

X069/201

NATIONAL
QUALIFICATIONS
2000

WEDNESDAY, 31 MAY
9.00 AM – 11.00 AM

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.

SECTION A

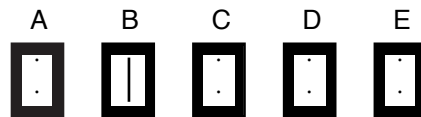
For questions 1 to 20 in this section of the paper, an answer is recorded on the answer sheet by indicating the choice A, B, C, D or E by a stroke made in ink in the appropriate box of the answer sheet—see the example below.

EXAMPLE

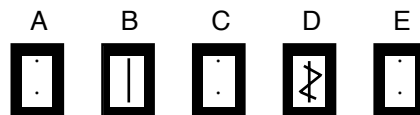
The energy unit measured by the electricity meter in your home is the

- 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:



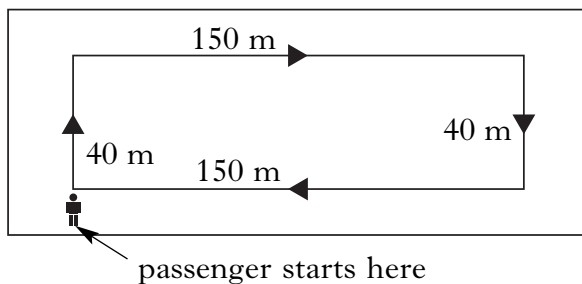
SECTION A

Answer questions 1–20 on the answer sheet.

1. Which of the following is a vector quantity?

- A Speed
- B Distance
- C Velocity
- D Time
- E Energy

2. At an airport a passenger starts at the entrance to the terminal building, walks around inside the building as shown below and arrives back at the entrance.



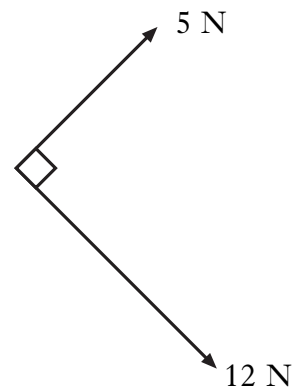
Which of the following correctly shows the total distance walked and the size of the final displacement?

	<i>Total distance in m</i>	<i>Final displacement in m</i>
A	0	155
B	0	380
C	190	155
D	380	0
E	380	380

3. One newton is the force required to give

- A a mass of 1 g an acceleration of 1 mm/s^2
- B a mass of 1 g an acceleration of 1 m/s^2
- C a mass of 1 kg an acceleration of 1 mm/s^2
- D a mass of 1 kg an acceleration of 1 m/s^2
- E a mass of 1 kg an acceleration of 10 m/s^2 .

4. Two forces act at right angles as shown below.

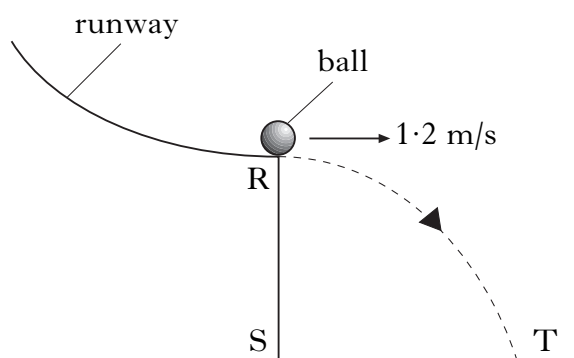


The size of the resultant force is

- A 7 N
- B 13 N
- C 17 N
- D 60 N
- E 169 N.

[Turn over

5. A ball rolls down a runway and leaves it at point R.



The horizontal speed of the ball at R is 1.2 m/s .

The ball takes 0.4 s to travel from R to T.

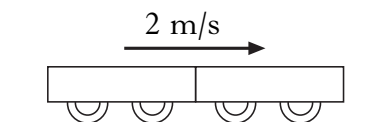
The distance ST is

- A 0.33 m
- B 0.48 m
- C 3.0 m
- D 4.8 m
- E 12 m .

6. A trolley of mass 1 kg travelling at 4 m/s collides with a stationary trolley X.



The two trolleys join together and move off with a speed of 2 m/s .



What is the mass of trolley X?

- A 0.5 kg
- B 1 kg
- C 2 kg
- D 7 kg
- E 8 kg

7. An engine applies a force of 2000 N to move a lorry at a constant speed.

The lorry travels a distance of 100 m in a time of 16 s .

