1 The units of physical quantities can be expressed in terms of the fundamental (base) units of the SI system. In which line in the table are the fundamental units correctly matched to the physical quantity?

	Physical quantity	Fundamental units	
A	charge	$A\ s^{-1}$	⬭
B	power	$kg\ m^2\ s^{-3}$	⬭
C	potential difference	$kg\ m^2\ s\ A^{-1}$	⬭
D	energy	$kg\ m^2\ s^{-1}$	⬭

(Total 1 mark)

2 When the temperature of a copper wire increases, its ability to conduct electricity

A remains the same. ⬭

B increases. ⬭

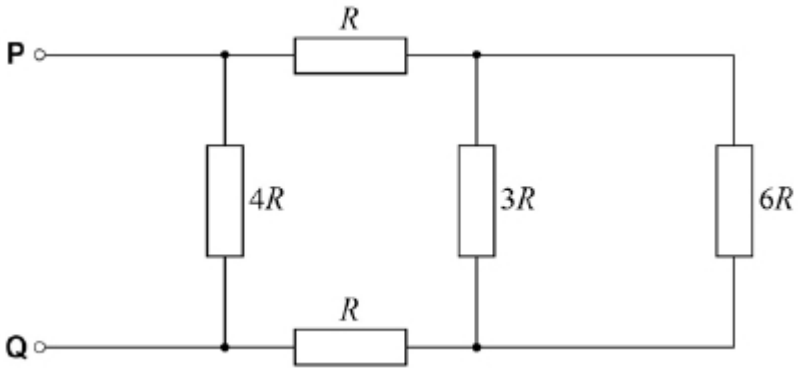
C decreases. ⬭

D remains the same at first and then increases. ⬭

(Total 1 mark)

3 The diagram shows a network of resistors connected between the terminals **P** and **Q**.

The resistance of each resistor is shown.



What is the effective resistance between **P** and **Q**?

A R ⬭

B $2R$ ⬭

C $3R$ ⬭

D $4R$ ⬭

(Total 1 mark)

4 A metal wire has a length l and a cross-sectional area A. When a potential difference V is applied to the wire, there is a current I in the wire.

What is the resistivity of the wire?

A $\frac{IA}{Vl}$ ⬭

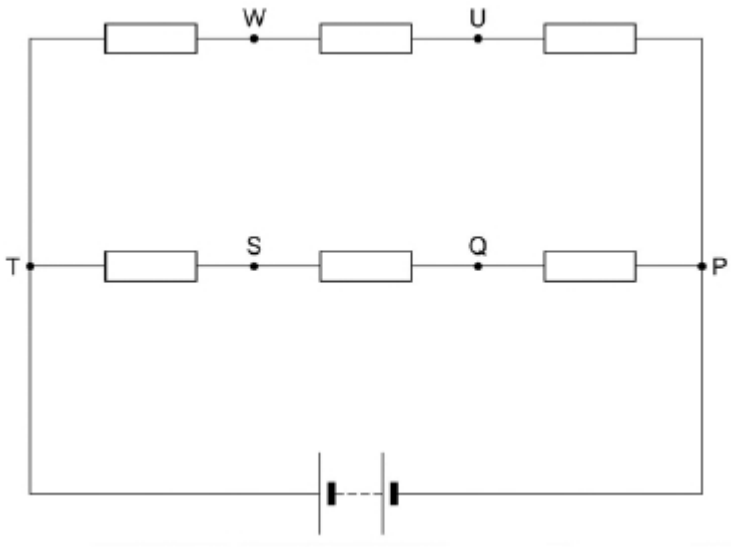
B $\frac{VA}{Il}$ ⬭

C $\frac{Il}{VA}$ ⬭

D $\frac{Vl}{IA}$ ⬭

(Total 1 mark)

5 In the circuit shown below, each of the resistors has the same resistance.



A voltmeter with very high resistance is connected between two points in the circuit.

Between which two points of connection would the voltmeter read zero?

