Electricity and D.C. Circuits

(Past Year Topical Questions 2010-2015)

May/June 2010 (11)

30 In terms of energy transfer W and charge q, what are the definitions of potential difference (p.d.) and electromotive force (e.m.f.)?

	p.d.	e.m.f.
A	$\frac{W}{q}$	$\frac{W}{q}$
B	$\frac{W}{q}$	Wq
C	Wq	$\frac{W}{q}$
D	Wq	Wq

31 What is the unit of resistivity?

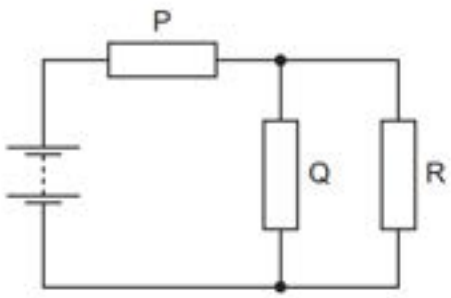
A Ωm^{-2} **B** Ωm^{-1} **C** Ω **D** Ωm

32 The resistance of a thermistor depends on its temperature, and the resistance of a light-dependent resistor (LDR) depends on the illumination.

Under which conditions will the resistance of both a thermistor and an LDR be highest?

	thermistor	LDR
A	highest temperature	highest illumination
B	highest temperature	lowest illumination
C	lowest temperature	highest illumination
D	lowest temperature	lowest illumination

33 The resistors P, Q and R in the circuit have equal resistance.



The battery, of negligible internal resistance, supplies a total power of 12 W.

What is the power dissipated by heating in resistor R?

A 2 W **B** 3 W **C** 4 W **D** 6 W

34 In deriving a formula for the combined resistance of three different resistors in series, Kirchhoff's laws are used.

Which physics principle is involved in this derivation?

A the conservation of charge

B the direction of the flow of charge is from negative to positive

C the potential difference across each resistor is the same

D the current varies in each resistor, in proportion to the resistor value

35 A source of e.m.f. of 9.0 mV has an internal resistance of 6.0 Ω.

It is connected across a galvanometer of resistance 30 Ω.

What will be the current in the galvanometer?

A 250 μA **B** 300 μA **C** 1.5 mA **D** 2.5 mA

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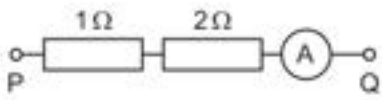
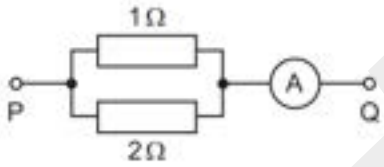
36 In each arrangement of resistors, the ammeter has a resistance of 2Ω.

Which arrangement gives the largest reading on the ammeter when the same potential difference is applied between points P and Q?

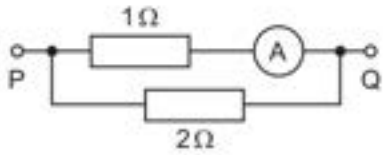
A



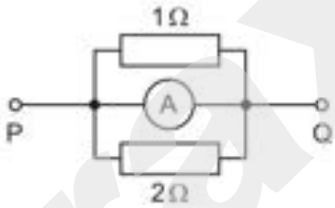
B



C



D



37 What are the correct descriptions of a γ-ray and a β-particle?

	γ-ray	β-particle
A	high-speed electron	electromagnetic radiation
B	electromagnetic radiation	helium-4 nucleus
C	electromagnetic radiation	high-speed electron
D	high-speed electron	helium-4 nucleus

May/June 2010 (12)

30 The resistance of a thermistor depends on its temperature, and the resistance of a light-dependent resistor (LDR) depends on the illumination.

Under which conditions will the resistance of both a thermistor and an LDR be highest?

	thermistor	LDR
A	highest temperature	highest illumination
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C	lowest temperature	highest illumination
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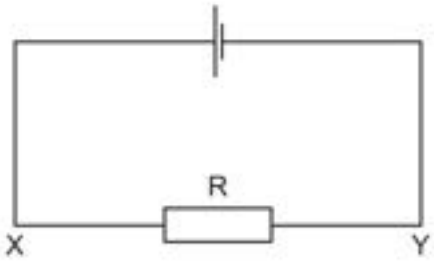
October/November 2010 (11)

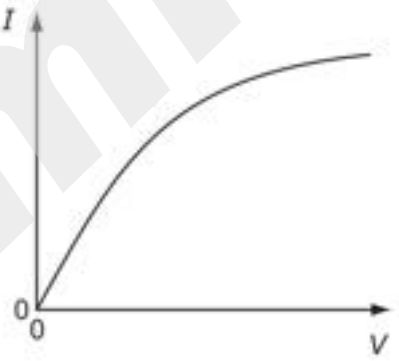
31 The current in the circuit shown is 4.8 A.



What is the direction of flow and the rate of flow of electrons through the resistor R?

	direction of flow	rate of flow
A	X to Y	$3.0 \times 10^{19} s^{-1}$
B	X to Y	$6.0 \times 10^{18} s^{-1}$
C	Y to X	$3.0 \times 10^{19} s^{-1}$
D	Y to X	$6.0 \times 10^{18} s^{-1}$

32 Which component has the *I*-*V* graph shown?



A filament lamp

B light-dependent resistor

C semiconductor diode

D thermistor

33 A copper wire is cylindrical and has resistance R.

What will be the resistance of a copper wire of twice the length and twice the radius?

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

34 A relay is required to operate 800 m from its power supply. The power supply has negligible internal resistance. The relay requires 16.0 V and a current of 0.60 A to operate.

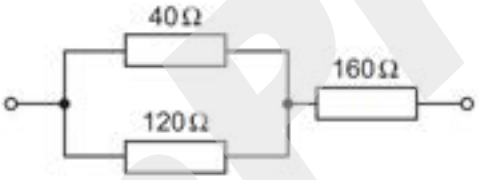
A cable connects the relay to the power supply and two of the wires in the cable are used to supply power to the relay.

The resistance of each of these wires is 0.0050 Ω per metre.

What is the minimum output e.m.f. of the power supply?

A 16.6 V **B** 18.4 V **C** 20.8 V **D** 29.3 V

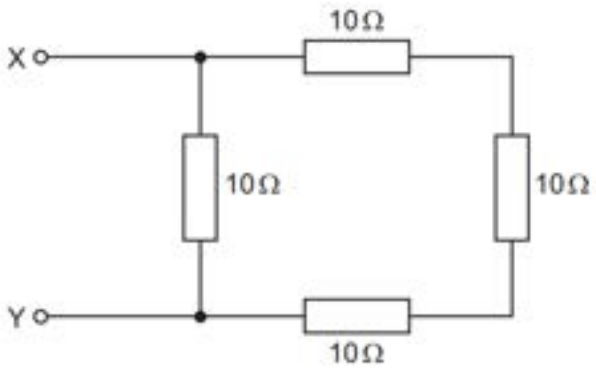
35 The diagram shows part of a circuit.



What is the total resistance of the combination of the three resistors?

A 320 Ω **B** 240 Ω **C** 190 Ω **D** 80 Ω

36 The diagram shows an arrangement of resistors.



What is the total electrical resistance between X and Y?

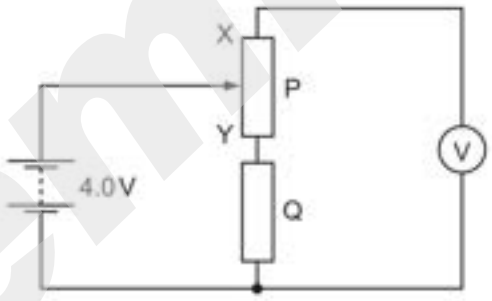
A less than 1Ω

B between 1Ω and 10Ω

C between 10Ω and 30Ω

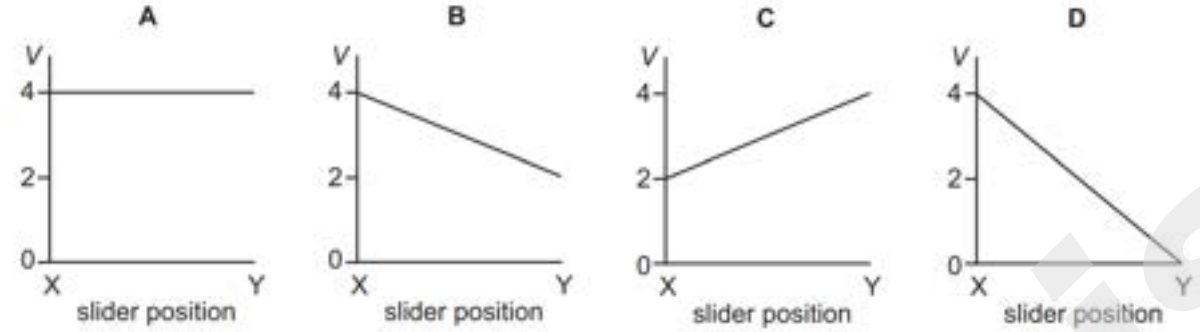
D 40Ω

37 In the circuit below, P is a potentiometer of total resistance 10 Ω and Q is a fixed resistor of resistance 10 Ω. The battery has an e.m.f. of 4.0 V and negligible internal resistance. The voltmeter has a very high resistance.



The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading *V* is plotted against slider position.

Which graph would be obtained?



October/November 2010 (12)

30 Which electrical component is represented by the following symbol?

A a diode

B a potentiometer

C a resistor

D a thermistor

31 When there is **no current** in a wire, which statement about the conduction electrons in that wire is correct?

A Electrons in the wire are moving totally randomly within the wire.

B Equal numbers of electrons move at the same speed, but in opposite directions, along the wire.

C No current is flowing therefore the electrons in the wire are stationary.

D No current is flowing therefore the electrons in the wire are vibrating around a fixed point.

32 A high-resistance voltmeter connected across a battery reads 6.0 V.

When the battery is connected in series with a lamp of resistance of 10 Ω, the voltmeter reading falls to 5.6 V.

Which statement explains this observation?

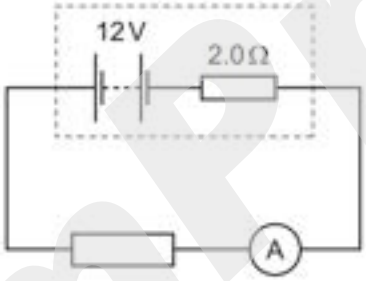
A The electromotive force (e.m.f.) of the battery decreases because more work is done across its internal resistance.

B The e.m.f. of the battery decreases because work is done across the lamp.

C The potential difference (p.d.) across the battery decreases because more work is done across its internal resistance.

D The p.d. across the battery decreases because work is done across the lamp.

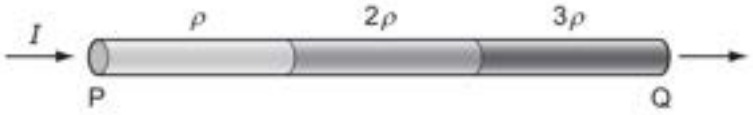
33 A battery of e.m.f. 12 V and internal resistance 2.0 Ω is connected in series with an ammeter of negligible resistance and an external resistor. External resistors of various different values are used.



Which combination of current and resistor value is **not** correct?

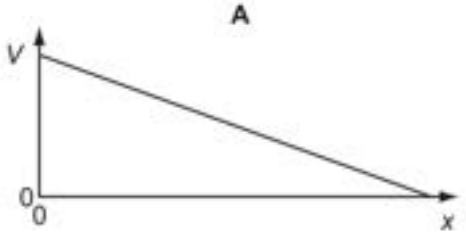
	current / A	external resistor value / Ω
A	1.0	10
B	1.2	8
C	1.5	6
D	1.8	4

34 A wire PQ is made of three different materials, with resistivities ρ, 2ρ and 3ρ. There is a current I in this composite wire, as shown.



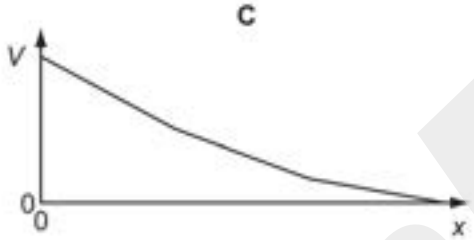
Which graph best shows how the potential V along the wire varies with distance x from P?

A

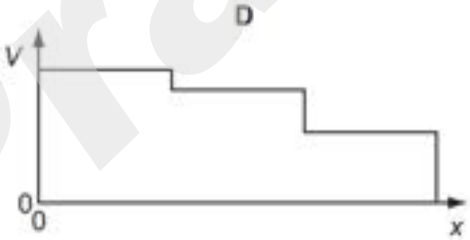


B

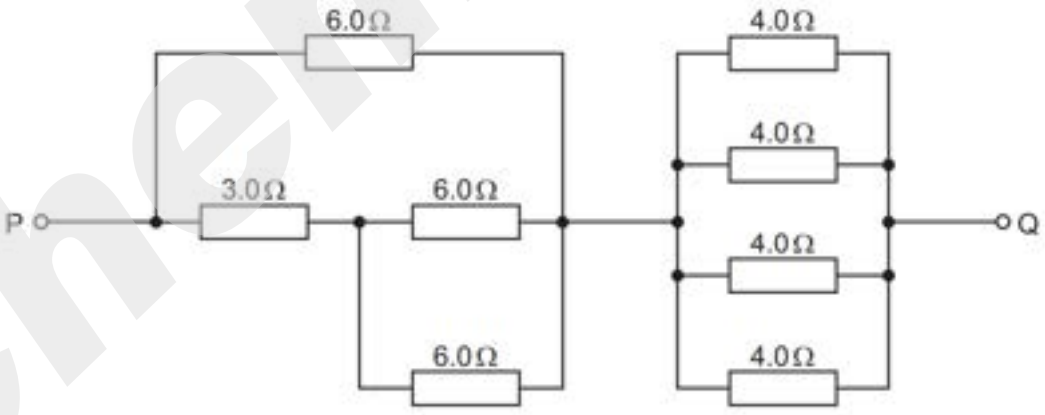
C



D



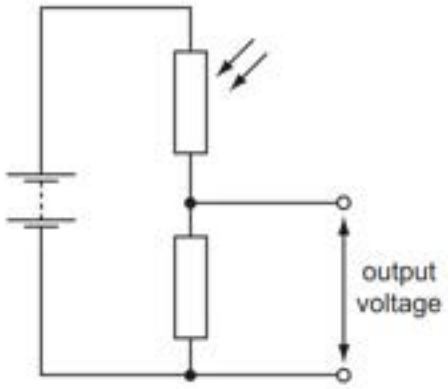
35 The diagram shows part of a circuit.



What is the resistance between the points P and Q due to the resistance network?

A 1.3Ω **B** 4.0Ω **C** 10Ω **D** 37Ω

36 The diagram shows a potential divider circuit.



The light level increases.

What is the effect on the resistance of the light-dependent resistor (LDR) and on the output voltage?

	resistance of the LDR	output voltage
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

37 Three resistors, with resistances R_1, R_2 and R_3, are connected in series and are found to have a combined resistance of 500 Ω. When connected in parallel, the combined resistance is found to be 50 Ω.

Which values will correspond to these results?

	R_1/Ω	R_2/Ω	R_3/Ω
A	160	160	80
B	200	200	100
C	225	225	50
D	230	230	40

May/June 2011 (11)

31 A copper wire of cross-sectional area 2.0 mm^2 carries a current of 10 A.

How many electrons pass through a given cross-section of the wire in one second?

A 1.0×10^{1} **B** 5.0×10^{6} **C** 6.3×10^{19} **D** 3.1×10^{25}

32 A battery is marked 9.0 V.

What does this mean?

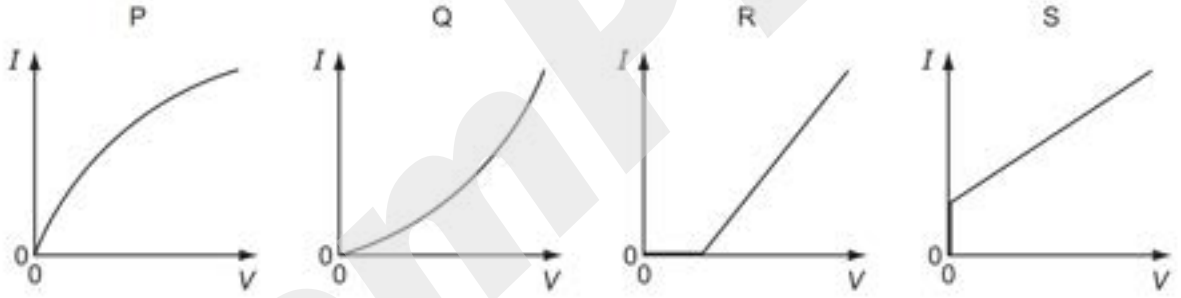
A Each coulomb of charge from the battery supplies 9.0 J of electrical energy to the whole circuit.

B The battery supplies 9.0 J to an external circuit for each coulomb of charge.

C The potential difference across any component connected to the battery will be 9.0 V.

D There will always be 9.0 V across the battery terminals.

