9. Electricity

9.3 Resistance and resistivity

Paper 1

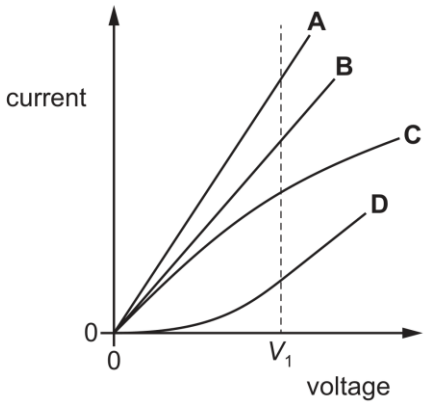
Question Paper

1 What is the unit of resistivity?

A Ωm^{-2} **B** Ωm^{-1} **C** Ω **D** Ωm

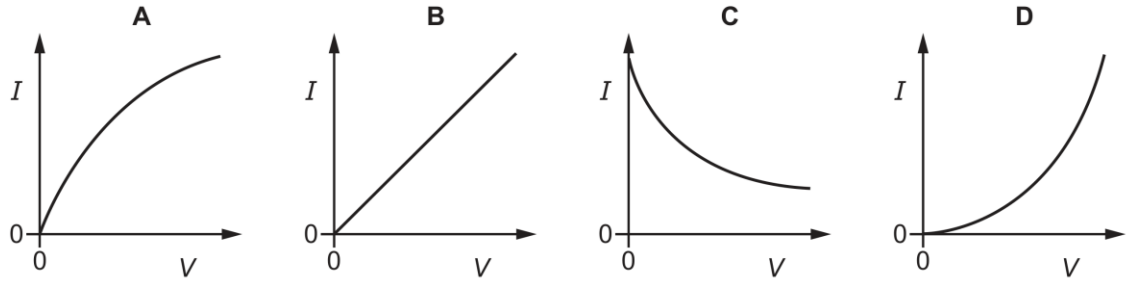
2 The I–V characteristics for four components, **A**, **B**, **C** and **D**, are shown.

Which component has the greatest resistance when the potential difference across it is V_1?

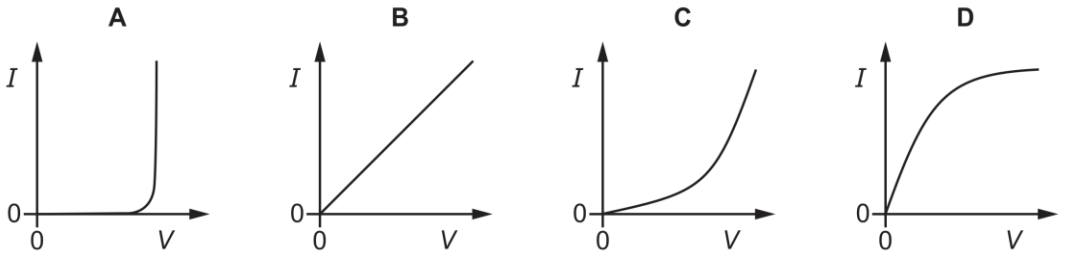


3 The potential difference V across a filament lamp is slowly raised from zero to its normal operating value.

Which graph represents the variation with V of the current I in the lamp?



4 Which graph shows the I–V characteristic of a filament lamp?



5 A metal wire has a length of 2.50 m and a cross-sectional area of $4.50 \times 10^{-6}\,m^2$. The resistivity of the metal is $3.50 \times 10^{-7}\,\Omega m$.

The wire is stretched so that its length increases to 2.65 m. The wire remains cylindrical and the **volume** of the wire remains constant.

What is the change in the resistance of the wire?

A 0.012 Ω **B** 0.024 Ω **C** 0.19 Ω **D** 0.22 Ω

6 An electrical cable is made up of one thick strand of copper wire that is surrounded by eight thin strands of copper wire. All nine strands of wire are connected in parallel with each other.

A cross-section of the cable is shown.



Each thin strand of wire has cross-sectional area A and length L.