The power developed by the engine is

- A 0.8 W
- B 12.5 W
- C 320 W
- D $12\,500 \text{ W}$
- E $3\,200\,000 \text{ W}$.

8. Below are three statements concerning the transfer of heat energy.

Which of these statements is/are correct?

I Different substances require different quantities of heat energy to raise the temperature of 1 kg by 1°C .

II When a substance changes state, no heat energy is gained or lost.

III When a substance changes state, its temperature does not change.

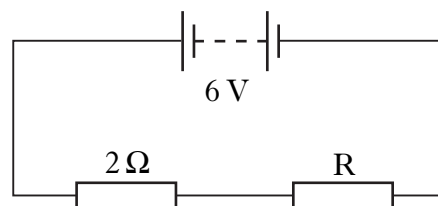
- A I only
 B I and II only
 C I, II and III
 D II and III only
 E I and III only

9. The specific latent heat of vaporisation of water is $2.26 \times 10^6 \text{ J/kg}$.

The energy required to change 50 g of water at 100°C to steam is

- A $1.13 \times 10^5 \text{ J}$
 B $1.13 \times 10^6 \text{ J}$
 C $1.13 \times 10^7 \text{ J}$
 D $1.13 \times 10^8 \text{ J}$
 E $1.13 \times 10^{11} \text{ J}$.

10. The circuit diagram shows a $2\ \Omega$ resistor and a resistor R of unknown value connected across a 6 V supply.

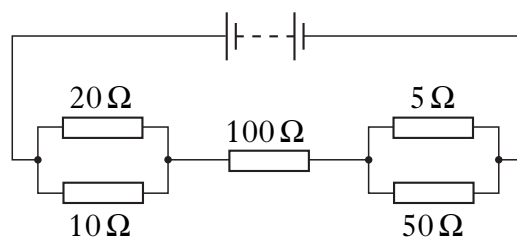


The current in the $2\ \Omega$ resistor is 2 A.

Which line correctly shows the voltage across resistor R and the current through R?

	<i>Voltage</i>	<i>Current</i>
A	2 V	2 A
B	2 V	4 A
C	4 V	2 A
D	6 V	2 A
E	6 V	4 A

11. In the circuit shown below, the current in each resistor is different.

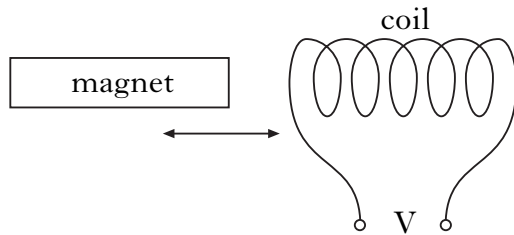


The current is **smallest** in the

- A $5\ \Omega$ resistor
 B $10\ \Omega$ resistor
 C $20\ \Omega$ resistor
 D $50\ \Omega$ resistor
 E $100\ \Omega$ resistor.

[Turn over

12. When a magnet is pushed into or pulled out of a coil of wire, a voltage is induced across the ends of the coil.



Which of the following produces the greatest induced voltage?

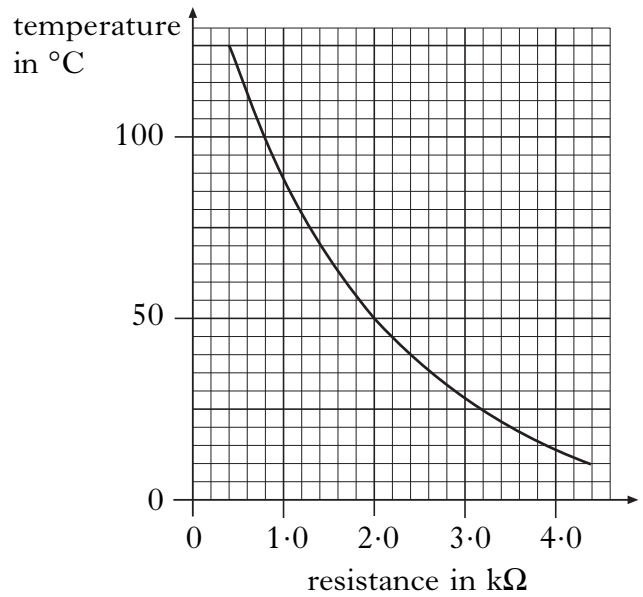
	<i>Strength of magnet</i>	<i>Speed of magnet</i>	<i>Number of turns in coil</i>
A	weak	slow	20
B	weak	fast	40
C	strong	slow	20
D	strong	fast	20
E	strong	fast	40

13. A transformer is designed to produce an output of 92 V from a 230 V a.c. mains input.

Which of the following gives the required output?