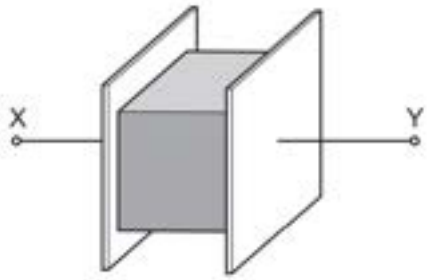
33 The graphs show possible current-voltage (I-V) relationships for a filament lamp and for a semiconductor diode.



Which row best specifies the correct I-V graphs for the lamp and the diode?

	filament lamp	semiconductor diode
A	P	R
B	P	S
C	Q	R
D	Q	S

34 The resistance of a metal cube is measured by placing it between two parallel plates, as shown.

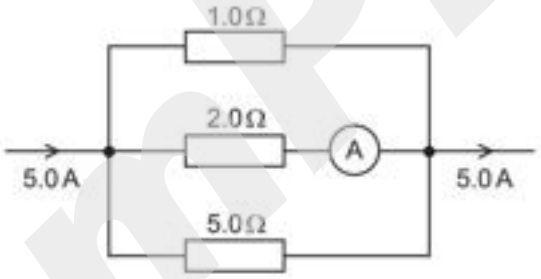


The cube has volume V and is made of a material with resistivity ρ. The connections to the cube have negligible resistance.

Which expression gives the electrical resistance of the metal cube between X and Y?

A $\rho V^{\frac{1}{3}}$ **B** $\rho V^{\frac{2}{3}}$ **C** $\frac{\rho}{V^{\frac{1}{3}}}$ **D** $\frac{\rho}{V^{\frac{2}{3}}}$

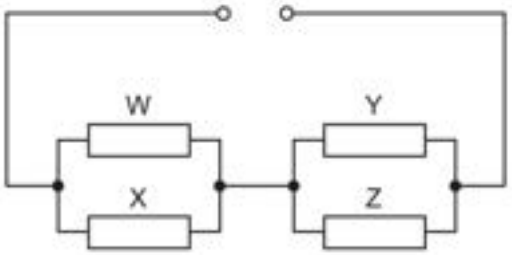
35 The diagram shows part of a current-carrying circuit. The ammeter has negligible internal resistance.



What is the reading on the ammeter?

A 0.7A **B** 1.3A **C** 1.5A **D** 1.7A

36 Four resistors of equal value are connected as shown.



How will the powers to the resistors change when resistor W is removed?

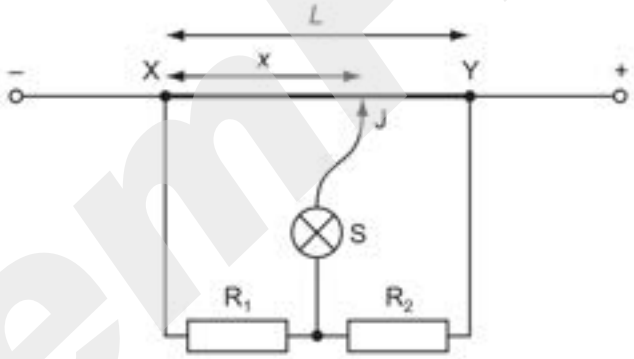
A The powers to X, Y and Z will all increase.

B The power to X will decrease and the powers to Y and Z will increase.

C The power to X will increase and the powers to Y and Z will decrease.

D The power to X will increase and the powers to Y and Z will remain unaltered.

37 In the circuit shown, XY is a length *L* of uniform resistance wire. R_1 and R_2 are unknown resistors. J is a sliding contact that joins the junction of R_1 and R_2 to points on XY through a small signal lamp S.



To determine the ratio $\frac{V_1}{V_2}$ of the potential differences across R_1 and R_2, a point is found on XY at which the lamp is off. This point is at a distance *x* from X.

What is the value of the ratio $\frac{V_1}{V_2}$?

A $\frac{L}{x}$ **B** $\frac{x}{L}$ **C** $\frac{L-x}{x}$ **D** $\frac{x}{L-x}$

May/June 2011 (12)

33 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** $4R$

34 A source of electromotive force (e.m.f.) E has a constant internal resistance r and is connected to an external variable resistor of resistance R.

As R is increased from a value below r to a value above r, which statement is correct?

A The terminal potential difference remains constant.

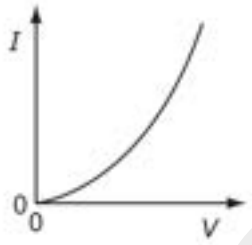
B The current in the circuit increases.

C The e.m.f. of the source increases.

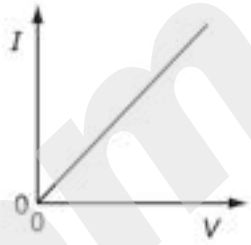
D The largest output power is obtained when R reaches r.

35 Which graph best represents the way in which the current I through a thermistor depends upon the potential difference V across it?

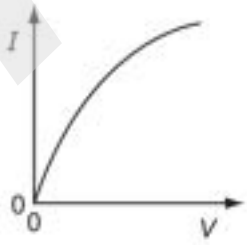
A



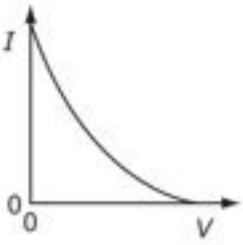
B



C

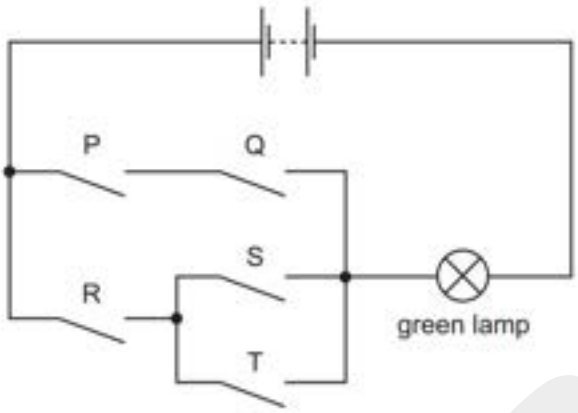


D



36 Safety on railways is increased by using several electrical switches.

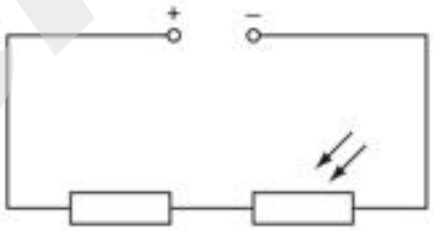
In the diagram, switches P, Q, R, S and T control the current through a green lamp.



Which row does **not** allow the green lamp to light?

	P	Q	R	S	T
A	closed	closed	closed	open	closed
B	closed	open	closed	closed	open
C	closed	open	open	closed	closed
D	open	open	closed	open	closed

37 The diagram shows a fixed resistor and a light-dependent resistor (LDR) in series with a constant low-voltage supply.



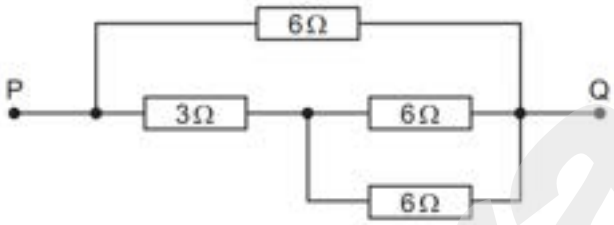
When the LDR is in the dark, the fixed resistor and the LDR have the same value of resistance.

Light is shone on the LDR.

What happens to the potential differences across the two components?

	p.d. across resistor	p.d. across LDR
A	decreased	increased
B	increased	decreased
C	no change	increased
D	no change	decreased

38 The diagram shows a d.c. circuit.



What is the resistance between the points P and Q due to the resistance network?

A 0.47Ω **B** 2.1Ω **C** 3.0Ω **D** 21Ω

May/June 2011 (13)

31 A battery is marked 9.0 V.

What does this mean?

A Each coulomb of charge from the battery supplies 9.0 J of electrical energy to the whole circuit.

B The battery supplies 9.0 J to an external circuit for each coulomb of charge.

C The potential difference across any component connected to the battery will be 9.0 V.

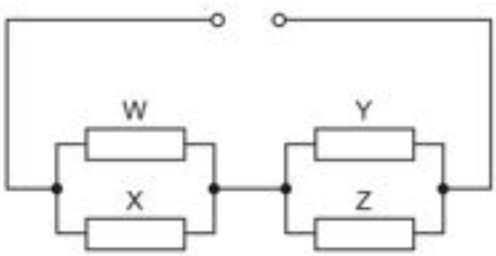
D There will always be 9.0 V across the battery terminals.

32 A copper wire of cross-sectional area 2.0 mm^2 carries a current of 10 A.

How many electrons pass through a given cross-section of the wire in one second?

A 1.0×10^{1} **B** 5.0×10^{6} **C** 6.3×10^{19} **D** 3.1×10^{25}

33 Four resistors of equal value are connected as shown.



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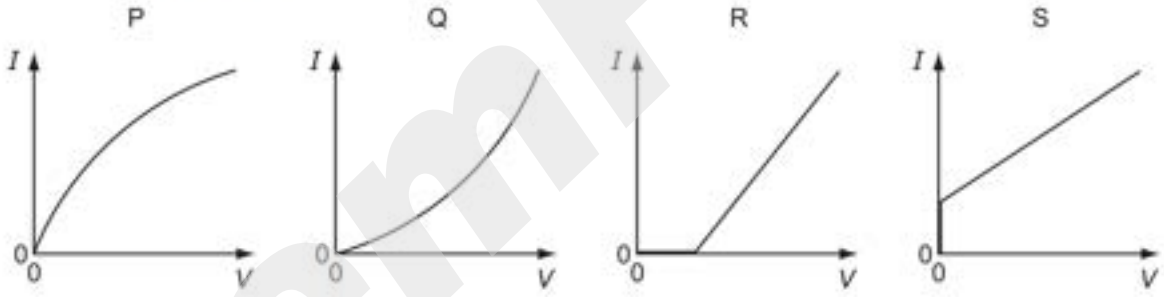
34 The graphs show possible current-voltage (I-V) relationships for a filament lamp and for a semiconductor diode.



Which row best specifies the correct I-V graphs for the lamp and the diode?

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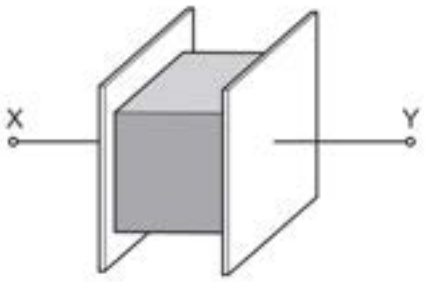
35 The resistance of a metal cube is measured by placing it between two parallel plates, as shown.

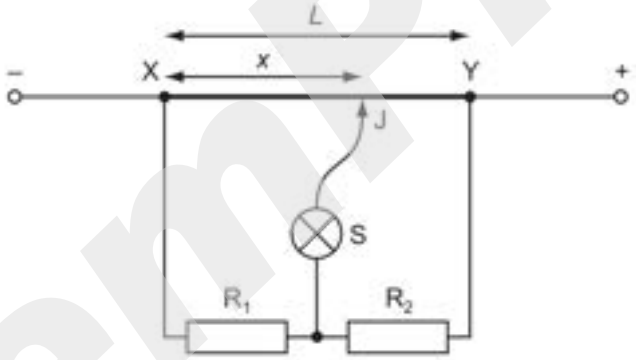


The cube has volume V and is made of a material with resistivity ρ. The connections to the cube have negligible resistance.

Which expression gives the electrical resistance of the metal cube between X and Y?

A $\rho V^{\frac{1}{3}}$ **B** $\rho V^{\frac{2}{3}}$ **C** $\frac{\rho}{V^{\frac{1}{3}}}$ **D** $\frac{\rho}{V^{\frac{2}{3}}}$

36 In the circuit shown, XY is a length L of uniform resistance wire. R_1 and R_2 are unknown resistors. J is a sliding contact that joins the junction of R_1 and R_2 to points on XY through a small signal lamp S.

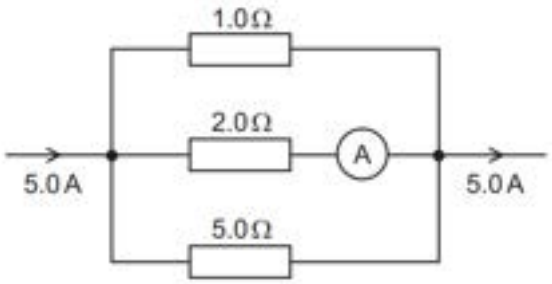


To determine the ratio $\frac{V_1}{V_2}$ of the potential differences across R_1 and R_2, a point is found on XY at which the lamp is off. This point is at a distance x from X.

What is the value of the ratio $\frac{V_1}{V_2}$?

A $\frac{L}{x}$ **B** $\frac{x}{L}$ **C** $\frac{L-x}{x}$ **D** $\frac{x}{L-x}$

37 The diagram shows part of a current-carrying circuit. The ammeter has negligible internal resistance.



What is the reading on the ammeter?

A 0.7A **B** 1.3A **C** 1.5A **D** 1.7A

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34 Which of the equations that link some of the following terms is correct?

potential difference (p.d.)	V
current	I
resistance	R
charge	Q
energy	E
power	P
time	t

A $P = \frac{Q^2R}{t}$

B $ER^2 = V^2t$

C $\frac{VI}{P} = t$

D $PQ = EI$

35 Which statement is **not** valid?

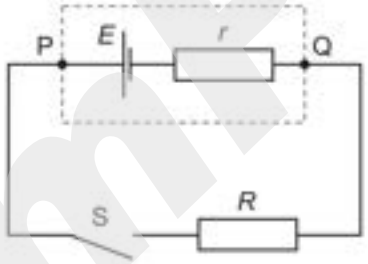
A Current is the speed of the charged particles that carry it.

B Electromotive force (e.m.f.) is the energy converted to electrical energy from other forms, per unit charge.

C The potential difference (p.d.) between two points is the work done in moving unit charge from one point to the other.

D The resistance between two points is the p.d. between the two points, per unit current.

36 A cell of e.m.f. *E* and internal resistance *r* is connected in series with a switch S and an external resistor of resistance *R*.



The p.d. between P and Q is *V*.

When S is closed,

A *V* decreases because there is a p.d. across *R*.

B *V* decreases because there is a p.d. across *r*.

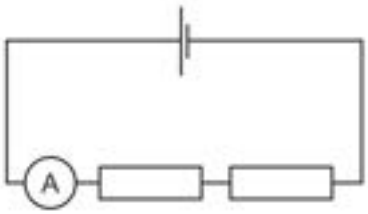
C *V* remains the same because the decrease of p.d. across *r* is balanced by the increase of p.d. across *R*.

D *V* remains the same because the sum of the p.d.s across *r* and *R* is still equal to *E*.

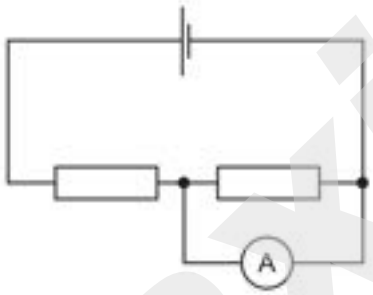
37 A cell, two resistors of equal resistance and an ammeter are used to construct four circuits. The resistors are the only parts of the circuits that have resistance.

In which circuit will the ammeter show the greatest reading?

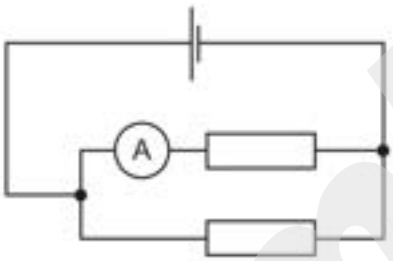
A



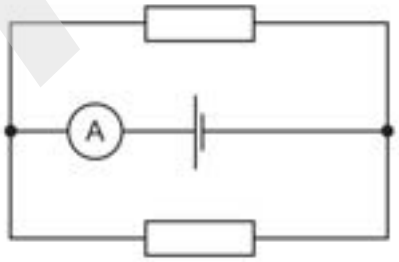
B



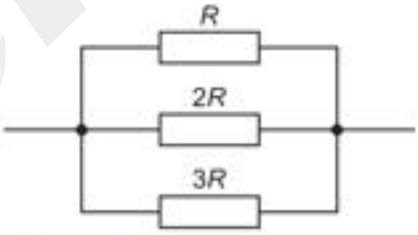
C



D



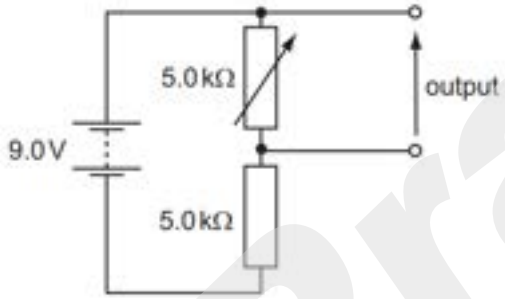
38 Three resistors of resistance R, $2R$ and $3R$ are connected in parallel.