The thick strand of wire has cross-sectional area $4A$ and length L.

The cable has total resistance R.

Which expression gives the resistivity of copper?

A $\frac{4A}{33RL}$ **B** $\frac{12A}{RL}$ **C** $\frac{4AR}{L}$ **D** $\frac{12AR}{L}$

7 A car has sensors for detecting the light intensity and temperature of its environment.

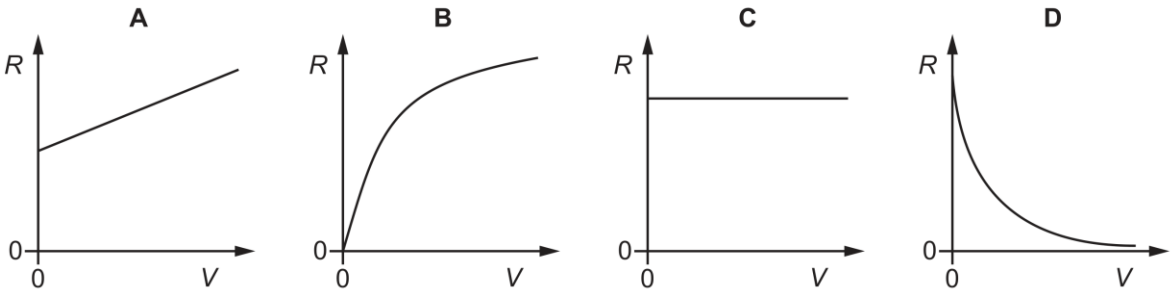
The sensors make use of a light-dependent resistor (LDR) and a thermistor.

The car moves from a warm and dark environment into a cold and bright environment.

What are the changes to the resistances of the LDR and thermistor?

	resistance of LDR	resistance of thermistor
A	increases	increases
B	increases	decreases
C	decreases	increases
D	decreases	decreases

8 Which graph could show how the resistance *R* of a filament lamp varies with the applied potential difference (p.d.) *V*, as *V* is increased to the normal operating p.d.?



9 A piece of conducting putty is in the shape of a cylinder of length 60 mm and diameter 20 mm. The resistance between the ends of the cylinder is 20 Ω.

What is the resistivity of the putty?

A 0.033 Ω m **B** 0.10 Ω m **C** 0.42 Ω m **D** 5.2 Ω m

10 The potential difference across a metal wire is kept constant. The length l and the diameter *d* of the wire are both varied. The type of metal is kept the same.

How is the current in the wire related to l and *d*?

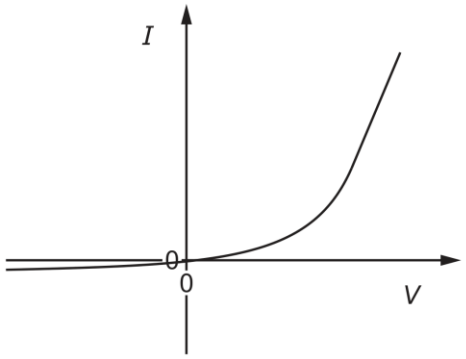
A It is directly proportional to l and inversely proportional to *d*.

B It is directly proportional to l and inversely proportional to d^2.

C It is inversely proportional to l and directly proportional to *d*.

D It is inversely proportional to l and directly proportional to d^2.

11 The graph shows the I–V characteristic for a semiconductor diode.



Which statement can be deduced from the graph?

A Above a certain positive potential difference the diode obeys Ohm's law.

B Current is directly proportional to potential difference when the current in the diode is in one direction.

C The diode has zero resistance when the current in the diode is in one direction.

D The resistance of the diode depends upon the potential difference across it.

12 A wire has a resistance of 30 Ω. A second wire is made from the same material, has the same mass and is three times as long as the first wire.

What is the resistance of the second wire?

A 10 Ω **B** 30 Ω **C** 90 Ω **D** 270 Ω

13 The intensity of light incident on a light-dependent resistor (LDR) is increased. The temperature of a thermistor is increased. In each case, the current in the component is maintained at a constant value.

What happens to the potential difference across each component?

