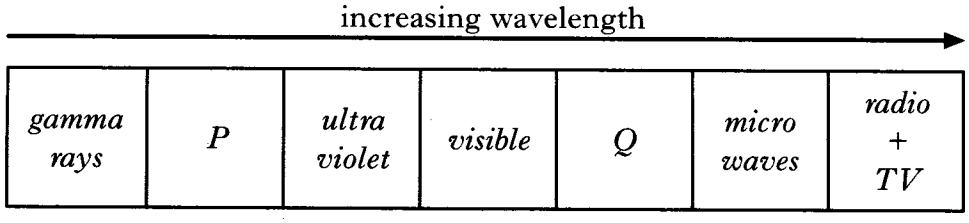


Explain how the curved reflector on the satellite aids the **transmission** of the microwaves. You must sketch a diagram as part of your answer. **2**

29. (continued)

(*c*) Microwaves are part of the electromagnetic spectrum.

The diagram below shows the electromagnetic spectrum arranged in order of wavelength. Two parts of the spectrum, P and Q, have been omitted. Name the radiations P and Q.



1

(*d*) All radiations in the electromagnetic spectrum travel at a speed of 3×10^8 m/s in space.

The satellite transmits microwaves on the following three frequencies.

$1{\cdot}0 \times 10^{10}$ Hz
$9{\cdot}0 \times 10^9$ Hz
$8{\cdot}0 \times 10^9$ Hz

Calculate the wavelength of the microwaves with the **longest** wavelength. **3**

(9)

[Turn over for Question 30 on *Page twenty-two*

Marks

30. Companies delivering radioactive sources have to follow strict safety rules. One rule is that sources must be labelled. The following information is displayed on a label on a radioactive source.

RADIOACTIVE SOURCE	
Source:	beta and gamma emitter
Year of delivery:	2003
Half life:	10 years
Activity:	20 000 Bq

(*a*) (i) What is meant by the activity of a source? **1**

(ii) Calculate the activity of the source in year 2043. **2**

(*b*) After delivery, the source is placed in a thick walled aluminium storage box. Which type of radiation from the source, if either, could penetrate the storage box? You must explain your answer. **2**

(*c*) A technician handling an **alpha-emitting** source estimates that his hand receives an absorbed dose of 5×10^{-5} Gy. The mass of the technician's hand is 500 g.

(i) Calculate the total energy absorbed by the technician's hand. **2**

(ii) Using information from the table below, calculate the dose equivalent received by his hand.

Type of radiation	*Quality factor*
Alpha	20
Beta	1
Gamma	1
X rays	1
Slow neutrons	2·3

2

(9)

[END OF QUESTION PAPER]