	<i>Number of turns in the primary</i>	<i>Number of turns in the secondary</i>
A	92	230
B	138	230
C	200	500
D	230	138
E	500	200

14. The graph below shows how the resistance of a thermistor varies with temperature.

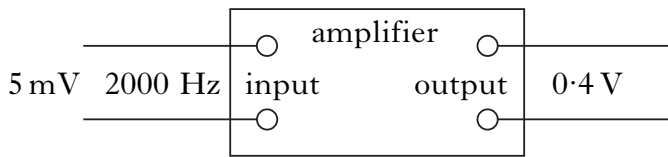


The thermistor is connected in a circuit. At a temperature of 50°C, the current in the thermistor is 4 mA.

At this temperature the voltage across the thermistor is

- A 0.008 V
- B 0.5 V
- C 2 V
- D 8 V
- E 8 000 V.

15. A signal of voltage 5 mV and frequency 2000 Hz is applied to the input of an amplifier.

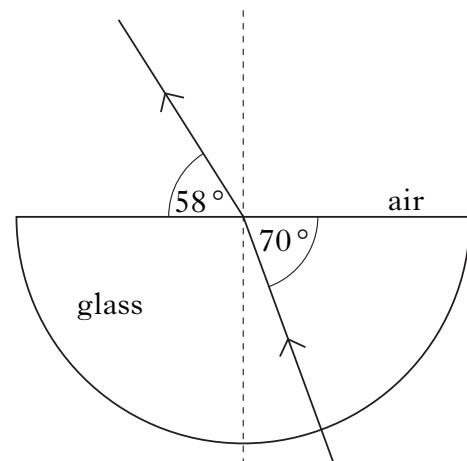


The output voltage is 0.4 V.

Which line shows the correct voltage gain of the amplifier and the frequency of the output signal?

	<i>Voltage gain</i>	<i>Output frequency in Hz</i>
A	0.0125	2000
B	0.08	50
C	0.08	2000
D	80	50
E	80	2000

16. A ray of light passes through a glass block as shown below.

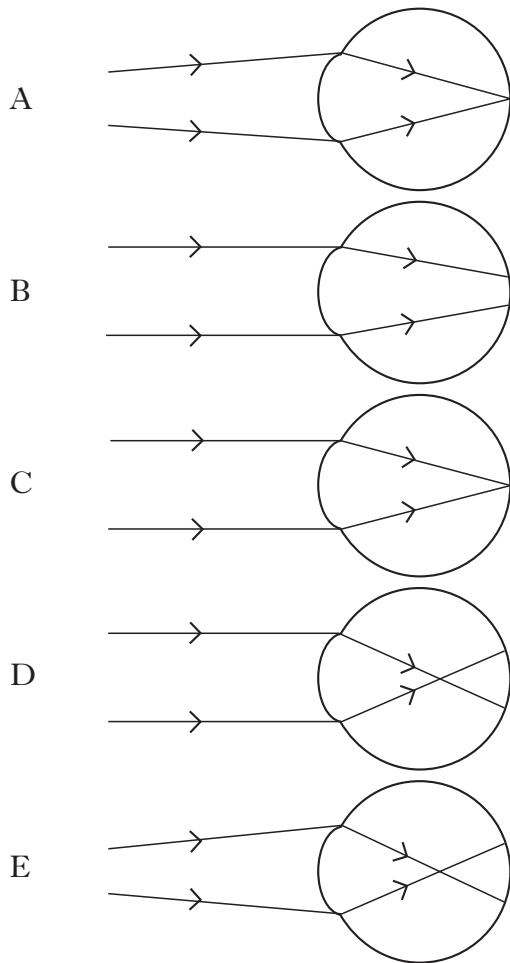


Which line correctly shows the angle of incidence in the glass and the corresponding angle of refraction?