A Q and U ⬭

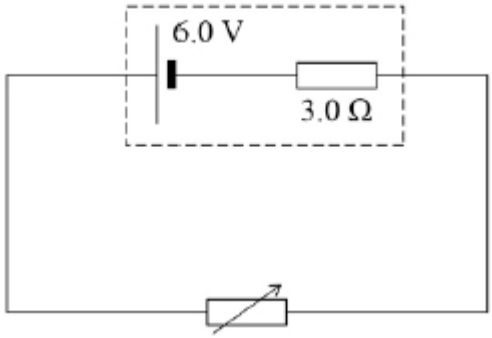
B P and T ⬭

C Q and W ⬭

D S and U ⬭

(Total 1 mark)

6 The cell in the following circuit has an emf (electromotive force) of 6.0 V and an internal resistance of 3.0 Ω. The resistance of the variable resistor is set to 12 Ω.



How much electrical energy is converted into thermal energy **within the cell** in 1 minute?

A 0.48 J ⬭

B 29 J ⬭

C 45 J ⬭

D 144 J ⬭

(Total 1 mark)

7 Three identical cells, each of internal resistance R, are connected in series with an external resistor of resistance R. The current in the external resistor is I. If one of the cells is reversed in the circuit, what is the new current in the external resistor?

A $\frac{I}{3}$ ⬭

B $\frac{4I}{9}$ ⬭

C $\frac{I}{2}$ ⬭

D $\frac{2I}{3}$ ⬭

(Total 1 mark)

8 In a cathode ray tube 7.5×10^{15} electrons strike the screen in 40 s. What current does this represent?

Charge of the electron is 1.6×10^{-19} C.

A 1.3×10^{-16} A ⬭

B 5.3×10^{-15} A ⬭

C 3.0×10^{-5} A ⬭

D 1.2×10^{-3} A ⬭

(Total 1 mark)

9 A cylindrical conductor of length l, diameter D, and resistivity ρ has a resistance R.

What is the resistance of another cylindrical conductor of length l, diameter $\frac{D}{2}$, and resistivity ρ?

A $8R$ ⬭

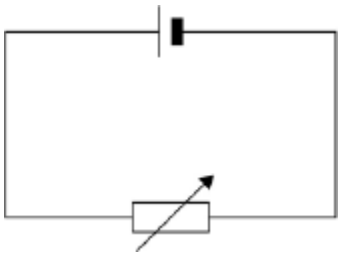
B $4R$ ⬭

C $2R$ ⬭

D R ⬭

(Total 1 mark)

10 The cell in the circuit has an emf of 2.0 V. When the variable resistor has a resistance of 4.0 Ω, the potential difference (pd) across the terminals of the cell is 1.0 V.



What is the pd across the terminals of the cell when the resistance of the variable resistor is 12 Ω?

A 0.25 V ⬭

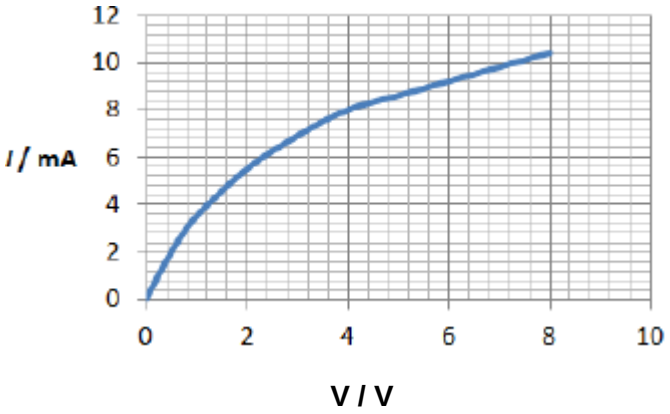
B 0.75 V ⬭

C 1.33 V ⬭

D 1.50 V ⬭

(Total 1 mark)

11 The graph shows the current–voltage (*I*–*V*) characteristics of a filament lamp.



What is the resistance of the filament when the potential difference (pd) across it is 4.0 V?

A 500 Ω ⬭

B 1700 Ω ⬭

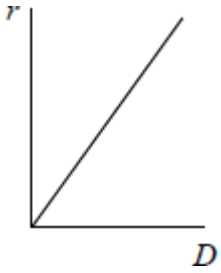
C 2000 Ω ⬭

D 6000 Ω ⬭

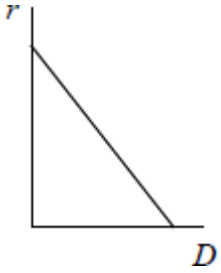
(Total 1 mark)