Using I to represent the current through the resistor of resistance R, which row represents the relationships between the currents through the resistors?

	resistor resistance		
	R	$2R$	$3R$
A	I	$\frac{1}{3}I$	$\frac{1}{2}I$
B	I	$\frac{1}{2}I$	$\frac{1}{3}I$
C	I	$\frac{2}{3}I$	$\frac{1}{3}I$
D	I	$2I$	$3I$

39 The diagram shows a potential divider circuit designed to provide a variable output p.d.

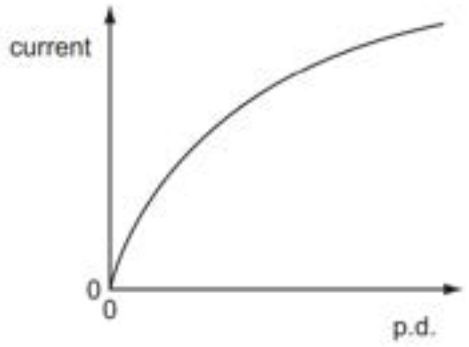


Which row gives the available range of output p.d.?

	maximum output	minimum output
A	3.0 V	0
B	4.5 V	0
C	9.0 V	0
D	9.0 V	4.5 V

October/November 2011 (12)

33 The graph shows the variation with potential difference (p.d.) of the current in a lamp filament.



Which statement explains the shape of this graph?

A As the filament temperature rises, electrons can pass more easily through the filament.

B It takes time for the filament to reach its working temperature.

C The power output of the filament is proportional to the square of the current in it.

D The resistance of the filament increases with a rise in temperature.

34 Two electrically-conducting cylinders X and Y are made from the same material.

Their dimensions are as shown.

The resistance of each cylinder is measured between its ends.

What is the ratio $\frac{\text{resistance of X}}{\text{resistance of Y}}$?

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

35 A power supply of electromotive force (e.m.f.) 12 V and internal resistance 2 Ω is connected in series with a load resistor. The value of the load resistor is varied from 0.5 Ω to 4 Ω.

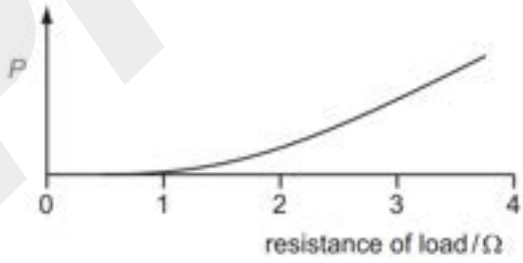
Which graph shows how the power *P* dissipated in the load resistor varies with the resistance of the load resistor?

A

B

C

D

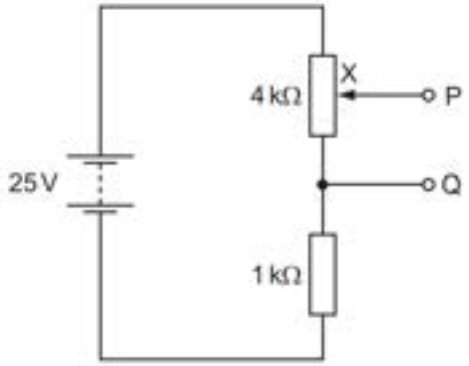


36 Each of Kirchhoff's laws is linked to the conservation of a physical quantity.

Which physical quantities are assumed to be conserved in the formulation of Kirchhoff's first law and of Kirchhoff's second law?

	Kirchhoff's first law	Kirchhoff's second law
A	energy	charge
B	energy	momentum
C	charge	energy
D	momentum	energy

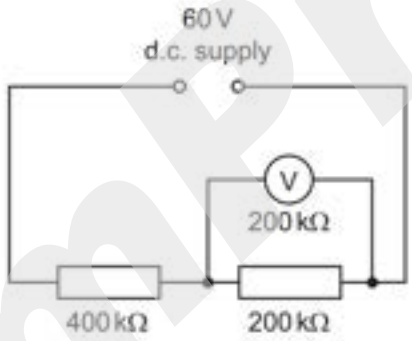
37 The diagram shows a potential divider circuit which, by adjustment of the contact X, can be used to provide a variable potential difference between the terminals P and Q.



What are the limits of this potential difference?

A 0 and 5 V **B** 0 and 20 V **C** 0 and 25 V **D** 5 V and 25 V

38 A constant 60 V d.c. supply is connected across two resistors of resistance 400 kΩ and 200 kΩ.



What is the reading on a voltmeter, also of resistance 200 kΩ, when connected across the 200 kΩ resistor as shown in the diagram?

A 12 V **B** 15 V **C** 20 V **D** 30 V

October/November 2011 (13)

34 Which statement is **not** valid?

A Current is the speed of the charged particles that carry it.

B Electromotive force (e.m.f.) is the energy converted to electrical energy from other forms, per unit charge.

C The potential difference (p.d.) between two points is the work done in moving unit charge from one point to the other.

D The resistance between two points is the p.d. between the two points, per unit current.

35 Which statement about electrical resistivity is correct?

A The resistivity of a material is numerically equal to the resistance in ohms of a cube of that material, the cube being of side length one metre and the resistance being measured between opposite faces.

B The resistivity of a material is numerically equal to the resistance in ohms of a one metre length of wire of that material, the area of cross-section of the wire being one square millimetre and the resistance being measured between the ends of the wire.

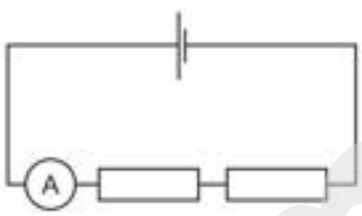
C The resistivity of a material is proportional to the cross-sectional area of the sample of the material used in the measurement.

D The resistivity of a material is proportional to the length of the sample of the material used in the measurement.

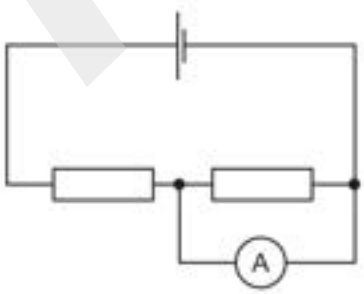
36 A cell, two resistors of equal resistance and an ammeter are used to construct four circuits. The resistors are the only parts of the circuits that have resistance.

In which circuit will the ammeter show the greatest reading?

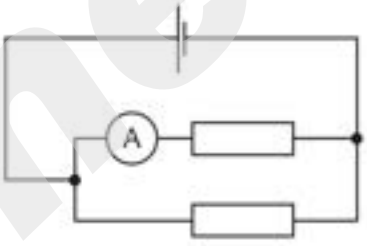
A



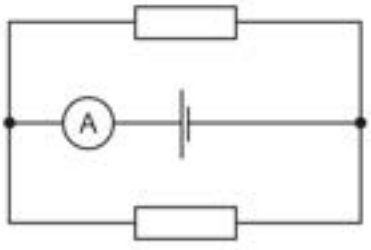
B



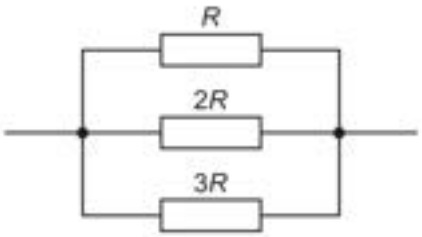
C



D



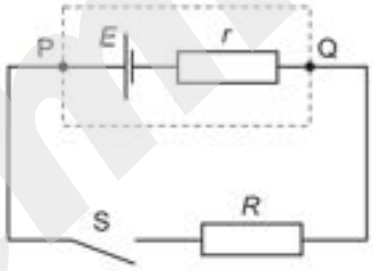
37 Three resistors of resistance R, $2R$ and $3R$ are connected in parallel.



Using I to represent the current through the resistor of resistance R, which row represents the relationships between the currents through the resistors?

	resistor resistance		
	R	$2R$	$3R$
A	I	$\frac{1}{3}I$	$\frac{1}{2}I$
B	I	$\frac{1}{2}I$	$\frac{1}{3}I$
C	I	$\frac{2}{3}I$	$\frac{1}{3}I$
D	I	$2I$	$3I$

38 A cell of e.m.f. E and internal resistance r is connected in series with a switch S and an external resistor of resistance R.



The p.d. between P and Q is V.

When S is closed,

A V decreases because there is a p.d. across R.

B V decreases because there is a p.d. across r.

C V remains the same because the decrease of p.d. across r is balanced by the increase of p.d. across R.

D V remains the same because the sum of the p.d.s across r and R is still equal to E.

39 Which of the equations that link some of the following terms is correct?

potential difference (p.d.)	V
current	I
resistance	R
charge	Q
energy	E
power	P
time	t

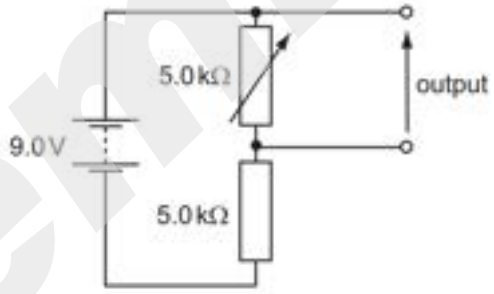
A $P = \frac{Q^2R}{t}$

B $ER^2 = V^2t$

C $\frac{VI}{P} = t$

D $PQ = EI$

40 The diagram shows a potential divider circuit designed to provide a variable output p.d.



Which row gives the available range of output p.d.?

	maximum output	minimum output
A	3.0 V	0
B	4.5 V	0
C	9.0 V	0
D	9.0 V	4.5 V

May/June 2012 (11)

33 There is a current of 10 mA in a conductor for half an hour.

How much charge passes a point in the conductor in this time?

A 0.3 C **B** 5 C **C** 18 C **D** 300 C

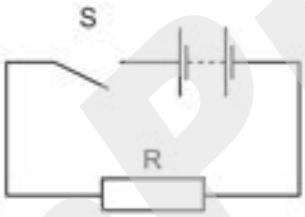
34 An iron wire has length 8.0 m and diameter 0.50 mm. The wire has resistance R.

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

35 The diagram shows a simple circuit.



Which statement is correct?

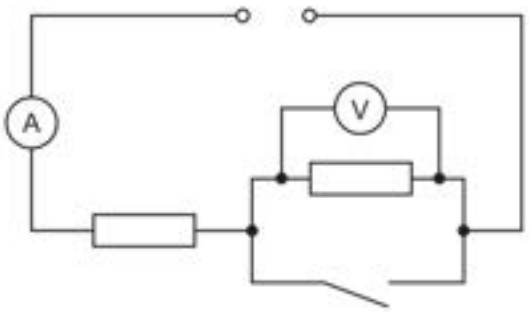
A When switch S is closed, the electromotive force (e.m.f.) of the battery falls because work is done against the internal resistance of the battery.

B When switch S is closed, the e.m.f. of the battery falls because work is done against the resistance R.

C When switch S is closed, the potential difference across the battery falls because work is done against the internal resistance of the battery.

D When switch S is closed, the potential difference across the battery falls because work is done against the resistance R.

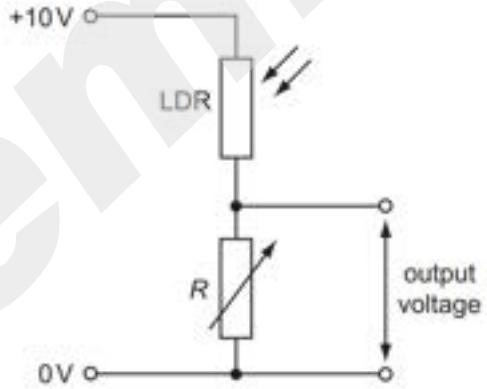
36 In the circuit below, the ammeter reading is I and the voltmeter reading is V.



When the switch is closed, which row describes what happens to I and V?

	I	V
A	decreases	decreases to zero
B	increases	decreases to zero
C	increases	stays the same
D	stays the same	increases

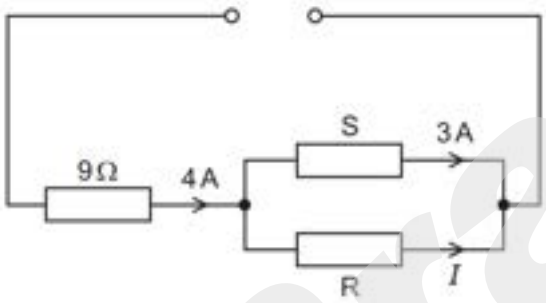
37 A potential divider consists of a light-dependent resistor (LDR) in series with a variable resistor of resistance R. The resistance of the LDR decreases when the light level increases. The variable resistor can be set at either high resistance or low resistance.



Which situation gives the largest output voltage?

	light level at LDR	*R*
A	high	high
B	high	low
C	low	high
D	low	low

38 The circuit below has a current I in the resistor R.



What must be known in order to determine the value of I?

A e.m.f. of the power supply

B resistance of resistor S

C Kirchhoff's first law

D Kirchhoff's second law

May/June 2012 (12) & May/June 2012 (13)

32 When will 1 C of charge pass a point in an electrical circuit?

A when 1 A moves through a potential difference of 1 V

B when a power of 1 W is used for 1 s

C when the current is 5 mA for 200 s

D when the current is 10 A for 10 s

33 Two copper wires of the same length but different diameters carry the same current.

Which statement about the flow of charged particles through the wires is correct?

A Charged particles are provided by the power supply. Therefore the speed at which they travel depends only on the voltage of the supply.

B The charged particles in both wires move with the same average speed because the current in both wires is the same.

C The charged particles move faster through the wire with the larger diameter because there is a greater volume through which to flow.

D The charged particles move faster through the wire with the smaller diameter because it has a larger potential difference applied to it.

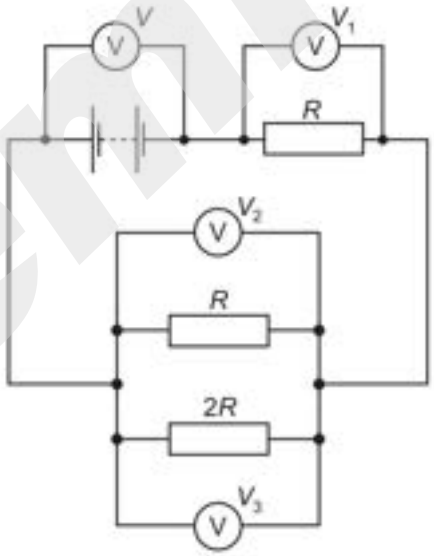
34 A power cable X has resistance R and carries current I.

A second cable Y has resistance $2R$ and carries current $\frac{1}{2}I$.

What is the ratio $\frac{\text{power dissipated in Y}}{\text{power dissipated in X}}$?

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

35 The diagram shows a circuit with four voltmeter readings V, V_1, V_2 and V_3.



Which equation relating the voltmeter readings must be true?

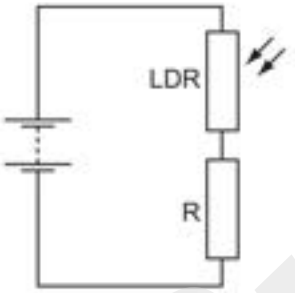
A $V = V_1 + V_2 + V_3$

B $V + V_1 = V_2 + V_3$

C $V_3 = 2(V_2)$

D $V - V_1 = V_3$

36 A light-dependent resistor (LDR) is connected in series with a resistor R and a battery.



The resistance of the LDR is equal to the resistance of R when no light falls on the LDR.

When the light intensity falling on the LDR increases, which statement is correct?

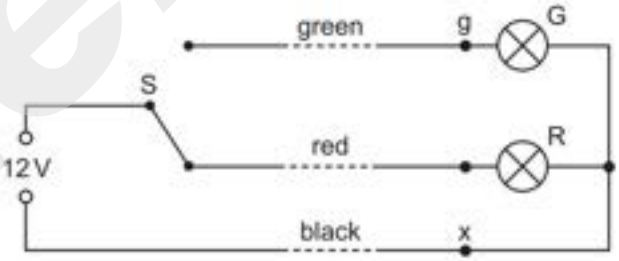
A The current in R decreases.

B The current in the LDR decreases.

C The p.d. across R decreases.

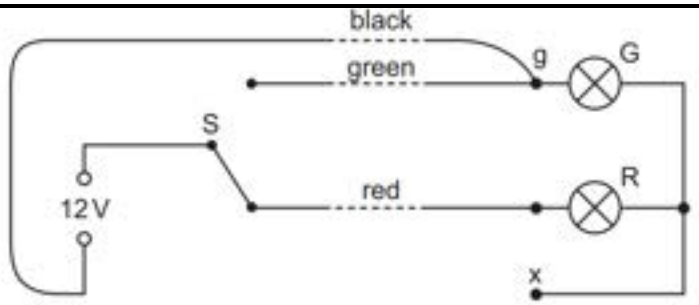
D The p.d. across the LDR decreases.

37 The diagram shows the circuit for a signal to display a green or a red light. It is controlled by the switch S.



The signal is some way from S to which it is connected by a cable with green, red and black wires. At the signal, the green and red wires are connected to the corresponding lamp and the black wire is connected to a terminal x to provide a common return. The arrangement is shown correctly connected and with the switch set to illuminate the red lamp.

During maintenance, the wires at the signal are disconnected and, when reconnected, the black wire is connected in error to the green lamp (terminal g) instead of terminal x. The red wire is connected correctly to its lamp and connections at S remain as in the diagram.



When the system is tested with the switch connection to the red wire, what does the signal show?