	<i>Angle of incidence</i>	<i>Angle of refraction</i>
A	20°	32°
B	32°	20°
C	58°	70°
D	70°	32°
E	70°	58°

[Turn over

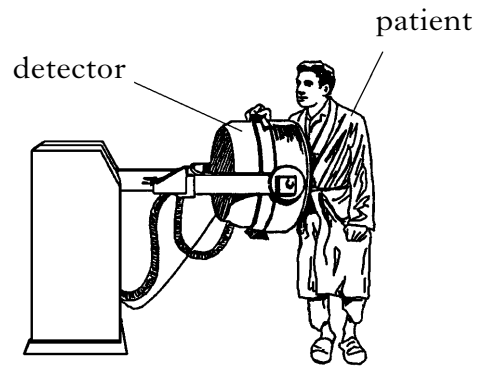
17. Which of the following diagrams shows the focusing of rays of light from a distant object by the eye of a long-sighted person?



18. An atom of helium consists of electrons, neutrons and protons.
The nucleus contains
- A electrons only
 - B neutrons and electrons
 - C protons and electrons
 - D protons and neutrons
 - E protons, neutrons and electrons.

19. The activity of a radioactive source is measured in
- A joules
 - B becquerels
 - C sieverts
 - D grays
 - E watts.

20. A radioactive substance is to be injected into a patient so that blood flow can be monitored.



A number of different substances which emit either β or γ radiation are available.

The substances have different half-lives.

Which substance, A, B, C, D or E is the most suitable?

<i>Substance</i>	<i>Radiation emitted</i>	<i>Half-life</i>
A	β	2 days
B	β	2 years
C	γ	2 seconds
D	γ	2 days
E	γ	2 years

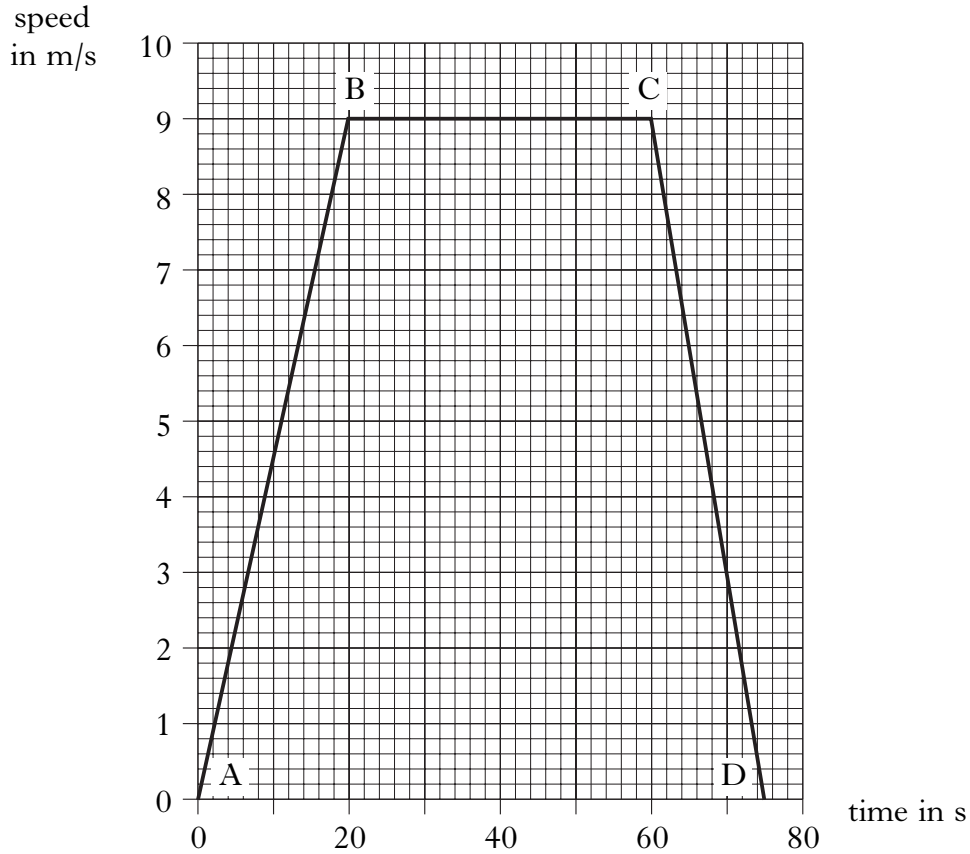
[Turn over for Section B]

SECTION B

Marks

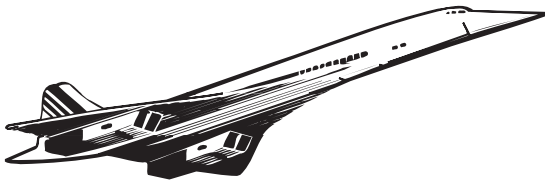
Write your answers to questions 21–30 in the answer book.