12 Which graph shows how the resistance per unit length *r* of a wire varies with diameter *D* of the wire?

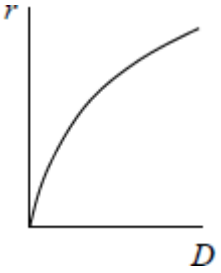
A



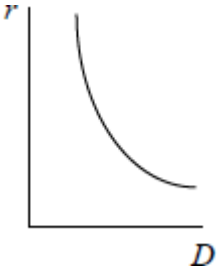
B



C



D



A ☐

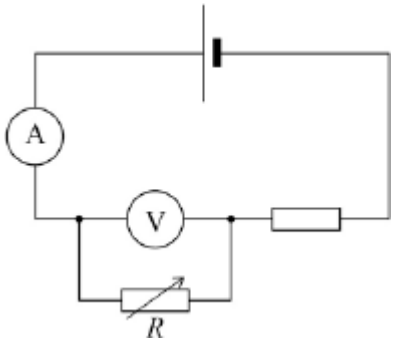
B ☐

C ☐

D ☐

(Total 1 mark)

13 In the circuit shown in the diagram the cell has negligible internal resistance.

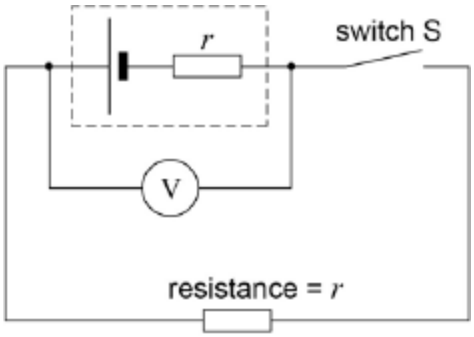


What happens to the reading of both meters when the resistance of R is decreased?

	Reading of ammeter	Reading of voltmeter	
A	increases	increases	☐
B	increases	decreases	☐
C	decreases	increases	☐
D	unchanged	decreases	☐

(Total 1 mark)

14 In the circuit shown, V is a voltmeter with a very high resistance. The internal resistance of the cell, r, is equal to the external resistance in the circuit.



external resistance

Which of the following is not equal to the emf of the cell?

A the reading of the voltmeter when the Switch S is open ⬭

B the chemical energy changed to electrical energy when unit charge passes through the cell ⬭

C twice the reading of the voltmeter when the switch S is closed ⬭

D the electrical energy produced when unit current passes through the cell ⬭

(Total 1 mark)

15 The current in a wire is 20 mA.

How many electrons pass a point in the wire in 2 minutes?

A 2.5×10^{17} ⬭

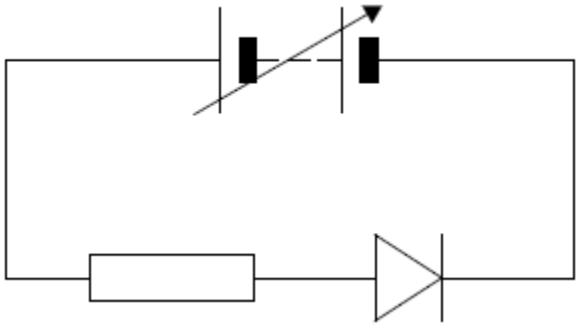
B 1.5×10^{19} ⬭

C 2.5×10^{20} ⬭

D 1.5×10^{22} ⬭

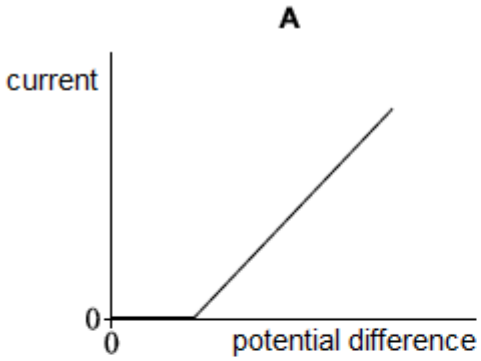
(Total 1 mark)

16 A resistor and diode are connected in series with a variable power supply as shown in the diagram.

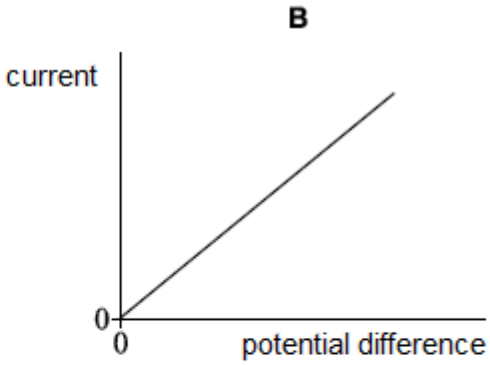


Which best shows the characteristic for the combination of the resistor and diode?