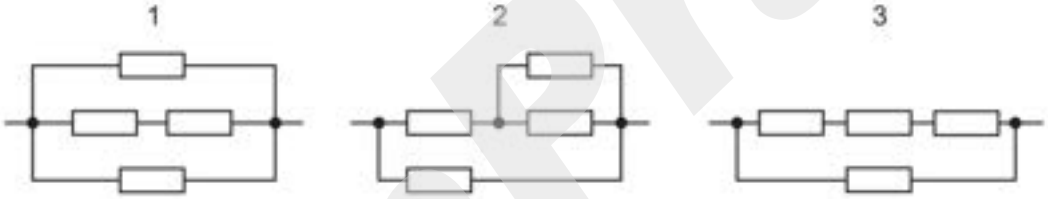
A the green lamp illuminated normally

B the red lamp illuminated normally

C the red and green lamps both illuminated normally

D the red and green lamps both illuminated dimly

38 Four identical resistors are connected in the three networks below.



Which arrangement has the highest total resistance and which has the lowest?

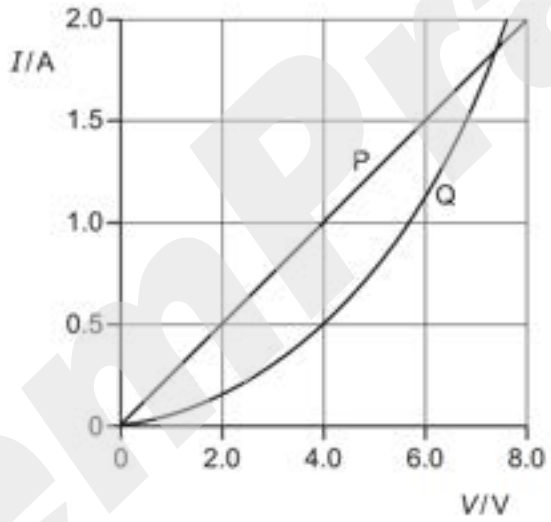
	highest	lowest
A	1	2
B	1	3
C	3	1
D	3	2

33 A cylindrical wire of length 10 m and diameter 2.0 mm has a resistance of 0.050 Ω.

From which material is the wire made?

	material	resistivity / Ω m
A	bronze	1.6×10^{-7}
B	nichrome	1.6×10^{-6}
C	silver	1.6×10^{-8}
D	zinc	6.3×10^{-8}

34 The *I*-*V* characteristics of two electrical components P and Q are shown below.



Which statement is correct?

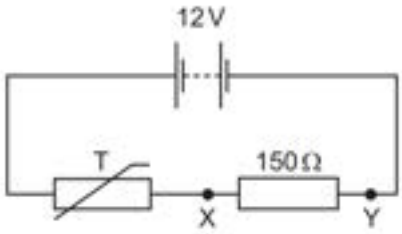
A P is a resistor and Q is a filament lamp.

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

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

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

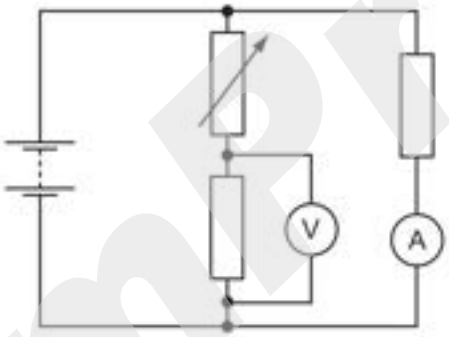
35 In a fire alarm system, a thermistor T has a resistance of 2000Ω at room temperature. Its resistance decreases as the temperature increases. The alarm is triggered when the potential difference between X and Y reaches 4.5 V.



What is the resistance of the thermistor when the alarm is triggered?

A 90Ω **B** 150Ω **C** 250Ω **D** 1300Ω

36 A network of electrical components is connected across a battery of negligible internal resistance, as shown.

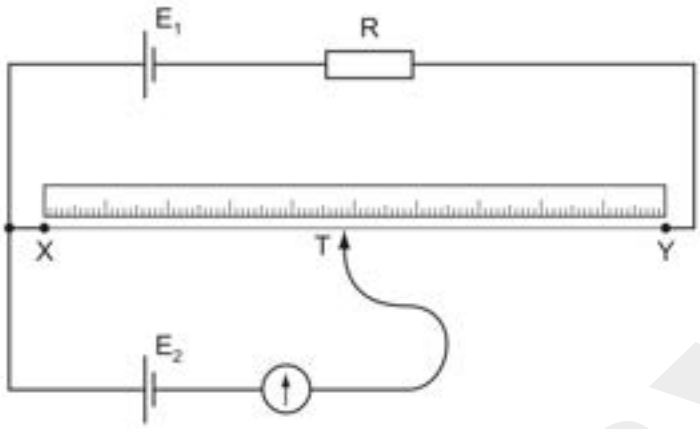


The resistance of the variable resistor is increased.

What is the effect on the readings of the ammeter and voltmeter?

	ammeter	voltmeter
A	decreases	increases
B	increases	decreases
C	unchanged	decreases
D	unchanged	increases

37 The diagram shows a potentiometer circuit.



The contact T is placed on the wire and moved along the wire until the galvanometer reading is zero. The length XT is then noted.

In order to calculate the potential difference per unit length of the wire XY, which value must also be known?

A the e.m.f. of the cell E_1

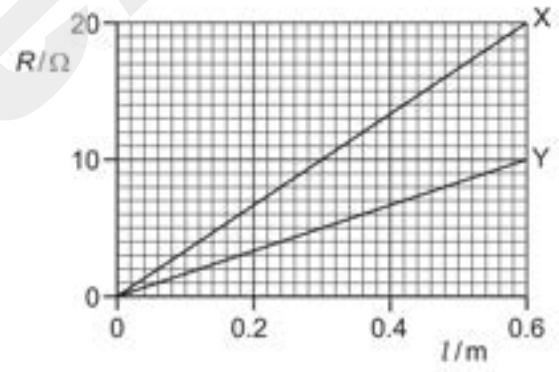
B the e.m.f. of the cell E_2

C the resistance of resistor R

D the resistance of the wire XY

October/November 2012(12)

34 The graph shows the variation with length *l* of resistance *R* for two wires X and Y made from the same material.



What does the graph show?

A cross-sectional area of X = 2 × cross-sectional area of Y

B resistivity of X = 2 × resistivity of Y

C when equal lengths of X and Y are connected in series to a battery, power in X = 2 × power in Y

D when equal lengths of X and Y are connected in parallel to a battery, current in X = 2 × current in Y

35 A cell of internal resistance 2.0 Ω and electromotive force (e.m.f.) 1.5 V is connected to a resistor of resistance 3.0 Ω.

What is the potential difference across the 3.0 Ω resistor?

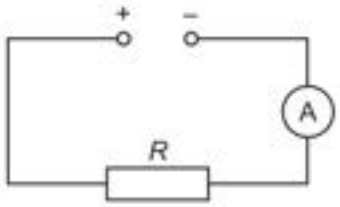
A 1.5 V **B** 1.2 V **C** 0.9 V **D** 0.6 V

36 A 100 Ω resistor conducts a current with changing direction and magnitude, as shown.

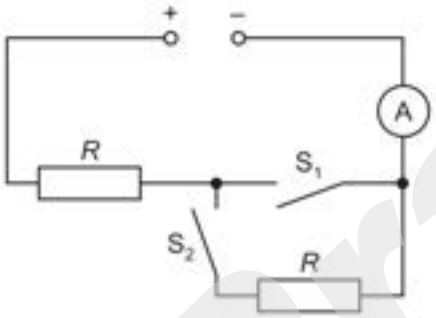
What is the mean power dissipated in the resistor?

A 100 W **B** 150 W **C** 250 W **D** 400 W

37 The ammeter reading in the circuit below is I.



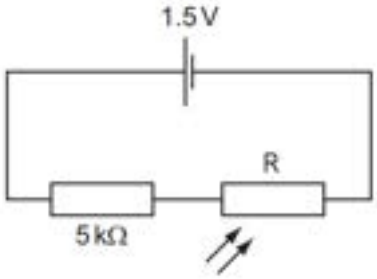
Another circuit containing the same voltage supply, two switches, an ammeter and two resistors each of resistance R, is shown.



Which row is **not** correct?

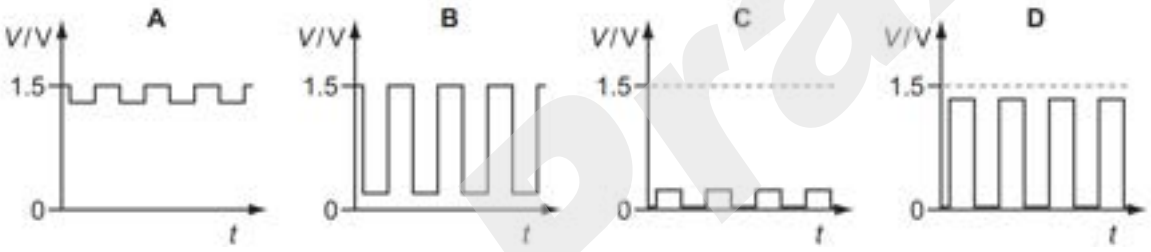
	S_1	S_2	ammeter reading
A	closed	closed	I
B	closed	open	I
C	open	closed	I
D	open	open	0

38 A light-dependent resistor R has resistance of about 1 MΩ in the dark and about 1 kΩ when illuminated. It is connected in series with a 5 kΩ resistor to a 1.5 V cell of negligible internal resistance.



The light-dependent resistor is illuminated (in an otherwise dark room) by a flashing light.

Which graph best shows the variation with time *t* of potential difference *V* across R?



October/November 2012 (13)

32 Which values of current and resistance will produce a rate of energy transfer of 16 J s^{-1}?

	current / A	resistance / Ω
A	1	4
B	2	8
C	4	1
D	16	1

33 A copper wire is stretched so that its diameter is reduced from 1.0 mm to a uniform 0.5 mm.

The resistance of the unstretched copper wire is 0.2 Ω.

What will be the resistance of the stretched wire?

A 0.4 Ω **B** 0.8 Ω **C** 1.6 Ω **D** 3.2 Ω

34 Four statements about potential difference or electromotive force are listed.

1 It involves changing electrical energy into other forms.

2 It involves changing other energy forms into electrical energy.

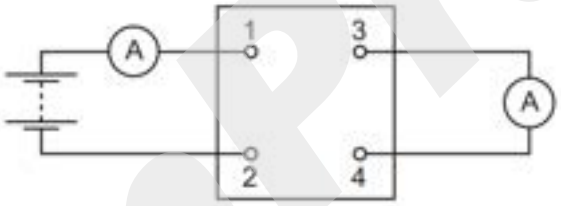
3 It is the energy per unit charge to move charge right round a circuit.

4 It is the work done per unit charge by the charge moving from one point to another.

Which statements apply to potential difference and which apply to electromotive force?

	potential difference	electromotive force
A	1 and 3	2 and 4
B	1 and 4	2 and 3
C	2 and 3	1 and 4
D	2 and 4	1 and 3

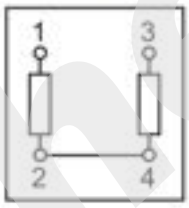
35 The diagram shows a four-terminal box connected to a battery and two ammeters.



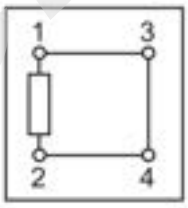
The currents in the two meters are identical.

Which circuit, within the box, will give this result?

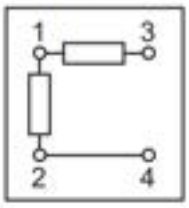
A



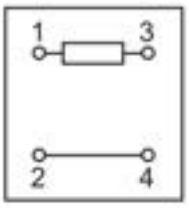
B



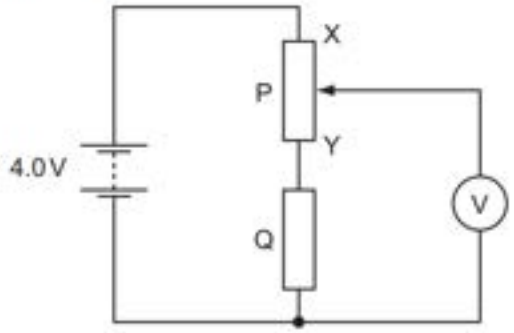
C



D



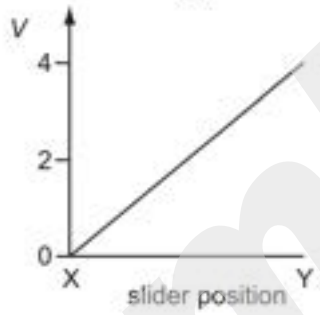
36 In the circuit below, P is a potentiometer of total resistance 10Ω and Q is a fixed resistor of resistance 10Ω. The battery has an e.m.f. of 4.0V and negligible internal resistance. The voltmeter has a very high resistance.



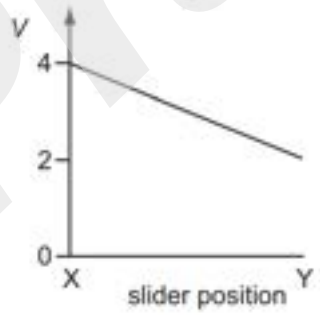
The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading *V* is plotted against slider position.

Which graph is obtained?

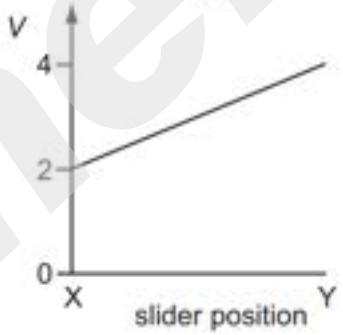
A



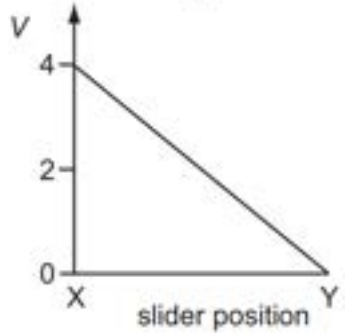
B



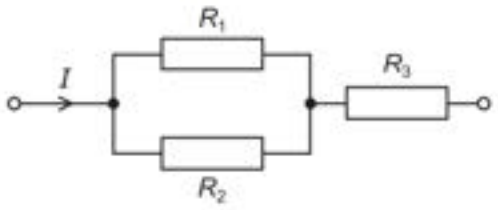
C



D



37 The diagram shows a resistor network. The potential difference across the network is V.



Is the equation shown below correct for the network?

$$V = I(1/R_1 + 1/R_2 + R_3)$$

A Yes, it correctly combines two series resistors with one parallel resistor, and correctly uses Ohm's Law.

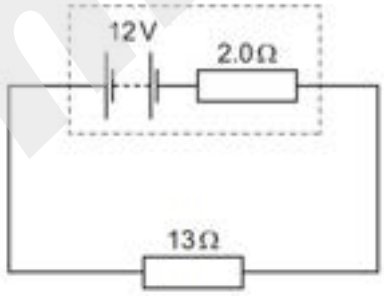
B Yes, it correctly combines two parallel resistors with one series resistor, and correctly uses Ohm's Law.

C No, because it should read $V = I \div (1/R_1 + 1/R_2 + R_3)$.

D No, because the terms $1/R_2$ and R_3 have different units and cannot be added.

May/June 2013 (11)

32 A power supply of electromotive force (e.m.f.) 12 V and internal resistance 2.0 Ω is connected in series with a 13 Ω resistor.



What is the power dissipated in the 13 Ω resistor?

A 8.3 W **B** 9.6 W **C** 10 W **D** 11 W

33 When a battery is connected to a resistor, the battery gradually becomes warm. This causes the internal resistance of the battery to increase whilst its e.m.f. stays unchanged.

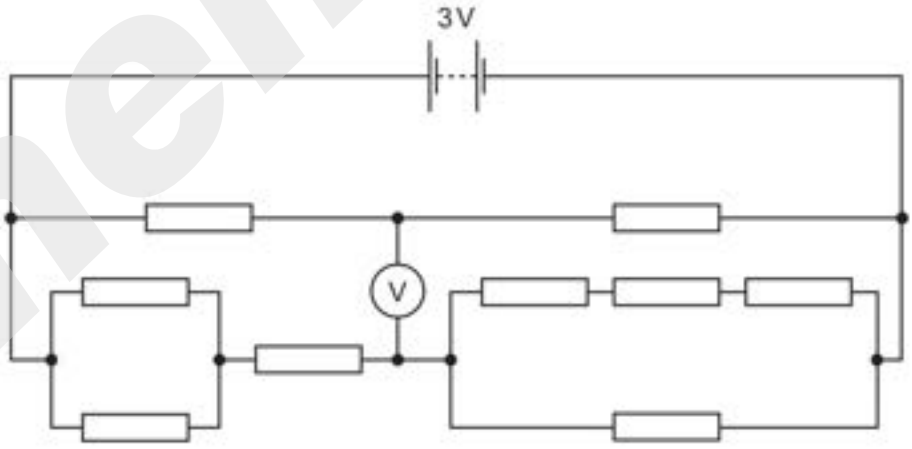
As the internal resistance of the battery increases, how do the terminal potential difference and the output power change, if at all?

	terminal potential difference	output power
A	decrease	decrease
B	decrease	unchanged
C	unchanged	decrease
D	unchanged	unchanged

34 The principles of conservation of which two quantities are associated with Kirchhoff's first and second laws?

	first law	second law
A	charge	energy
B	charge	voltage
C	energy	charge
D	voltage	charge

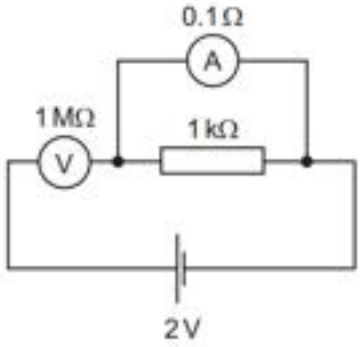
35 A circuit is set up as shown, supplied by a 3 V battery. All resistances are 1 kΩ.