21. The graph below represents the motion of a cyclist travelling between two sets of traffic lights.



- (a) Describe the motion of the cyclist
- (i) between B and C 2
 - (ii) between C and D. 2
- (b) Calculate the acceleration between A and B. 2
- (c) Calculate the distance between the two sets of traffic lights. 3
- (d) Later in the journey the cyclist free-wheels down a hill at constant speed.
Explain this motion in terms of the forces acting on the cyclist. 2
- (9)**

22. An aircraft magazine gives the following information about Concorde.

Mass	185 000 kg	 <p style="text-align: right;">Concorde</p>
Maximum speed	605 m/s	
Take-off speed	112 m/s	
Landing speed	83 m/s	
Number of engines	4	
Force from each engine	170 kN	

- (a) (i) Calculate the total force exerted by the engines.
- (ii) With all of its engines on, at one point on the runway Concorde has an acceleration of 3.20 m/s^2 .
Calculate the frictional force acting on Concorde at this point. 4
- (b) Some modern aircraft are controlled by on-board computer systems linked by optical fibres.
The diagram below shows a ray of light inside an optical fibre.



- (i) (A) Copy and complete the diagram to show the path of the ray of light in the fibre.
- (B) Name the effect that occurs when the ray hits the inside surface of the fibre.
- (ii) In an optical fibre link in an aircraft, light travels a distance of 62 m.
Calculate the time taken for a light signal to travel along this fibre.
(speed of light in fibre = $2.0 \times 10^8 \text{ m/s}$) 4

(8)

[Turn over

23. A chairlift at a ski resort carries skiers through a vertical distance of 400 m.



(a) One of the skiers has a mass of 90.0 kg .

What is the weight of this skier?

2

(b) (i) The chairlift carries 3000 skiers of average mass 90.0 kg in one hour.
What is the total gravitational potential energy gained by the skiers?

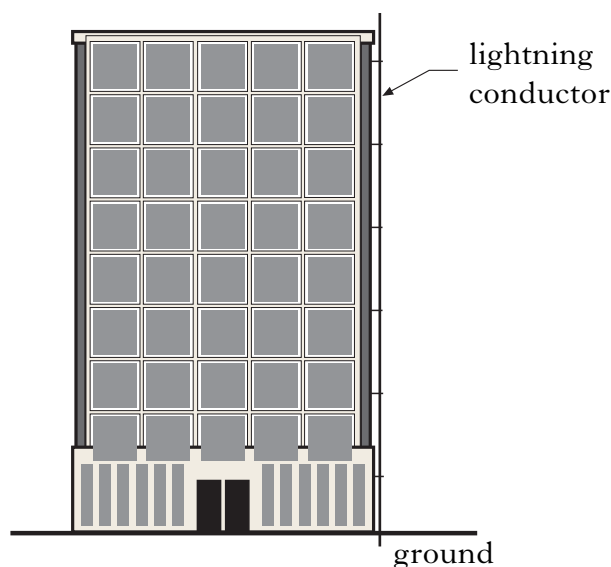
(ii) The chairlift is powered by an electric motor which is 67.5% efficient.

Calculate the input power to the motor.

5

(7)

24. A lightning conductor is fitted to a tall building.



The specification for the lightning conductor is:

length	50.0 m
resistance per metre	0.080 Ω
mass	100 kg
specific heat capacity	385 J/kg $^{\circ}$ C.

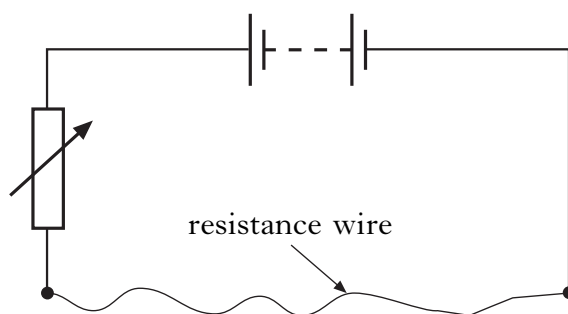
During a thunderstorm, a total charge of 300 C flows through the lightning conductor to the ground in 0.120 s.