	LDR	thermistor
A	increases	increases
B	increases	decreases
C	decreases	increases
D	decreases	decreases

14 An iron wire has length 8.0 m and diameter 0.50 mm. The wire has resistance R.

A second iron wire has length 2.0 m and diameter 1.0 mm.

What is the resistance of the second wire?

A $\frac{R}{16}$ **B** $\frac{R}{8}$ **C** $\frac{R}{2}$ **D** R

15 A copper wire is to be replaced by an aluminium alloy wire of the same length and resistance. Copper has half the resistivity of the alloy.

What is the ratio $\frac{\text{diameter of alloy wire}}{\text{diameter of copper wire}}$?

A $\sqrt{2}$ **B** 2 **C** $2\sqrt{2}$ **D** 4

16 The potential difference (p.d.) across a filament lamp is increased.

Which statement is correct?

A The resistance of the lamp decreases because the temperature decreases.

B The resistance of the lamp decreases because the temperature increases.

C The resistance of the lamp increases because the temperature decreases.

D The resistance of the lamp increases because the temperature increases.

17 A metal wire has resistance R.

The wire is stretched so that its diameter decreases to 94.0% of the original diameter.

The volume of the wire is unchanged.

What is the resistance of the stretched wire?

A 1.06R **B** 1.13R **C** 1.20R **D** 1.28R

18 A length of wire is connected into an electric circuit. The current in the wire is measured.

Which change on its own could increase the current in the wire?

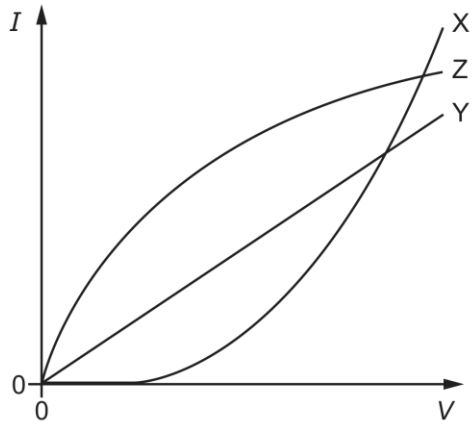
A an increase in the length of the wire

B an increase in the radius of the wire

C an increase in the resistance of the wire

D an increase in the resistivity of the wire

19 The graph shows the variation with potential difference V of the current I in components X, Y and Z.



Which row correctly identifies the components?

	metallic conductor at constant temperature	semiconductor diode	filament lamp
A	X	Z	Y
B	Y	X	Z
C	Y	Z	X
D	Z	Y	X

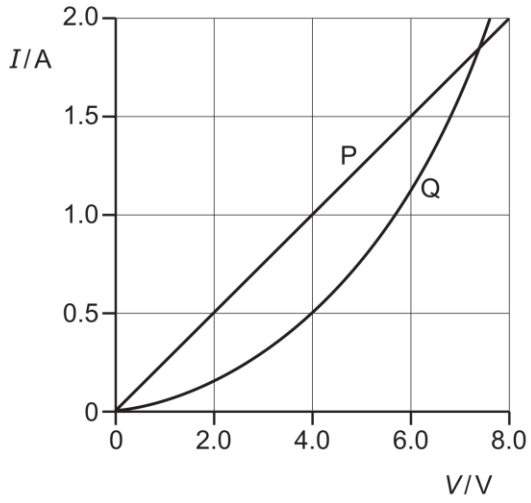
20 A wire of resistance 9.55 Ω has a diameter of 0.280 mm.

It is made of metal of resistivity 4.90×10^{-7} Ω m.

What is the length of the wire?

A 1.20 m **B** 4.80 m **C** 19.0 m **D** 76.0 m

21 The I–V characteristics of two electrical components P and Q are shown.



Which statement is correct?

A For a current of 0.5 A, the power dissipated in Q is double that in P.

B For a current of 1.9 A, the resistance of Q is approximately half that of P.

C The resistance of Q increases as the current in it increases.

D P is a fixed resistor and Q is a filament lamp.