What will be the reading on the voltmeter?

A 0 **B** 0.5 V **C** 1.0 V **D** 1.5 V

36 The diagram shows an incorrectly connected circuit. The ammeter has a resistance of 0.1 Ω and the voltmeter has a resistance of 1 MΩ.



Which statement is correct?

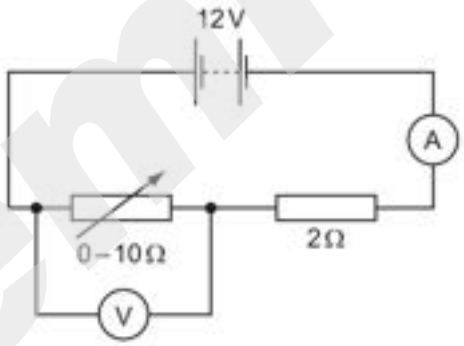
A The ammeter reads 2 mA.

B The ammeter reads 20 A.

C The voltmeter reads zero.

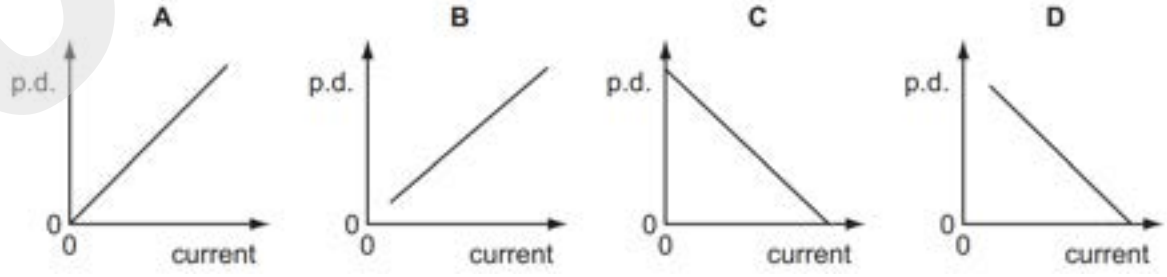
D The voltmeter reads 2 V.

37 A 12 V battery is in series with an ammeter, a 2 Ω fixed resistor and a 0 – 10 Ω variable resistor. A high-resistance voltmeter is connected across the variable resistor.



The resistance of the variable resistor is changed from zero to its maximum value.

Which graph shows how the potential difference (p.d.) measured by the voltmeter varies with the current measured by the ammeter?



May/June 2013 (12)

32 A power cable has length 2000 m. The cable is made of twelve parallel strands of copper wire, each with diameter 0.51 mm.

What is the resistance of the cable? (resistivity of copper = $1.7 \times 10^{-8}\,\Omega\text{m}$)

A 0.014 Ω **B** 3.5 Ω **C** 14 Ω **D** 166 Ω

33 A low-voltage supply with an e.m.f. of 20 V and an internal resistance of 1.5 Ω is used to supply power to a heater of resistance 6.5 Ω in a fish tank.

What is the power supplied to the water in the fish tank?

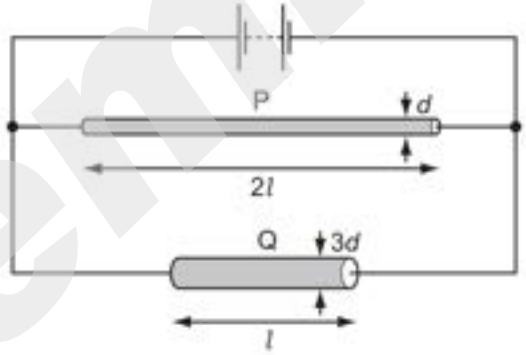
A 41 W **B** 50 W **C** 53 W **D** 62 W

34 A filament lamp has a resistance of 180 Ω when the current in it is 500 mA.

What is the power transformed in the lamp?

A 45 W **B** 50 W **C** 90 W **D** 1400 W

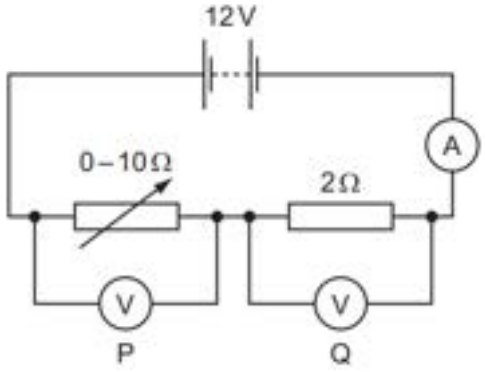
35 Two wires P and Q made of the same material are connected to the same electrical supply. P has twice the length of Q and one-third of the diameter of Q, as shown in the diagram.



What is the ratio $\frac{\text{current in P}}{\text{current in Q}}$?

A $\frac{2}{3}$ **B** $\frac{2}{9}$ **C** $\frac{1}{6}$ **D** $\frac{1}{18}$

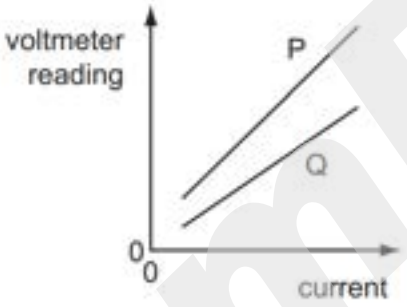
36 A 12 V battery is in series with an ammeter, a 2Ω fixed resistor and a 0 – 10Ω variable resistor. High-resistance voltmeters P and Q are connected across the variable resistor and the fixed resistor respectively, as shown.



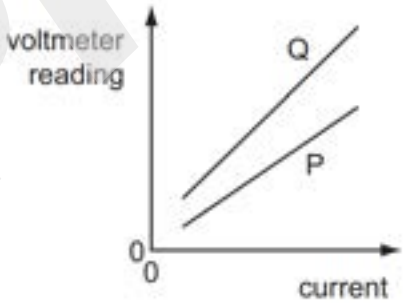
The resistance of the variable resistor is changed from its maximum value to zero.

Which graph shows the variation with current of the voltmeter readings?

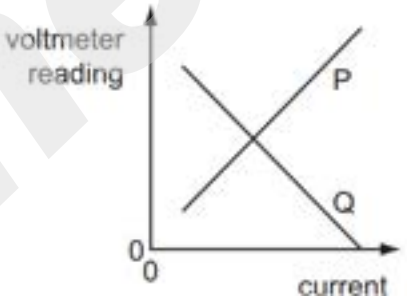
A



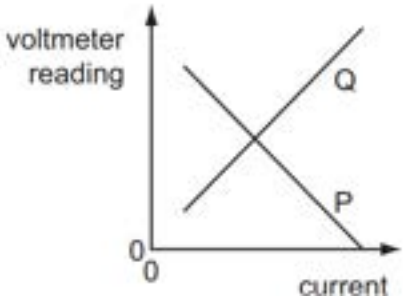
B



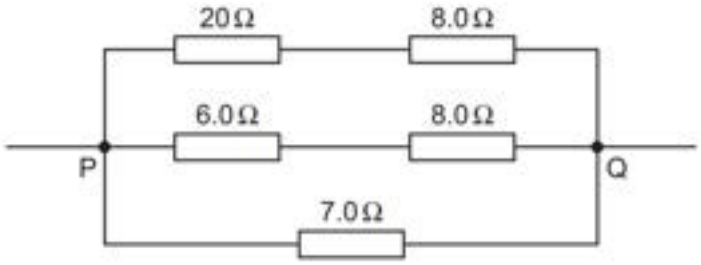
C



D



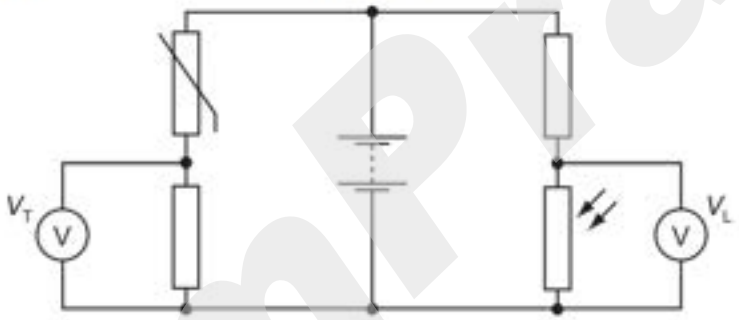
37 Five resistors are connected as shown.



What is the total resistance between P and Q?

A 0.25Ω **B** 0.61Ω **C** 4.0Ω **D** 16Ω

38 In the circuit below, the reading V_T on the voltmeter changes from high to low as the temperature of the thermistor changes. The reading V_L on the voltmeter changes from high to low as the level of light on the light-dependent resistor (LDR) changes.



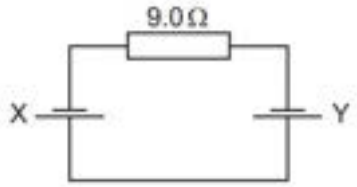
The readings V_T and V_L are both high.

What are the conditions of temperature and light level?

	temperature	light level
A	low	low
B	low	high
C	high	low
D	high	high

May/June 2013 (13)

31 Two cells X and Y are connected in series with a resistor of resistance 9.0Ω, as shown.



Cell X has an electromotive force (e.m.f.) of 1.0V and an internal resistance of 1.0Ω. Cell Y has an e.m.f. of 2.0V and an internal resistance of 2.0Ω.

What is the current in the circuit?

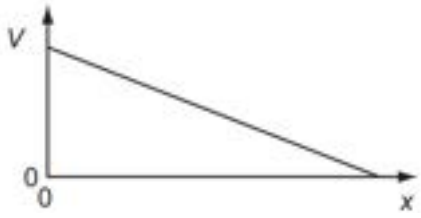
A 0.25A **B** 0.17A **C** 0.10A **D** 0.083A

32 The circular cross-sectional area of a metal wire varies along its length. There is a current in the wire. The narrow end of the wire is at a reference potential of zero.

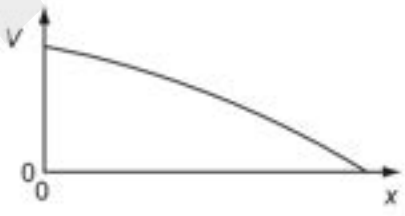
Which graph best represents the variation with distance *x* along the wire of the potential difference *V* relative to the reference zero?

A

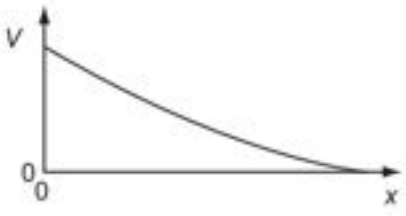
B



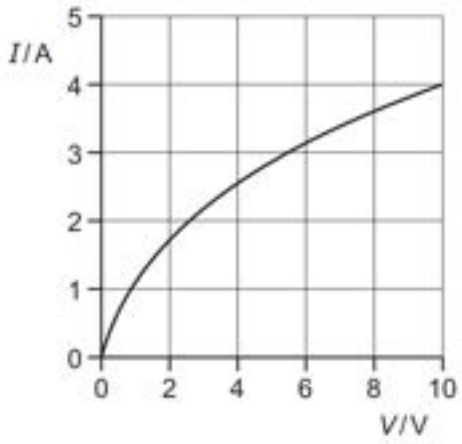
C



D



33 The graph shows how current I varies with voltage V for a filament lamp.



Since the graph is not a straight line, the resistance of the lamp varies with V.

Which row gives the correct resistance at the stated value of V?

	V/V	R/Ω
A	2.0	1.5
B	4.0	3.2
C	6.0	1.9
D	8.0	0.9

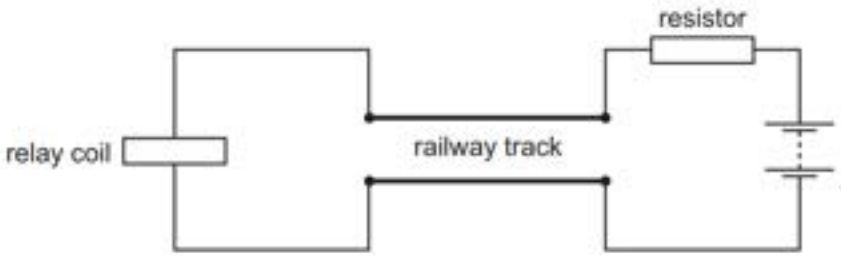
34 An electric power cable consists of six copper wires c surrounding a steel core s.

A length of 1.0 km of one of the copper wires has a resistance of 10 Ω and 1.0 km of the steel core has a resistance of 100 Ω.

What is the approximate resistance of a 1.0 km length of the power cable?

A 0.61 Ω **B** 1.6 Ω **C** 160 Ω **D** 610 Ω

35 The diagram shows a length of track from a model railway connected to a battery, a resistor and a relay coil.



With no train present, there is a current in the relay coil which operates a switch to turn on a light.

When a train occupies the section of track, most of the current flows through the wheels and axles of the train in preference to the relay coil. The switch in the relay turns off the light.

Why is a resistor placed between the battery and the track?

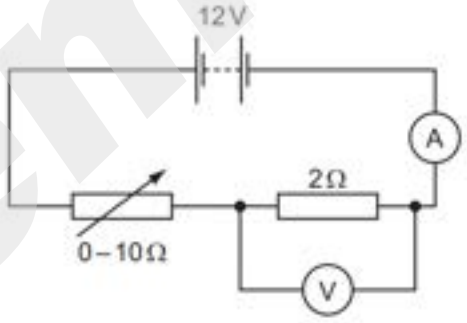
A to limit the heating of the wheels of the train

B to limit the energy lost in the relay coil when a train is present

C to prevent a short circuit of the battery when a train is present

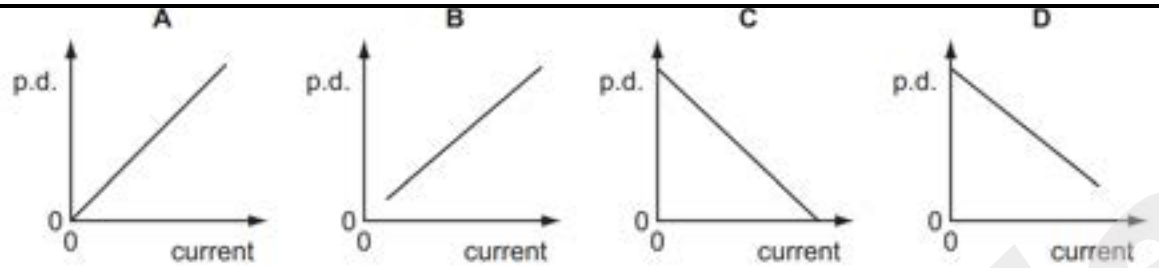
D to protect the relay when a train is present

36 A 12 V battery is in series with an ammeter, a 2 Ω fixed resistor and a 0 – 10 Ω variable resistor. A high-resistance voltmeter is connected across the fixed resistor.

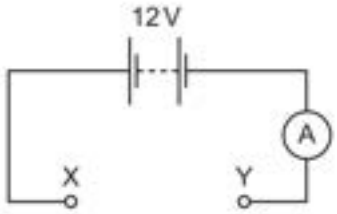


The resistance of the variable resistor is changed from zero to its maximum value.

Which graph shows how the potential difference (p.d.) measured by the voltmeter varies with the current measured by the ammeter?

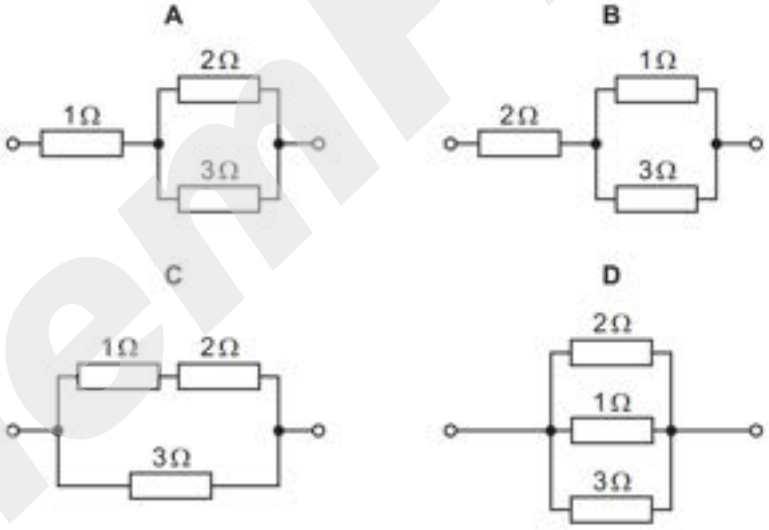


37 In the circuit shown, the battery and ammeter each have negligible resistance.



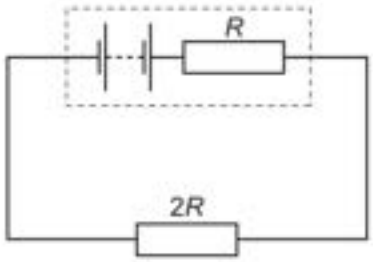
The following combinations of resistors are placed in turn between the terminals X and Y of the circuit.