- (a) Calculate the current in the lightning conductor during this time. 2
- (b) Show that the power in the lightning conductor is 25 MW. 3
- (c) (i) Calculate the maximum temperature rise that could be produced in the lightning conductor by this flow of charge.
- (ii) What assumption have you made in your calculation for (c) (i)? 4
- (9)**

[Turn over

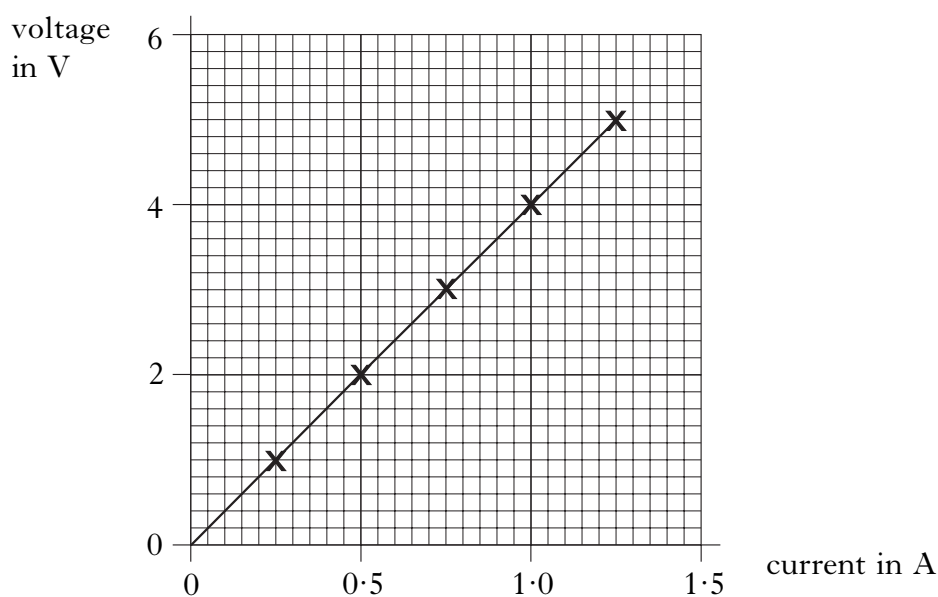
25. A student is given a piece of resistance wire 200 mm long and is asked to find its resistance.

Part of the circuit the student builds is shown below.



The student is also provided with a voltmeter and an ammeter.

- (a) Redraw the diagram to show how the student should connect the meters to measure the resistance of the wire. 2
- (b) The student now uses measurements from the experiment to draw the following graph.

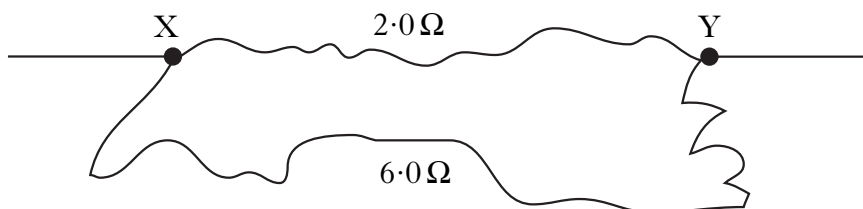


- (i) Describe how the student uses the circuit to obtain the measurements for the graph.
- (ii) Calculate the resistance of **one metre** of the wire. 5

25. (continued)

(c) Two pieces of wire have resistances of $2.0\ \Omega$ and $6.0\ \Omega$.

The wires are connected together as shown below.



Calculate the resistance between points X and Y.

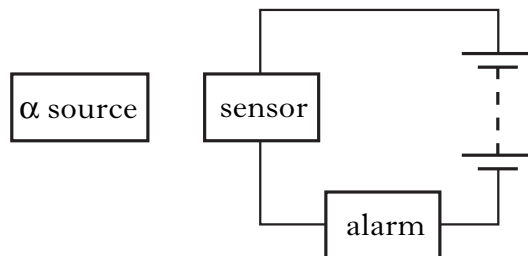
2
(9)

[Turn over

26. Some smoke alarms use a radioactive source which emits α -particles.

The detector operates because of ionisation caused by the α -particles in the space between the α source and the sensor.

If smoke or dust enters the space, the alarm operates.



- (a) (i) What is an α -particle?
(ii) What is meant by “ionisation”?
(iii) Why is an α source used instead of a source which emits β -particles or γ -rays?
(iv) The smoke alarm manufacturer has to choose from three α emitting sources. The half-life of each source is shown in the table.

<i>Source</i>	<i>Half-life</i>
A	4 hours
B	4 weeks
C	400 years

Which source should the manufacturer choose?

Explain your answer.