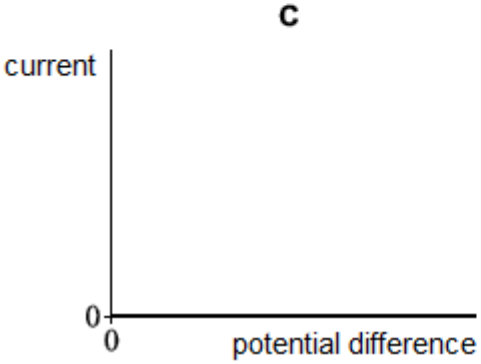
A



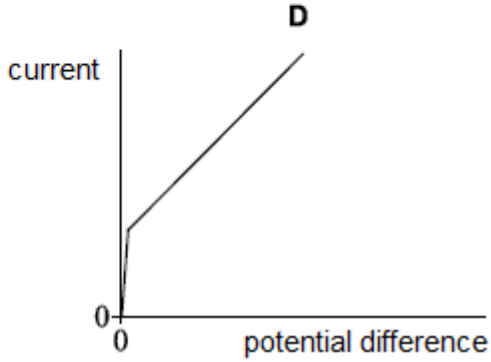
B



C



D



A ⬭

B ⬭

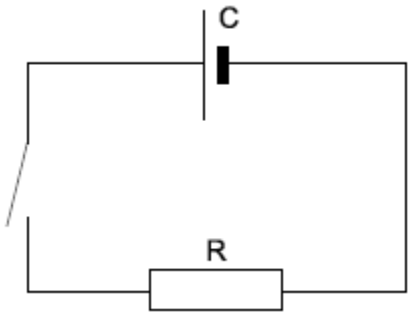
C ⬭

D ⬭

(Total 1 mark)

17 A cell C of negligible resistance and a switch are in series with a resistor R. The switch is moved to the on (closed) position for a time *t*.

Which change reduces the amount of charge flowing through R in time *t*?



A add an identical cell in parallel with C ⬭

B add an identical cell in series with C ⬭

C add a second resistor in series with R ⬭

D add a second resistor in parallel with R ⬭

(Total 1 mark)

18 The National Grid uses high-voltage transmission lines to carry electrical power around the UK. A particular transmission line delivers 800 MW of power at 132 kV to the user. It loses 1% of the transmitted power as heat.

What is the resistance of the transmission line?

A 0.2 Ω ⬭

B 6 Ω ⬭

C 20 Ω ⬭

D 2000 Ω ⬭

(Total 1 mark)

19 A potential divider circuit consists of a battery connected across a thermistor and variable resistor in series.

Which of the following causes the potential difference (pd) across the thermistor to increase?