Which combination would give an ammeter reading of 8 A?



October/November 2013 (11)

33 The diagram shows an electric circuit in which the resistance of the external resistor is $2R$ and the internal resistance of the source is R.



What is the ratio $\frac{\text{power in external resistor}}{\text{power in internal resistance}}$?

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

34 Two lamps are connected in series to a 250 V power supply. One lamp is rated 240 V, 60 W and the other is rated 10 V, 2.5 W.

Which statement most accurately describes what happens?

A Both lamps light at less than their normal brightness.

B Both lamps light normally.

C Only the 60 W lamp lights.

D The 10 V lamp blows.

35 The wire of a heating element has resistance R. The wire breaks and is replaced by a different wire.

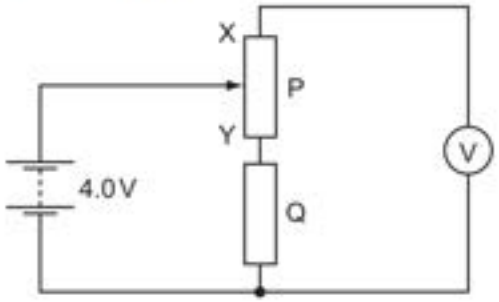
Data for the original wire and the replacement wire are shown in the table.

	length	diameter	resistivity of metal
original wire	l	d	ρ
replacement wire	l	$2d$	2ρ

What is the resistance of the replacement wire?

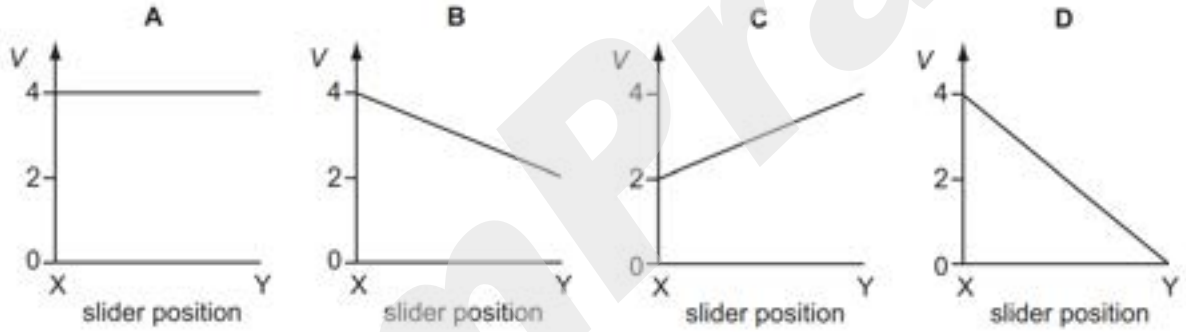
A $\frac{R}{4}$ **B** $\frac{R}{2}$ **C** R **D** $2R$

36 In the circuit below, P is a potentiometer of total resistance 10Ω and Q is a fixed resistor of resistance 10Ω. The battery has an electromotive force (e.m.f.) of 4.0V and negligible internal resistance. The voltmeter has a very high resistance.

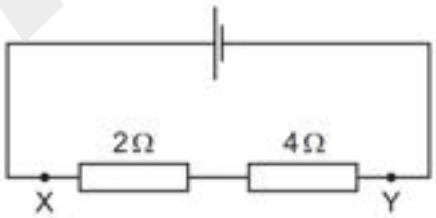


The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading *V* is plotted against slider position.

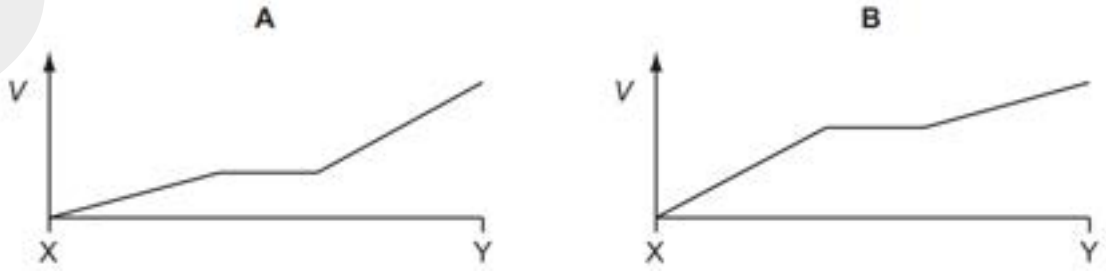
Which graph would be obtained?



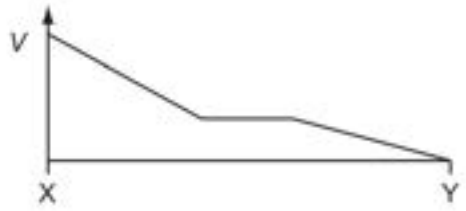
37 A 2Ω resistor and a 4Ω resistor are connected to a cell.



Which graph shows how the potential *V* varies with distance between X and Y?



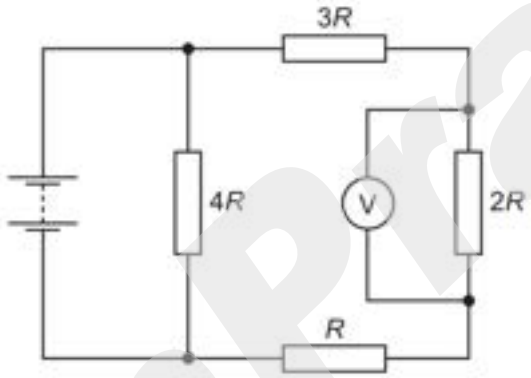
C



D

38 Four resistors of resistance R, $2R$, $3R$ and $4R$ are connected to form a network.

A battery of negligible internal resistance and a voltmeter are connected to the resistor network as shown.

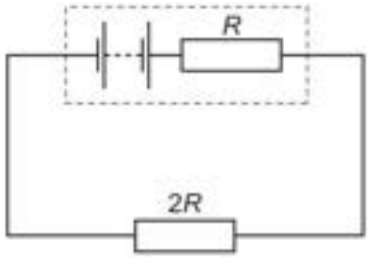


The voltmeter reading is 2 V.

What is the electromotive force (e.m.f.) of the battery?

A 2 V **B** 4 V **C** 6 V **D** 10 V

33 The diagram shows an electric circuit in which the resistance of the external resistor is $2R$ and the internal resistance of the source is R.



What is the ratio $\frac{\text{power in external resistor}}{\text{power in internal resistance}}$?

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

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Which statement most accurately describes what happens?

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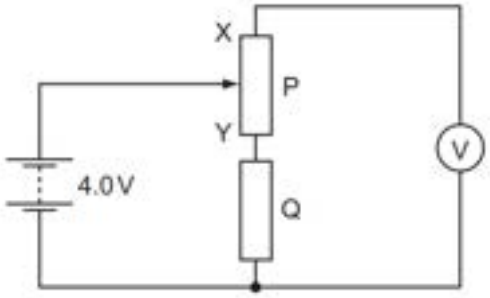
Data for the original wire and the replacement wire are shown in the table.

	length	diameter	resistivity of metal
original wire	l	d	ρ
replacement wire	l	$2d$	2ρ

What is the resistance of the replacement wire?

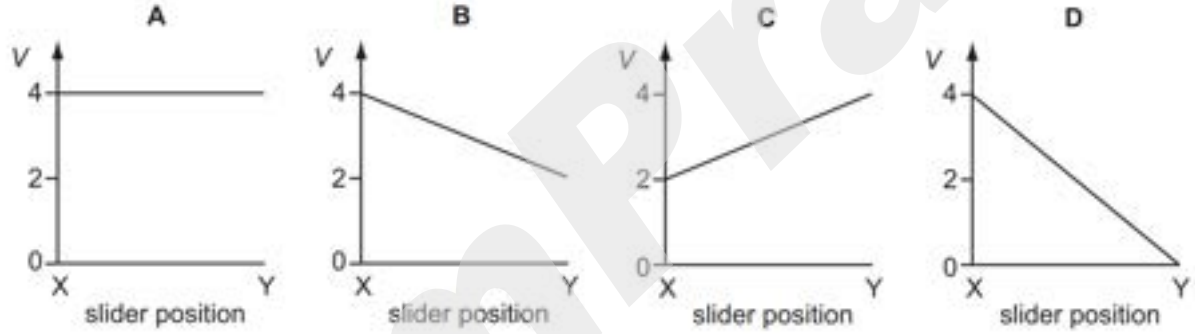
A $\frac{R}{4}$ **B** $\frac{R}{2}$ **C** R **D** $2R$

36 In the circuit below, P is a potentiometer of total resistance 10Ω and Q is a fixed resistor of resistance 10Ω. The battery has an electromotive force (e.m.f.) of 4.0V and negligible internal resistance. The voltmeter has a very high resistance.

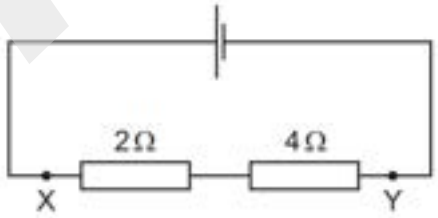


The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading *V* is plotted against slider position.

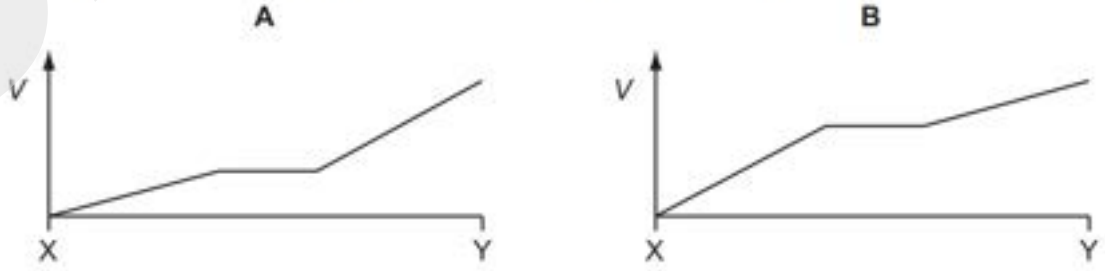
Which graph would be obtained?



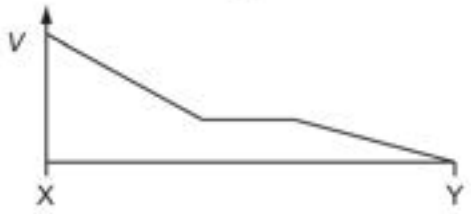
37 A 2Ω resistor and a 4Ω resistor are connected to a cell.



Which graph shows how the potential *V* varies with distance between X and Y?



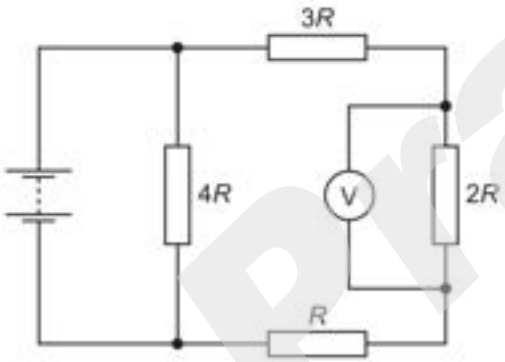
C



D

38 Four resistors of resistance R, $2R$, $3R$ and $4R$ are connected to form a network.

A battery of negligible internal resistance and a voltmeter are connected to the resistor network as shown.



The voltmeter reading is 2 V.

What is the electromotive force (e.m.f.) of the battery?

A 2 V **B** 4 V **C** 6 V **D** 10 V

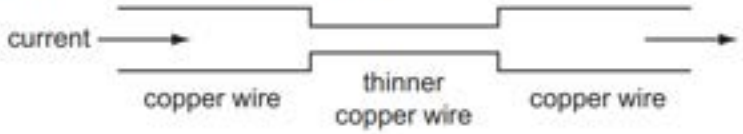
October/November 2013 (13)

32 The current in a component is reduced uniformly from 100 mA to 20 mA over a period of 8.0 s.

What is the charge that flows during this time?

A 160 mC **B** 320 mC **C** 480 mC **D** 640 mC

33 An electric current is passed from a thick copper wire through a section of thinner copper wire before entering a second thick copper wire as shown.



Which statement about the current and the speed of electrons in the wires is correct?

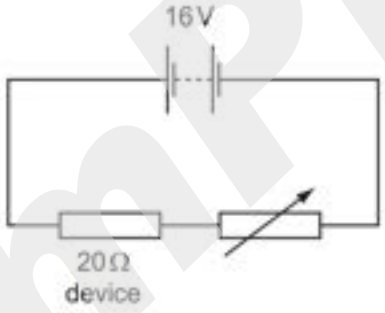
A The current and the speed of the electrons in the thinner wire are both less than in the thicker copper wires.

B The current and the speed of the electrons is the same in all the wires.

C The current is the same in all the wires but the speed of the electrons in the thinner wire is greater than in the thicker wires.

D The current is the same in all the wires but the speed of the electrons in the thinner wire is less than in the thicker wire.

34 An electrical device of fixed resistance 20 Ω is connected in series with a variable resistor and a battery of electromotive force (e.m.f.) 16 V and negligible internal resistance.



What is the resistance of the variable resistor when the power dissipated in the electrical device is 4.0 W?

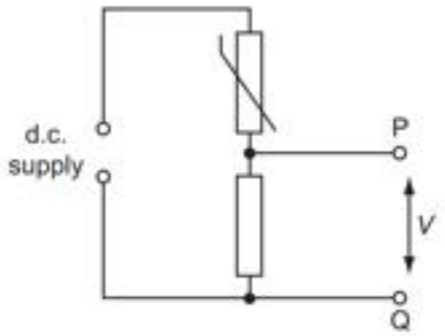
A 16 Ω **B** 36 Ω **C** 44 Ω **D** 60 Ω

35 A copper wire is cylindrical and has resistance R.

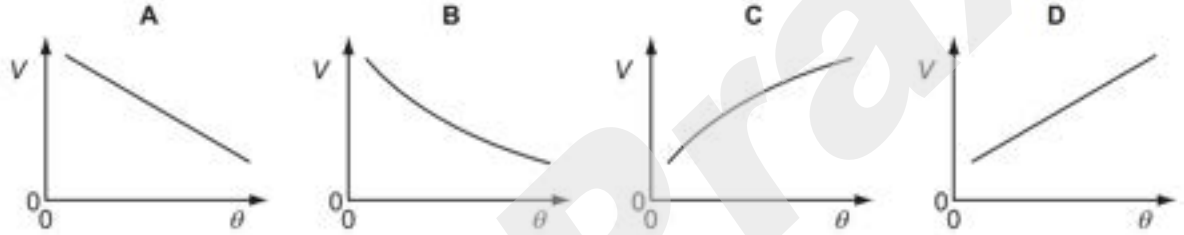
What will be the resistance of a copper wire of twice the length and twice the radius?

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

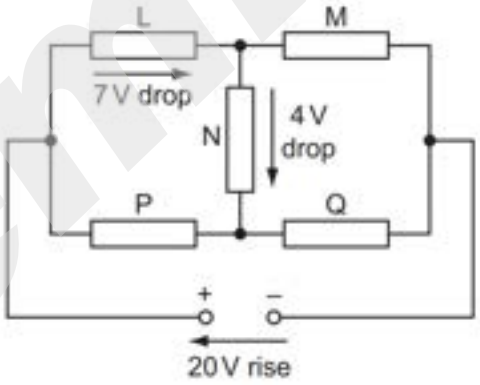
37 In the circuit shown, the resistance of the thermistor decreases as temperature increases.



Which graph shows the variation with Celsius temperature θ of potential difference V between points P and Q?



38 A 20 V d.c. supply is connected to a circuit consisting of five resistors L, M, N, P and Q.



There is a potential drop of 7 V across L and a further 4 V potential drop across N.

What are the potential drops across M, P and Q?

	potential drop across M/V	potential drop across P/V	potential drop across Q/V
A	9	7	13
B	13	7	13
C	13	11	9
D	17	3	17

May/June 2014 (11)

30 Two electrically-conducting cylinders X and Y are made from the same material.

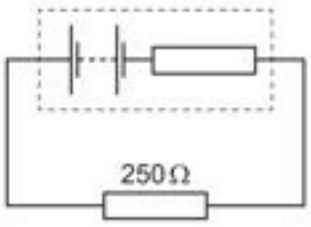
Their dimensions are as shown.

The resistance between the ends of each cylinder is measured.

What is the ratio $\frac{\text{resistance of X}}{\text{resistance of Y}}$?

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

31 A battery, with a constant internal resistance, is connected to a resistor of resistance 250Ω, as shown.



The current in the resistor is 40 mA for a time of 60 s. During this time 6.0 J of energy is lost in the internal resistance.