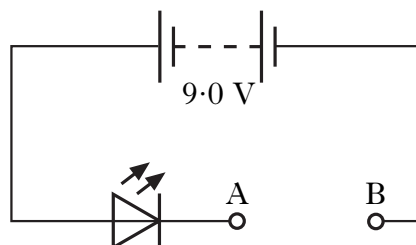
5

26. (continued)

- (b) One design of smoke detector has an LED which lights to show that the battery is in good condition.

A 9.0 V battery is used in the LED circuit shown below.

One component is missing, between A and B.



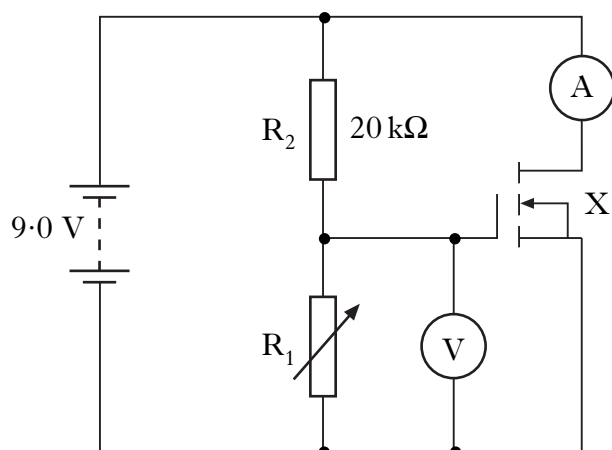
In normal operation, the LED carries a current of 20 mA and the voltage across it is 1.9 V.

- (i) What is the name of the component that should be connected between A and B?
- (ii) Calculate the value which this component should have so that the LED operates normally.

4
(9)

[Turn over

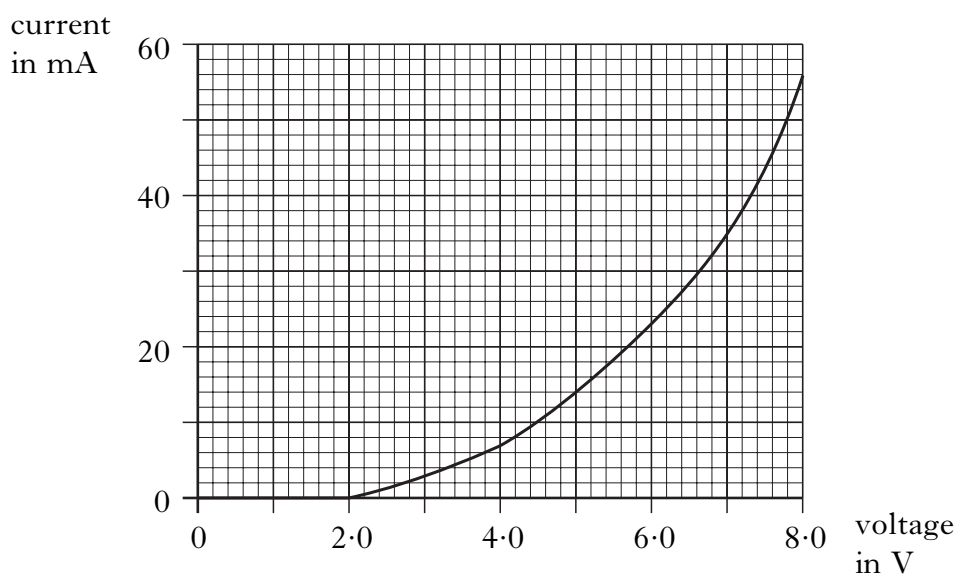
27. The circuit shown below is used to investigate the behaviour of component X.



- (a) (i) What is the name of component X?
- (ii) What name is given to the arrangement of the two series resistors R_1 and R_2 connected across the 9.0 V supply?
- (b) By using different values of resistor R_1 , different voltages are applied to the input of X.

2

The graph below shows how the current through X changes as the voltage applied to the input is altered.