A increasing the temperature of the thermistor ⬭

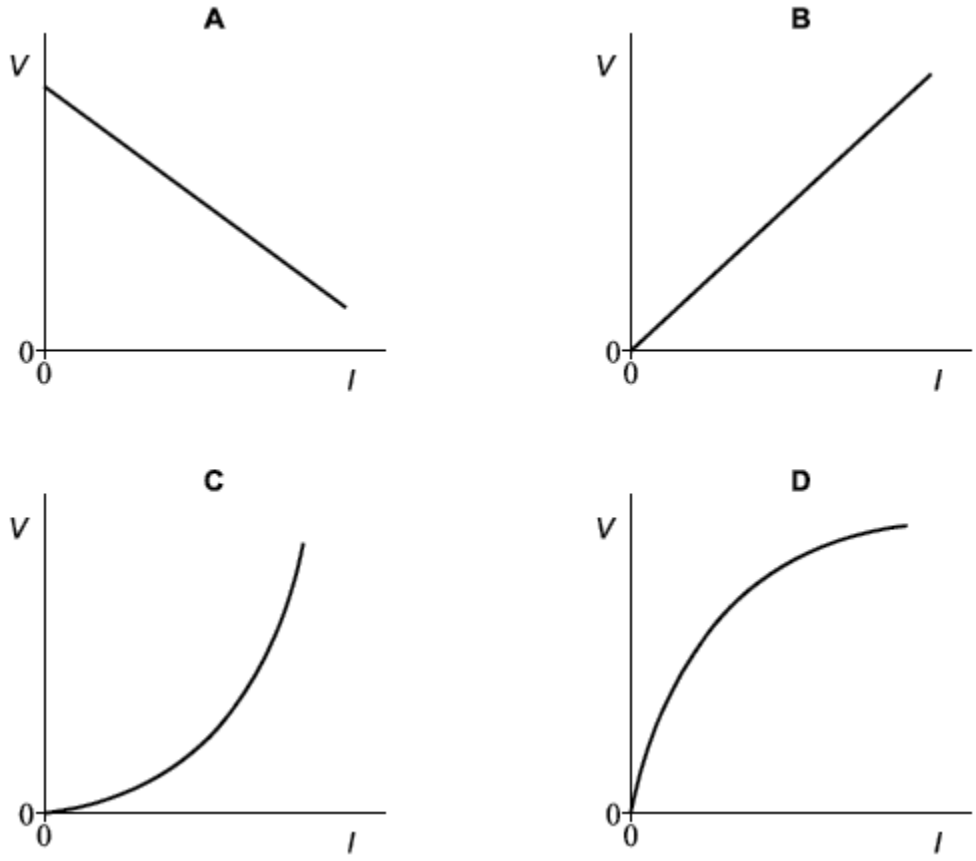
B increasing the resistance of the variable resistor ⬭

C reducing the emf of the battery ⬭

D adding a resistor across the variable resistor ⬭

(Total 1 mark)

20 A student investigates how the potential difference *V* across the terminals of a cell varies with the current *I* in the cell.



Which graph correctly shows how *V* varies with *I*?

A ⬭

B ⬭

C ⬭

D ⬭

(Total 1 mark)

21 A battery is connected to a 10 Ω resistor and a switch in series. A voltmeter is connected across the battery. When the switch is open (off) the voltmeter reads 1.45 V. When the switch is closed the reading is 1.26 V.

What is the internal resistance of the battery?

A 0.66 Ω ⬭

B 0.76 Ω ⬭

C 1.3 Ω ⬭

D 1.5 Ω ⬭

(Total 1 mark)

22 When fully charged the 2.0 mF capacitor used as a backup for a memory unit has a potential difference of 5.0 V across it. The capacitor is required to supply a constant current of 1.0 μA and can be used until the potential difference across it falls by 10%. For how long can the capacitor be used before it must be recharged?

A 10 s

B 100 s

C 200 s

D 1000 s

(Total 1 mark)

23 In parts (i) and (ii) circle the letter that corresponds to the correct answer.

(i) The resistance of a negative temperature coefficient (ntc) thermistor

A increases as temperature increases.

B is constant at temperatures below 0 °C.

C increases as temperature decreases.

D falls to zero when a critical temperature is reached.

(1)

(ii) The unit of potential difference can be expressed as

A $C\ s^{-1}$

B $J\ C^{-1}$

C $V\ A^{-1}$

D $J\ A^{-1}$

(1)

(Total 2 marks)

24 The resistance of a metallic conductor increases with temperature because, at higher temperatures,

A more electrons become available for conduction

B the conductor becomes a superconductor

C the amplitude of vibration of lattice ions increases

D the length and cross-sectional area of the conductor both increase

(Total 1 mark)

25 A 1.5 m length of wire has a cross-sectional area $5.0 \times 10^{-8}\ m^2$. When the potential difference across its ends is 0.20 V, it carries a current of 0.40 A. The resistivity of the material from which the wire is made is

A $6.0 \times 10^{7}\ \Omega\ m$

B $1.7 \times 10^{-8}\ \Omega\ m$

C $1.1 \times 10^{6}\ \Omega\ m$

D $9.4 \times 10^{-7}\ \Omega\ m$

(Total 1 mark)

26 The circuit in **Figure 1** is used to investigate how the potential difference V between the terminals of a cell varies as the current I in the circuit changes. **Figure 2** shows the graph of the results.