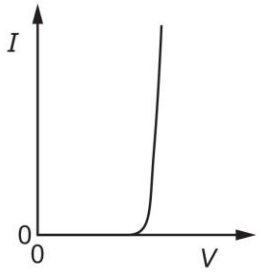
22 Two copper wires S and T, of equal length, are connected in parallel. Wire S has a diameter of 3.0 mm. Wire T has a diameter of 1.5 mm.

A potential difference is applied across the ends of this parallel arrangement.

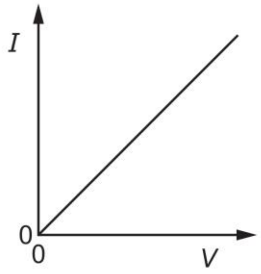
What is the value of the ratio $\frac{\text{current in S}}{\text{current in T}}$?

A $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** 2 **D** 4

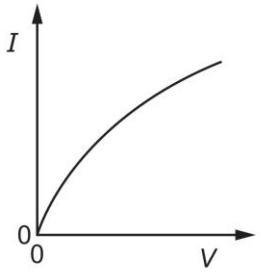
23 The graphs show the variation with potential difference V of the current I for three circuit components.



graph X



graph Y



graph Z

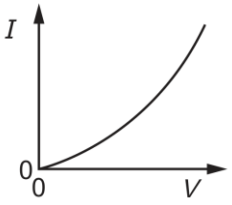
The components are a metal wire at constant temperature, a semiconductor diode and a filament lamp.

Which row correctly identifies these graphs?

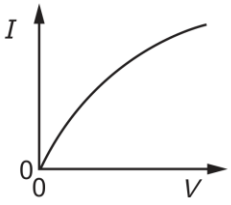
	metal wire at constant temperature	semiconductor diode	filament lamp
A	X	Z	Y
B	Y	X	Z
C	Y	Z	X
D	Z	X	Y

24 Which graph best represents the way the current I through a filament lamp varies with the potential difference V across it?

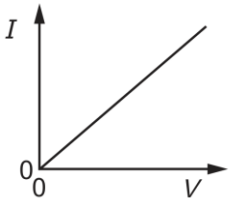
A



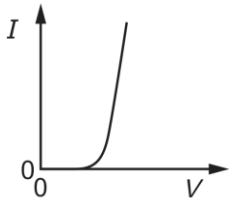
B



C



D

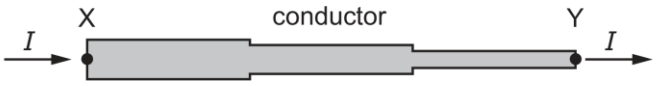


25 A cylindrical metal wire X has resistance R. The same volume of the same metal is made into a cylindrical wire Y of double the length.

What is the resistance of wire Y?

A R **B** $2R$ **C** $4R$ **D** $8R$

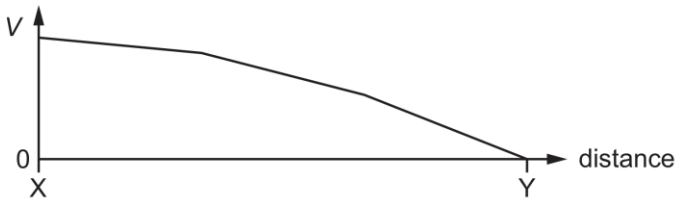
26 A conductor consists of three wires connected in series. The wires are all made of the same metal but have different cross-sectional areas. There is a current I in the conductor.



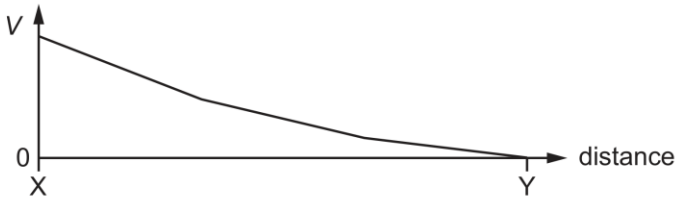
Point Y on the conductor is at zero potential.

Which graph best shows the variation of potential V with distance along the conductor?