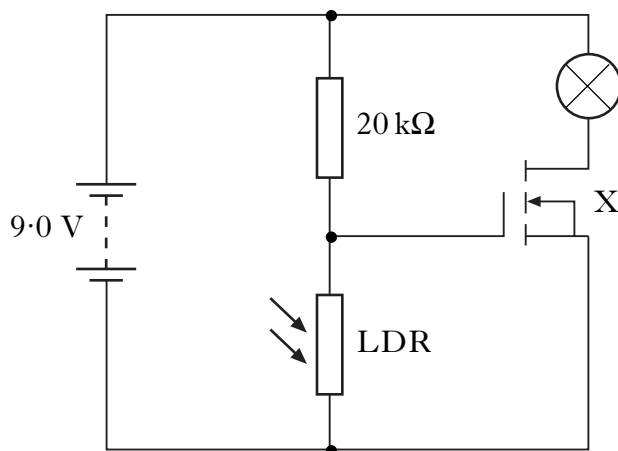


- (i) What is the reading on the voltmeter when device X starts to conduct?
- (ii) Calculate the value of resistor R_1 which is required to obtain this voltage.

3

27. (continued)

- (c) Component X is now connected into the circuit below to switch on an emergency lamp when it becomes dark.



The table below shows the resistance of the LDR in light and in dark.

<i>Lighting condition</i>	<i>Resistance of LDR in kΩ</i>
light	0.1
dark	10.0

Explain how this circuit operates to switch on the emergency lamp.

3
(8)

[Turn over

28. Typical wavelengths in air of light of different colours are given in the table below.

<i>Colour</i>	<i>Wavelength in air in m</i>
red	6.5×10^{-7}
green	5.2×10^{-7}
blue	4.0×10^{-7}

- (a) What is the speed of light in air? 1
- (b) The frequency of a certain colour of light is 4.6×10^{14} Hz.
What colour is this light?
You must justify your answer by calculation. 3
- (4)**

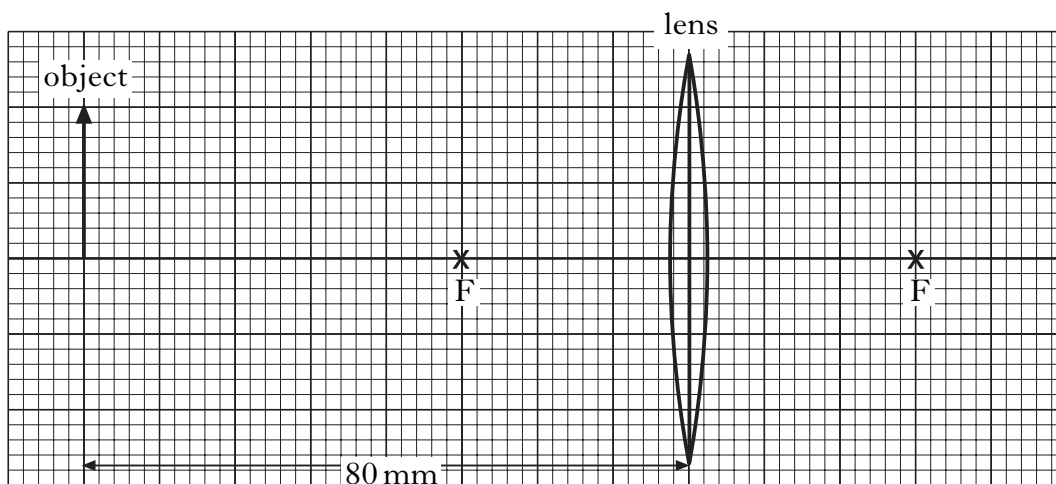
29. A converging lens has a focal length of 30 mm.

(a) Calculate the power of this lens.

2

(b) (i) In the diagram below, which is drawn to scale, an object is shown at a distance of 80 mm from a lens.

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

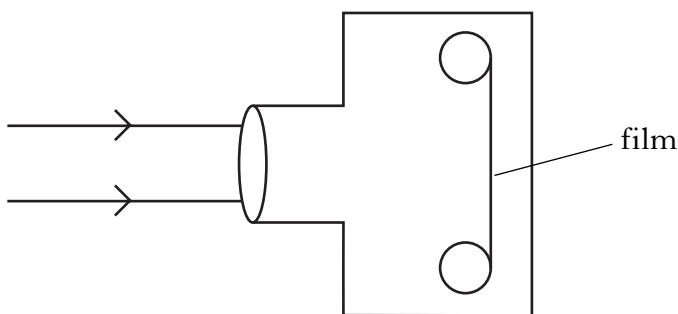


Copy the diagram onto squared paper and draw in two rays to show the formation of the image of this object.

(ii) State **two** ways in which this image is different from the object.

5

(c) This lens is now fitted to a camera. The diagram below shows rays of light coming to the lens from a distant object.



How far should the film be from the lens to give a sharp image?

Explain your answer.

2

(9)

[Turn over

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