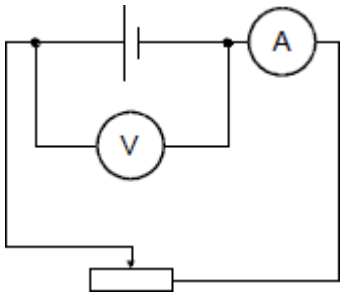


Figure 1

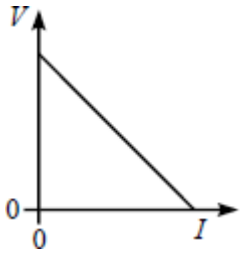


Figure 2

Which one of the following can be deduced from the gradient of the graph?

A The internal resistance of the cell

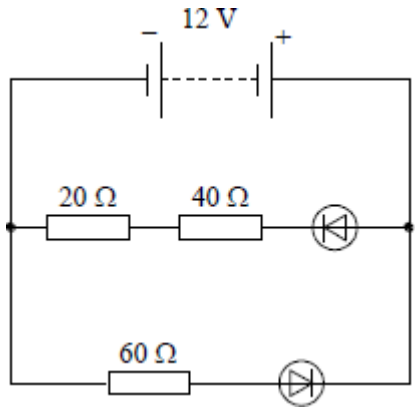
B The e.m.f. of the cell

C The power dissipated by the cell

D The resistance of the variable resistor

(Total 1 mark)

27 The 12 V battery in the circuit shown has negligible internal resistance. The diodes have 'ideal' characteristics.



The current through the battery is approximately

A 0 A

B 0.10 A

C 0.20 A

D 0.40 A

(Total 1 mark)

28 Copper metal is a good conductor of electricity because copper atoms in copper metal

A have gained an extra or “free” electron

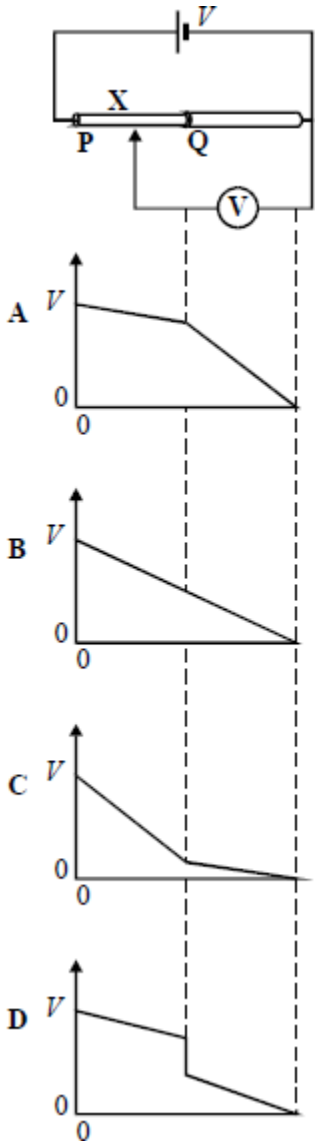
B are ionised so that both ions and “free” electrons can move

C have a negative charge because of the “free” electrons

D have lost an electron to form positive ions and “free” electrons

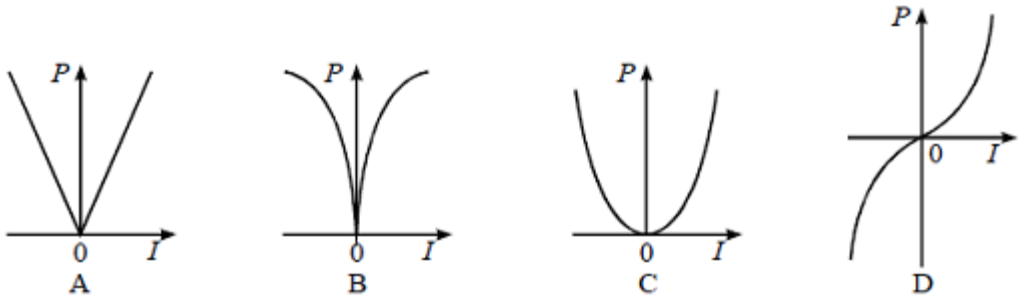
(Total 1 mark)

29 The diagram shows two wires, **P** and **Q**, of equal length, joined in series with a cell. A voltmeter is connected between the end of **Q** and a point **X** on the wires. The p.d. across the cell is V. Wire **Q** has twice the area of cross-section and twice the resistivity of wire **P**. The variation of the voltmeter reading as the point **X** is moved along the wires is best shown by



(Total 1 mark)

30 A metal wire is maintained at a constant temperature. Which one of the following graphs best represents the relationship between the dissipated power P and the current I in the wire?