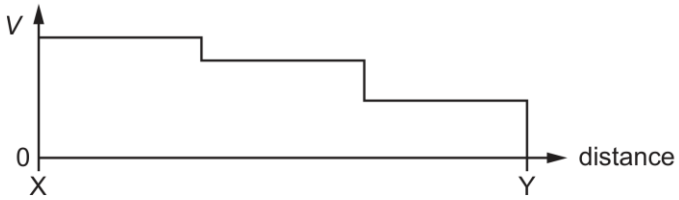
A



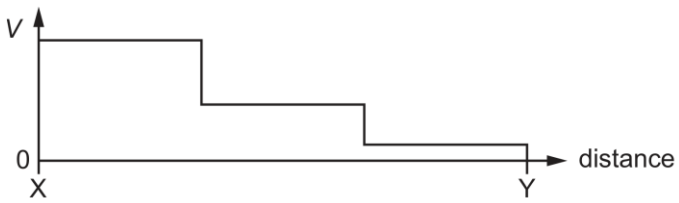
B



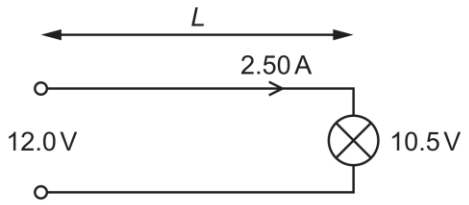
C



D



27 A cable of length *L* consisting of two wires is used to connect a 12.0 V power supply of negligible internal resistance to a lamp, as shown.



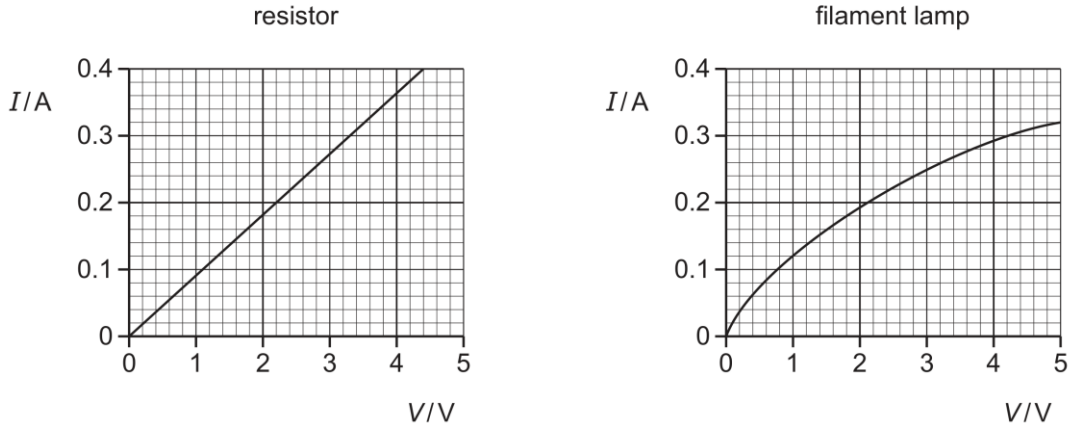
The potential difference across the lamp is 10.5 V. The current in the wire is 2.50 A.

Each wire is made of metal of resistivity $1.70 \times 10^{-8}\,\Omega\,\text{m}$ and has a cross-sectional area of $6.00 \times 10^{-7}\,\text{m}^2$.

What is the length *L* of the cable?

A 10.6 m **B** 21.2 m **C** 29.4 m **D** 58.8 m

28 A resistor and a filament lamp are connected in series with a power supply. The *I*–*V* characteristics of the resistor and of the lamp are shown below.



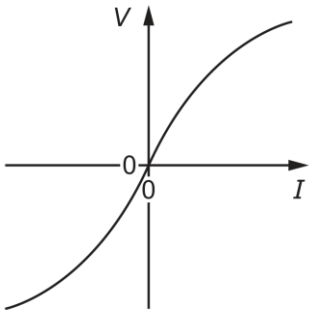
The potential difference (p.d.) across the resistor is 3.3 V.