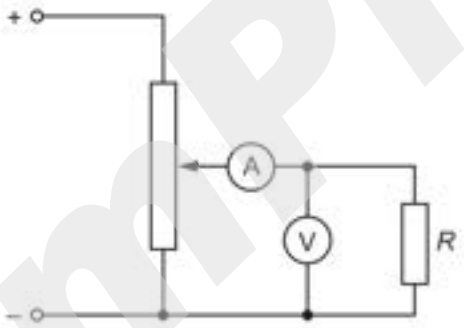
What are the energy supplied to the external resistor during the 60 s and the e.m.f. of the battery?

	energy / J	e.m.f. / V
A	2.4	2.4
B	2.4	7.5
C	24	10.0
D	24	12.5

32 Which symbol represents a component whose resistance is designed to change with temperature?

A **B** **C** **D**

33 In the circuit below, a voltmeter of resistance R_V and an ammeter of resistance R_A are used to measure the resistance R of the fixed resistor.



Which condition is necessary for an accurate value to be obtained for R?

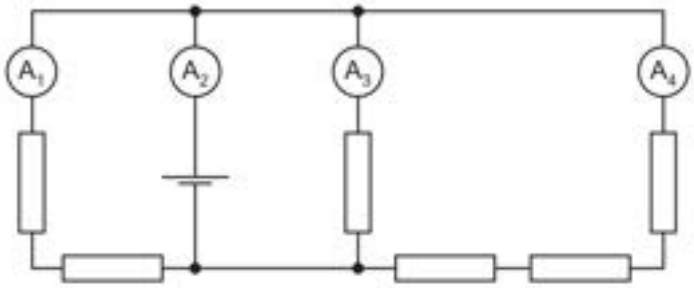
A R is much smaller than R_V.

B R is much smaller than R_A.

C R is much greater than R_V.

D R is much greater than R_A.

34 In the circuit shown, all the resistors are identical and all the ammeters have negligible resistance.



The reading on ammeter A_1 is 0.6 A.

What are the readings on the other ammeters?

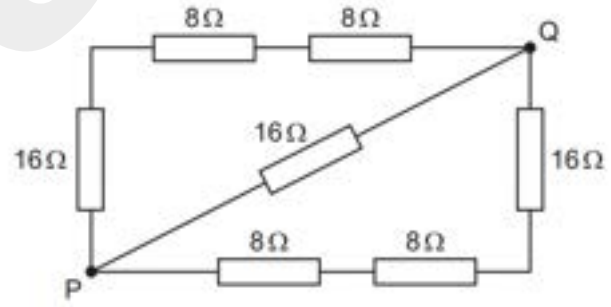
	reading on ammeter A_2 / A	reading on ammeter A_3 / A	reading on ammeter A_4 / A
A	1.0	0.3	0.1
B	1.4	0.6	0.2
C	1.8	0.9	0.3
D	2.2	1.2	0.4

35 The potential difference across a component in a circuit is 2.0 V.

How many electrons must flow through this component in order for it to be supplied with 4.8 J of energy?

A 2.6×10^{18} **B** 1.5×10^{19} **C** 3.0×10^{19} **D** 6.0×10^{19}

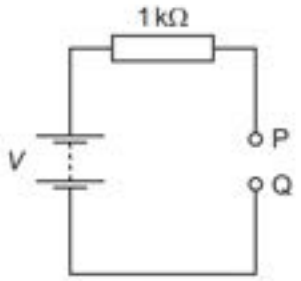
36 What is the total resistance between points P and Q in this network of resistors?



A 8Ω **B** 16Ω **C** 24Ω **D** 32Ω

May/June 2014 (12)

30 A battery of electromotive force (e.m.f.) V and negligible internal resistance is connected to a 1 kΩ resistor, as shown.



A student attempts to measure the potential difference (p.d.) between points P and Q using two voltmeters, one at a time. The first voltmeter has a resistance of 1 kΩ and the second voltmeter has a resistance of 1 MΩ.

What are the readings of the voltmeters?

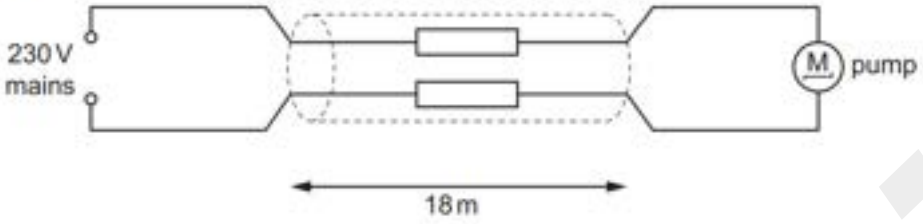
	reading on voltmeter with 1 kΩ resistance	reading on voltmeter with 1 MΩ resistance
A	$\frac{V}{2}$	$\frac{V}{2}$
B	$\frac{V}{2}$	V
C	V	$\frac{V}{2}$
D	V	V

31 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

32 The diagram shows an electric pump for a garden fountain connected by an 18 m cable to a 230 V mains electrical supply.

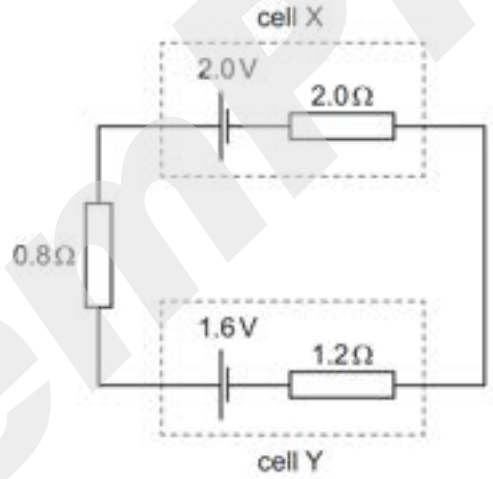


The performance of the pump is acceptable if the potential difference (p.d.) across it is at least 218 V. The current through it is then 0.83 A.

What is the maximum resistance per metre of each of the two wires in the cable if the pump is to perform acceptably?

A $0.40\,\Omega m^{-1}$ **B** $0.80\,\Omega m^{-1}$ **C** $1.3\,\Omega m^{-1}$ **D** $1.4\,\Omega m^{-1}$

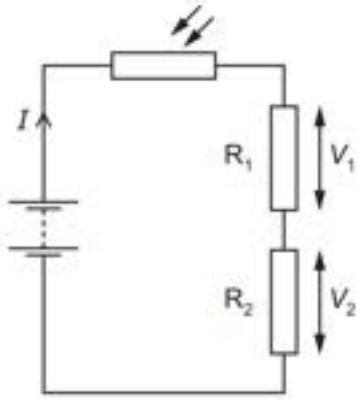
33 Cell X has an e.m.f. of 2.0 V and an internal resistance of 2.0 Ω. Cell Y has an e.m.f. of 1.6 V and an internal resistance of 1.2 Ω. These two cells are connected to a resistor of resistance 0.8 Ω, as shown.



What is the current in cell X?

A 0.10 A **B** 0.50 A **C** 0.90 A **D** 1.0 A

34 In the circuit shown, a light-dependent resistor (LDR) is connected to two resistors R_1 and R_2. The potential difference (p.d.) across R_1 is V_1 and the p.d. across R_2 is V_2. The current in the circuit is I.



Which statement about this circuit is correct?

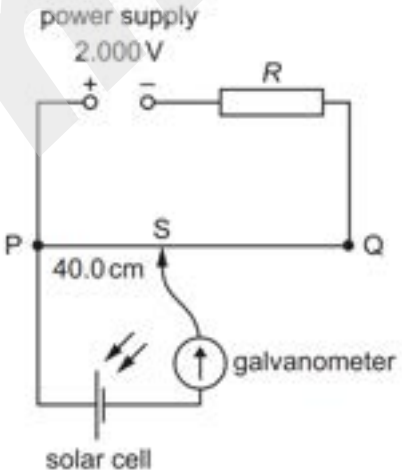
A The current I increases when the light intensity decreases.

B The LDR is an ohmic conductor.

C The p.d. V_2 increases when the light intensity decreases.

D The ratio $\frac{V_1}{V_2}$ is independent of light intensity.

35 A power supply and a solar cell are compared using the potentiometer circuit shown.



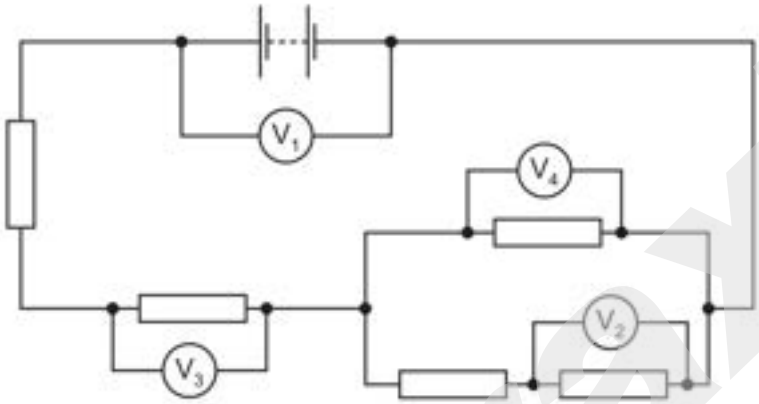
The e.m.f. produced by the solar cell is measured on the potentiometer.

The potentiometer wire PQ is 100.0 cm long and has a resistance of 5.00 Ω. The power supply has an e.m.f. of 2.000 V and the solar cell has an e.m.f. of 5.00 mV.

Which resistance *R* must be used so that the galvanometer reads zero when PS = 40.0 cm?

A 395 Ω **B** 795 Ω **C** 995 Ω **D** 1055 Ω

36 In the circuit shown, all the resistors are identical.

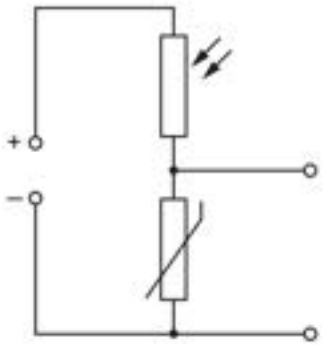


The reading on voltmeter V_1 is 8.0 V and the reading on voltmeter V_2 is 1.0 V.

What are the readings on the other voltmeters?

	reading on voltmeter V_3/V	reading on voltmeter V_4/V
A	1.5	1.0
B	3.0	2.0
C	4.5	3.0
D	6.0	4.0

37 The diagram shows a light-dependent resistor (LDR) and a thermistor forming a potential divider.



Under which set of conditions will the potential difference across the thermistor have the greatest value?

	illumination	temperature
A	low	low
B	high	low
C	low	high
D	high	high

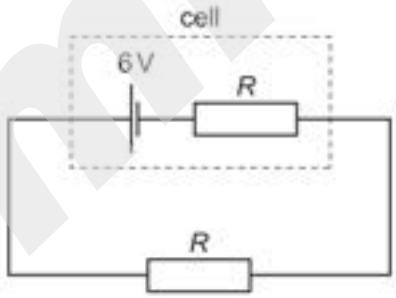
May/June 2014 (13)

33 Two wires P and Q made of the same material and of the same length are connected in parallel to the same voltage supply. Wire P has diameter 2 mm and wire Q has diameter 1 mm.

What is the ratio $\frac{\text{current in P}}{\text{current in Q}}$?

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

34 A cell has an electromotive force (e.m.f.) of 6 V and internal resistance *R*. An external resistor, also of resistance *R*, is connected across this cell, as shown.



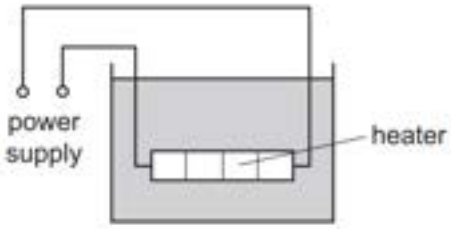
Power *P* is dissipated by the external resistor.

The cell is replaced by a different cell that has an e.m.f. of 6 V and negligible internal resistance.

What is the new power that is dissipated in the external resistor?

A 0.5*P* **B** *P* **C** 2*P* **D** 4*P*

35 The diagram shows a low-voltage circuit for heating the water in a fish tank.

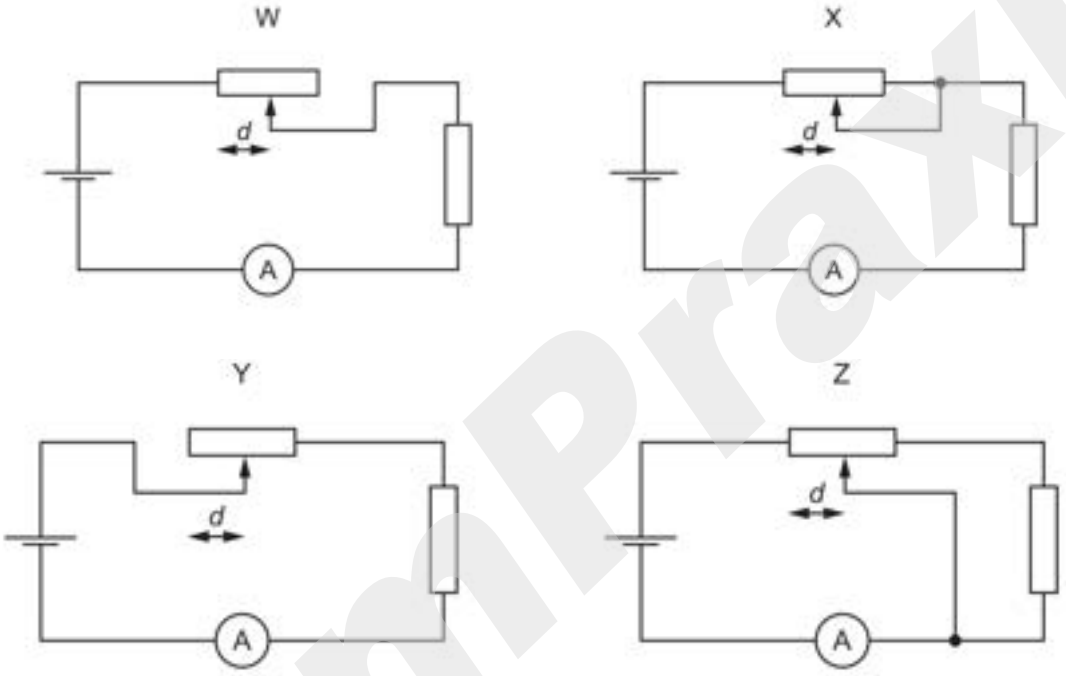


The heater has a resistance of 3.0Ω. The power supply has an e.m.f. of 12V and an internal resistance of 1.0Ω.

At which rate is energy supplied to the heater?

A 27W **B** 36W **C** 48W **D** 64W

36 The diagrams show the same cell, ammeter, potentiometer and fixed resistor connected in different ways.

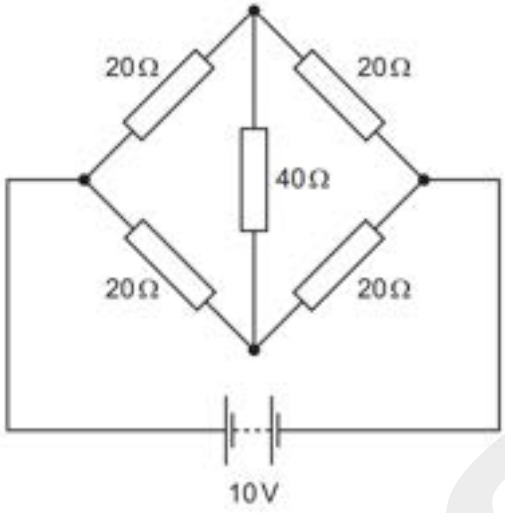


The distance *d* between the sliding contact and a particular end of the potentiometer is varied. The current measured is then plotted against the distance *d*.

For which two circuits will the graphs be identical?

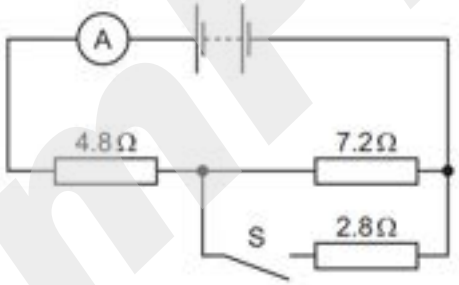
A W and X **B** W and Y **C** X and Y **D** Y and Z

37 What is the current in the 40 Ω resistor of the circuit shown?



A zero **B** 0.13 A **C** 0.25 A **D** 0.50 A

38 A battery of negligible internal resistance is connected to a resistor network, an ammeter and a switch S, as shown.



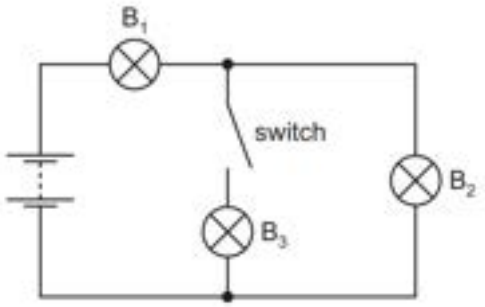
When S is open, the reading on the ammeter is 250 mA.

When S is closed, what is the **change** in the reading on the ammeter?

A 1.07 A **B** 1.32 A **C** 190 mA **D** 440 mA

October/November 2014 (11)

30 B_1, B_2 and B_3 are three identical lamps. They are connected to a battery with zero internal resistance, as shown.



Initially the switch is closed. The switch is then opened and lamp B_3 goes out.

What happens to the brightness of lamps B_1 and B_2 when the switch is opened?

	brightness of lamp B_1	brightness of lamp B_2
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

31 A battery is marked 9.0 V.

What does this mean?