(Total 1 mark)

31 Two resistors R_1 and R_2 are made of wires of the same material. The wire used for R_1 has half the diameter and is twice as long as the wire used for R_2.

What is the value of the ratio $\frac{\text{resistance of } R_1}{\text{resistance of } R_2}$?

A 8

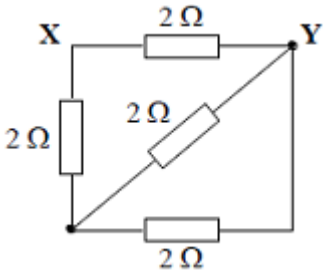
B 4

C 1

D 0.5

(Total 1 mark)

32 The diagram shows a network of four 2 Ω resistors.



The effective resistance, in Ω, between **X** and **Y** is

A 0.5

B 1.2

C 1.7

D 2.0

(Total 1 mark)

Mark schemes

1 B **[1]**

2 C **[1]**

3 B **[1]**

4 B **[1]**

5 A **[1]**

6 B **[1]**

7 A **[1]**

8 C **[1]**

9 B **[1]**

10 D **[1]**

11 A **[1]**

12 D **[1]**

13 B **[1]**

14 D **[1]**

15 B **[1]**

16 A **[1]**

17 C **[1]**

18 A

[1]

19 D

[1]

20 A

[1]

21 D

[1]

22 D

[1]

23 (i) C

B1

1

(ii) B

B1

1

[2]

24 C

[1]

25 B

[1]

26 A

[1]

27 C

[1]

28 D

[1]

29 B

[1]

30 C

[1]

31 A

[1]

32 B

[1]

Examiner reports

15 54% of students were able to perform this relatively straightforward calculation. Surprisingly D was the least popular distractor, suggesting students had more problems with correctly using seconds rather than minutes than dealing with the m in mA.

16 With 55% of students giving the correct answer, this question proved to be reasonably accessible. This may be because the experiment is often carried out with a protective resistor in series with the diode. The most popular distractor, D, indicates some confusion between current and pd. A relatively high number of students opted for C, suggesting some difficulties working out whether the diode was reverse biased or not.

17 Many students have difficulties with electricity questions. Using multiple choice questions such as this one may help deal with some misconceptions. The correct answer was given by 40% of students, but nearly 50% believed that adding a resistor in parallel would reduce the current (and hence the charge) through R, despite being told that the cell has negligible resistance. Presumably the students believed that the current through the cell does not change, and therefore the current is shared between the two resistors.

18 It is clear from answers to this question that few students (approximately 13%) had much understanding of how using high voltage power lines reduces energy loss. In fact the correct answer proved to be the least popular of the choices. The current through a transmission line is found from the power being delivered and the voltage of the line (P = IV). Hence higher voltages result in lower currents. The power dissipated is then related to the current in the line, and the resistance of the line. Students were expected to use P = IV to calculate the current in the line, and then use the power loss (1%P) = I^2R to calculate the resistance. Responses suggested that many students believe that the 132 kV is dropped across the line, rather than between the line and earth.

19 This proved to be more demanding than expected, with more students choosing A than the correct answer (D). This was perhaps due to students realising that thermistors had something to do with temperature, without realising that the higher the temperature the lower the resistance. It may be that these students rejected the other answers without checking them as an understanding of resistors in series and parallel should have led to the correct answer.

20 Students familiar with the characteristic for a fixed resistance were probably led to answer B without reading the question. This proved to be the most popular answer despite it being incorrect. Approximately 20% were sufficiently careful with their reading, or sufficiently familiar with the practical, to give the correct answer, A.

21 This calculation was fairly demanding with only 27% of students giving the correct answer. In fact answers B, C and D proved to be almost equally popular, suggesting a fair amount of informed guessing was going on. It may have been made easier had a circuit diagram been provided. In the absence of one, students should be encouraged to draw their own in the spaces on the paper.

22 This question was similar but a little more demanding, because its facility was 67%. The 15% of students who gave distractor B may have had difficulty in combining mF with μA, because they arrived at an answer of 100 s instead of 1000 s.

23 Part (i) was correctly answered by about three quarters of the candidates.

About half of the candidates correctly answered part (ii).