What is the resistance of the lamp?

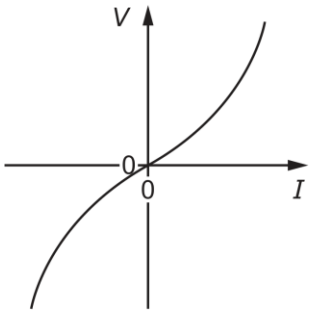
A 0.071 Ω **B** 4.2 Ω **C** 11 Ω **D** 14 Ω

29 Which graph best represents the variation with current I of potential difference V for a filament lamp?

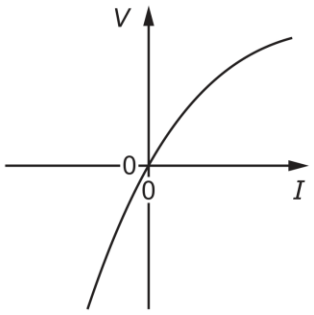
A



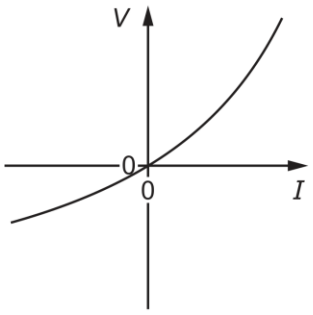
B



C



D

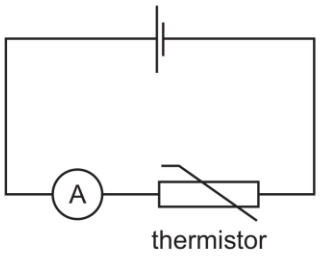


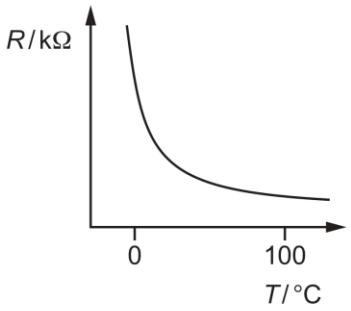
30 Four wires are made of the same metal. The cross-sectional areas, lengths and thermodynamic temperatures of the wires are shown.

Which wire has the largest resistance?

	cross-sectional area	length	temperature
A	A	$2L$	$2T$
B	A	L	T
C	$2A$	$2L$	$2T$
D	$2A$	L	T

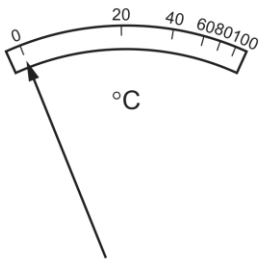
31 In the circuit shown, an analogue ammeter is to be recalibrated as a thermometer. The ammeter is connected in series with a thermistor. The thermistor is a component with a resistance that varies with temperature. The graph shows how the resistance R of the thermistor changes with temperature T.



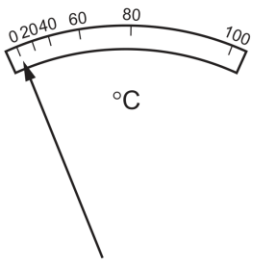


Which diagram could represent the temperature scale on the ammeter?

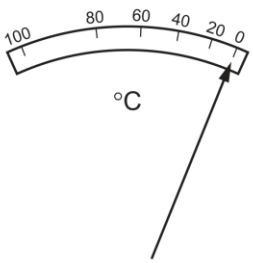
A



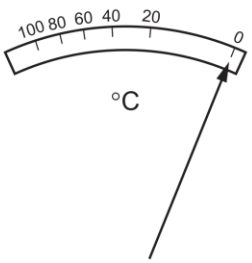
B



C



D

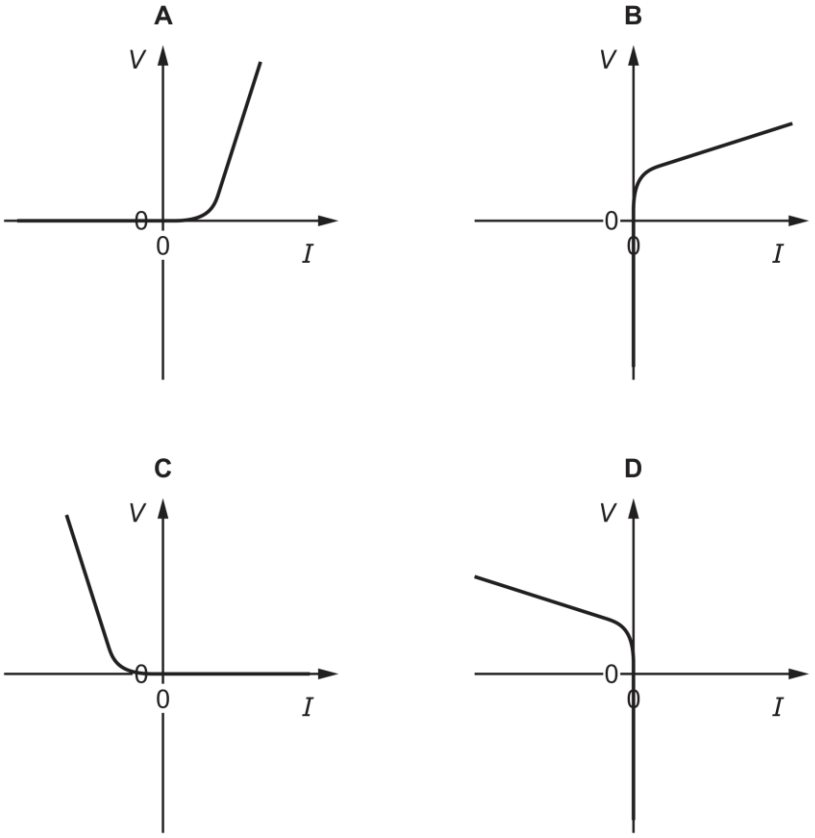


32 A cylindrical piece of a soft, electrically-conducting material has resistance R. It is rolled out so that its length is doubled but its volume stays constant.

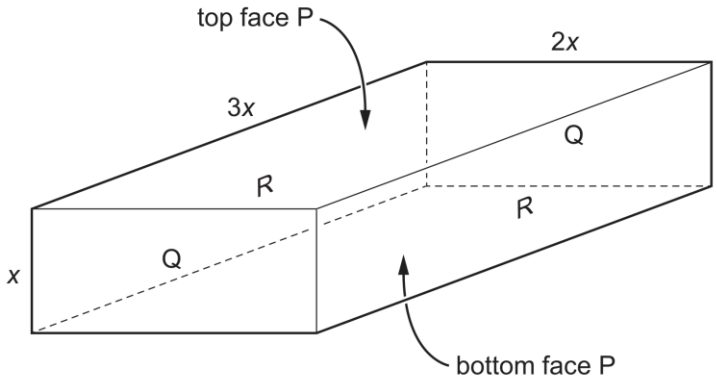
What is its new resistance?

A $\frac{R}{2}$ **B** R **C** $2R$ **D** $4R$

33 Which graph shows the variation of voltage V with current I for a semiconductor diode?



34 The diagram shows a rectangular block with dimensions x, $2x$ and $3x$.



Electrical contact can be made to the block between opposite pairs of faces (for example, between the faces labelled R).

Which statement describing the electrical resistance of the block is correct?

A It is maximum between the faces labelled P.

B It is maximum between the faces labelled Q.

C It is maximum between the faces labelled R.

D It is the same, whichever pair of faces is used.

35 A wire of length L has resistance R. The cross-section of the wire is circular with radius r.

A second wire, also of circular cross-section, and of the same material, has resistance $\frac{1}{2}R$.

What could be the radius and the length of the second wire?

	radius	length
A	$\frac{r}{2}$	$\frac{L}{2}$
B	$\frac{r}{\sqrt{2}}$	$\frac{L}{2}$
C	$r\sqrt{2}$	$2L$
D	$2r$	$2L$