A Each coulomb of charge from the battery supplies 9.0 J of electrical energy to the whole circuit.

B The battery supplies 9.0 J to an external circuit for each coulomb of charge.

C The potential difference across any component connected to the battery will be 9.0 V.

D There will always be 9.0 V across the battery terminals.

32 A pencil is used to draw a line of length 30 cm and width 1.2 mm. The resistivity of the material in the pencil is $2.0 \times 10^{-5}\,\Omega\,m$ and the resistance of the line is $40\,k\Omega$.

What is the thickness of the line?

A $1.25 \times 10^{-10}\,m$

B $1.25 \times 10^{-8}\,m$

C $1.25 \times 10^{-7}\,m$

D $1.25 \times 10^{-5}\,m$

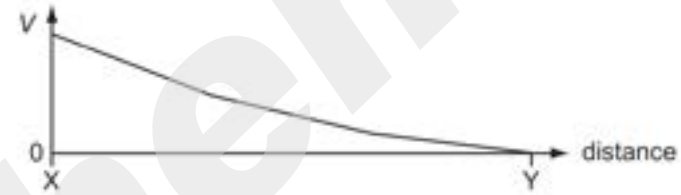
33 A conductor consists of three wires connected in series. The wires are all made of the same metal but have different cross-sectional areas. There is a current I in the conductor.

Point Y on the conductor is at zero potential.

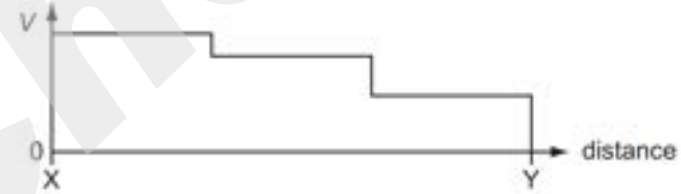
Which graph best shows the variation of potential V with distance along the conductor?

A

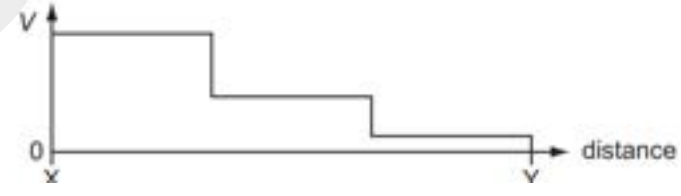
B



C

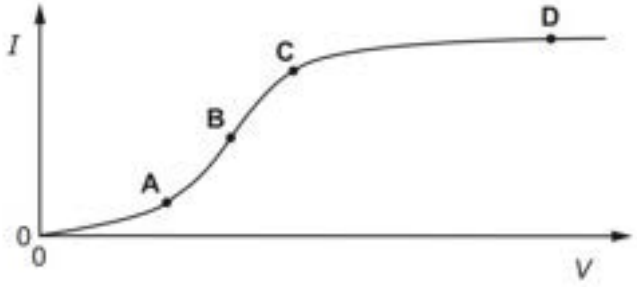


D



34 The graph shows how the electric current I through a conducting liquid varies with the potential difference V across it.

At which point on the graph does the liquid have the smallest resistance?



35 The combined resistance R_T of two resistors of resistances R_1 and R_2 connected in parallel is given by the formula shown.

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

Which statement is used in the derivation of this formula?

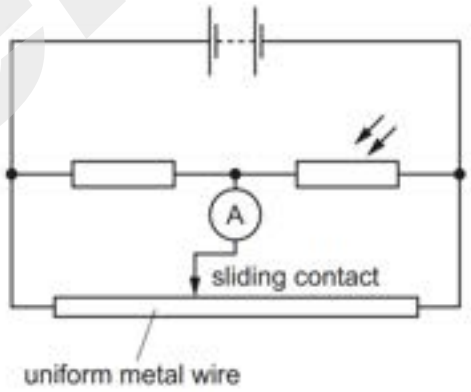
A The currents through the two resistors are equal.

B The potential difference across each resistor is the same.

C The supply current is split between the two resistors in the same ratio as the ratio of their resistances.

D The total power dissipated is the sum of the powers dissipated in the two resistors separately.

36 In the potentiometer circuit shown, the reading on the ammeter is zero.



The light-dependent resistor (LDR) is then covered up and the ammeter gives a non-zero reading.

Which change could return the ammeter reading to zero?

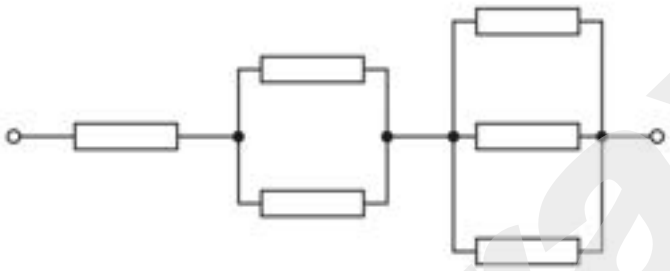
A Decrease the supply voltage.

B Increase the supply voltage.

C Move the sliding contact to the left.

D Move the sliding contact to the right.

37 Six resistors, each of resistance *R*, are connected as shown.



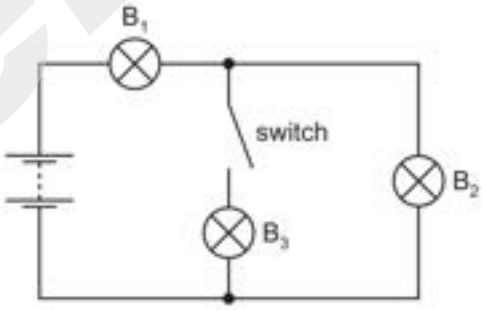
The combined resistance is 66 kΩ.

What is the value of *R*?

A 11 kΩ **B** 18 kΩ **C** 22 kΩ **D** 36 kΩ

October/November 2014(12)

30 B_1, B_2 and B_3 are three identical lamps. They are connected to a battery with zero internal resistance, as shown.



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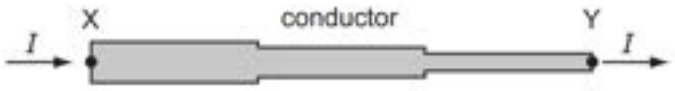

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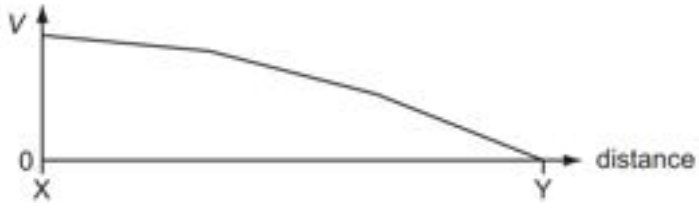
Which graph best shows the variation of potential V with distance along the conductor?

A



B

C

D

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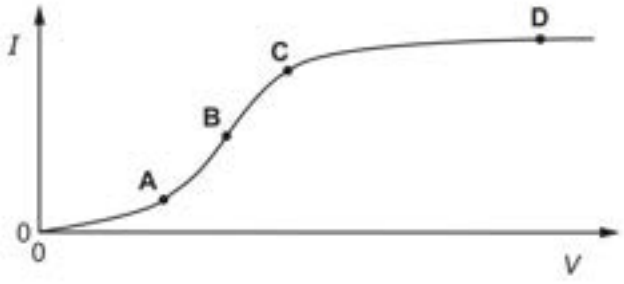

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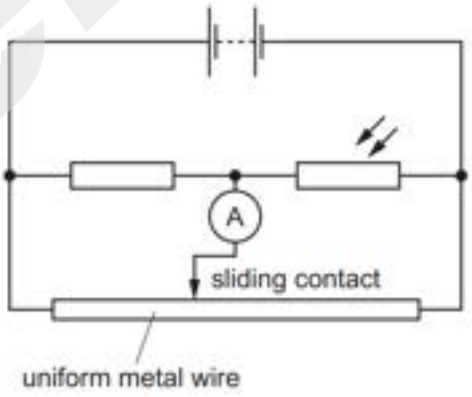

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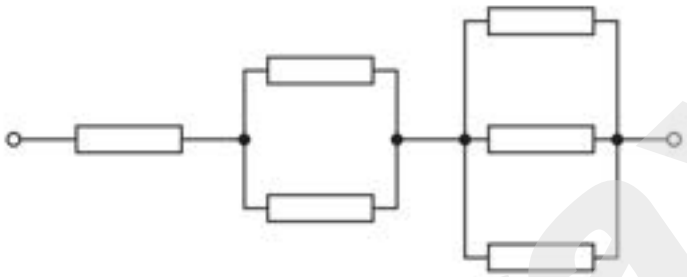
37 Six resistors, each of resistance R, are connected as shown.



The combined resistance is 66 kΩ.

What is the value of R?

A 11 kΩ **B** 18 kΩ C 22 kΩ D 36 kΩ

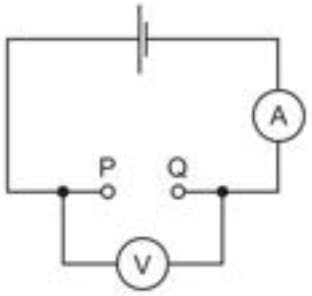
October/November 2014 (13)

33 A metal wire of length 0.50 m has a resistance of 12 Ω.

What is the resistance of a wire of length 2.0 m and made of the same material, but with half the diameter?

A 12 Ω B 48 Ω C 96 Ω D 192 Ω

34 A student found two unmarked resistors. To determine the resistance of the resistors, the circuit below was set up. The resistors were connected in turn between P and Q, noting the current readings. The voltage readings were noted without the resistors and with each resistor in turn.



The results were entered into a spreadsheet as shown.

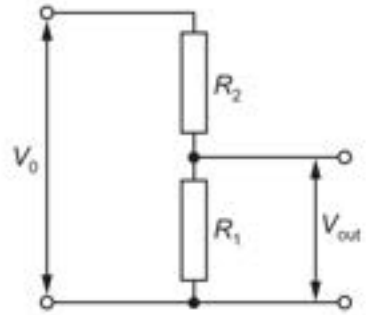
1.5	1.3	28	46
1.5	1.4	14	100

The student forgot to enter the column headings.

Which order of the headings would be correct?

A	e.m.f./V	V/V	R/Ω	I/mA
B	V/V	e.m.f./V	R/Ω	I/mA
C	V/V	e.m.f./V	I/mA	R/Ω
D	e.m.f./V	V/V	I/mA	R/Ω

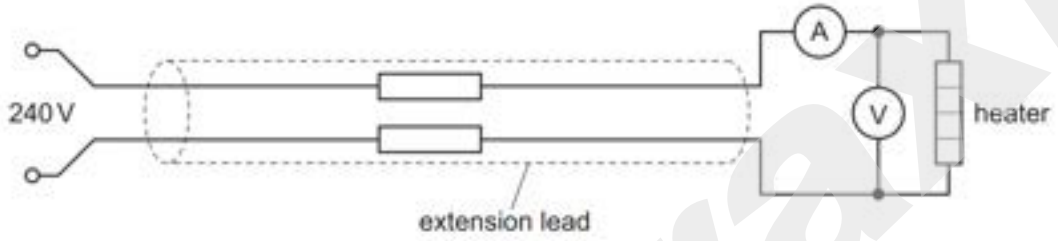
35 A potential divider consists of resistors of resistance R_1 and R_2 connected in series across a source of potential difference V_0. The potential difference across R_1 is V_{out}.



Which changes to R_1 and R_2 will increase the value of V_{out}?

	R_1	R_2
A	doubled	doubled
B	doubled	halved
C	halved	doubled
D	halved	halved

36 An extension lead is used to connect a 240 V electrical supply to a heater as shown.

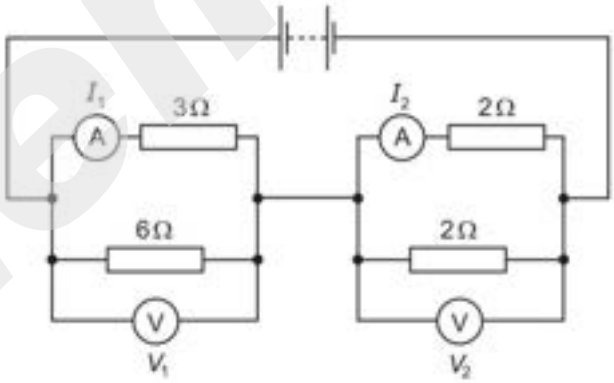


A voltmeter measures the potential difference (p.d.) across the heater as 216 V and an ammeter measures the current through the heater as 7.7 A.

What is the total resistance of the extension lead?

A 3.1 Ω **B** 6.2 Ω **C** 28 Ω **D** 31 Ω

37 In the circuit shown, the ammeters have negligible resistance and the voltmeters have infinite resistance.



The readings on the meters are I_1, I_2, V_1 and V_2, as labelled on the diagram.

Which statement is correct?

A $I_1 > I_2$ and $V_1 > V_2$

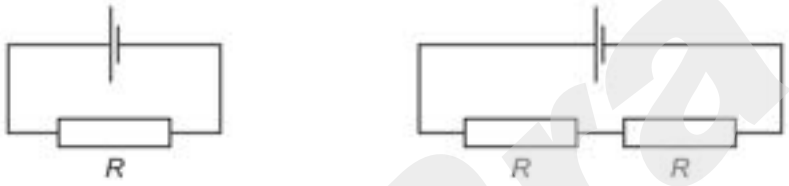
B $I_1 > I_2$ and $V_1 < V_2$

C $I_1 < I_2$ and $V_1 > V_2$

D $I_1 < I_2$ and $V_1 < V_2$

May/June 2015 (11)

33 The diagrams show two different circuits.



The cells in each circuit have the same electromotive force and zero internal resistance. The three resistors each have the same resistance R.

In the circuit on the left, the power dissipated in the resistor is P.

What is the total power dissipated in the circuit on the right?

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

34 Which equation that links some of the following terms is correct?

potential difference (p.d.)	V
current	I
resistance	R
charge	Q
energy	E
power	P
time	t

A $P = \frac{Q^2R}{t}$

B $ER^2 = V^2t$

C $\frac{VI}{P} = t$

D $PQ = EI$

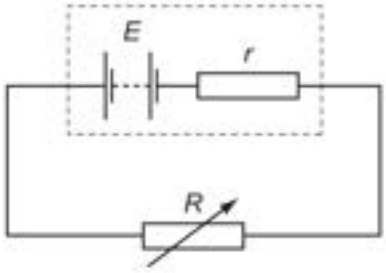
35 The charge that an electric battery can deliver is specified in ampere-hours.

For example, a battery of capacity 40 ampere-hours could supply, when fully charged, 0.2 A for 200 hours.

What is the maximum energy that a fully charged 12 V, 40 ampere-hour battery could supply?

A 1.7 kJ **B** 29 kJ **C** 1.7 MJ **D** 29 MJ

36 A battery with e.m.f. E and internal resistance r is connected in series with a variable external resistor.



The value of the external resistance R is slowly increased from zero.

Which statement is correct? (Ignore any temperature effects.)

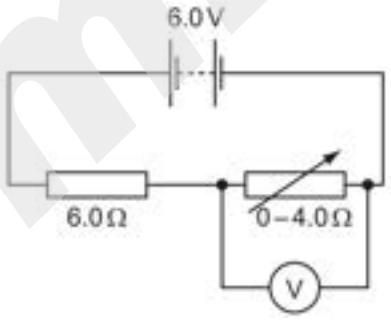
A The potential difference across the external resistance decreases.

B The potential difference across the internal resistance increases.

C The power dissipated in r increases and then decreases.

D The power dissipated in R increases and then decreases.

37 A battery of electromotive force (e.m.f.) 6.0 V and negligible internal resistance is connected in series with a resistor of resistance 6.0 Ω and a variable resistor of resistance from zero to 4.0 Ω. A voltmeter is connected across the variable resistor. The resistance of the variable resistor is changed.



What is the range of the voltmeter reading?

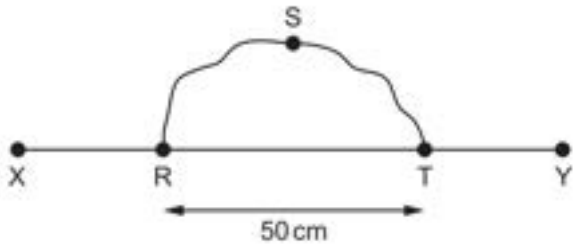
A 0 V – 2.4 V

B 0 V – 3.6 V

C 2.4 V – 6.0 V

D 3.6 V – 6.0 V

38 A wire RST is connected to another wire XY as shown.



Each wire is 100 cm long with a resistance per unit length of $10\,\Omega\,m^{-1}$.

What is the total resistance between X and Y?

A 3.3Ω **B** 5.0Ω **C** 8.3Ω **D** 13.3Ω

33 Which statement is **not** valid?

A Current is the speed of the charged particles that carry it.

B Electromotive force (e.m.f.) is the energy converted to electrical energy from other forms per unit charge.

C The potential difference (p.d.) between two points is the work done per unit charge when moving charge from one point to the other.

D The resistance between two points is the p.d. between the two points per unit current.

34 A cell of e.m.f. *E* delivers a charge *Q* to an external circuit.

Which statement is correct?

A The energy dissipation in the external circuit is *EQ*.

B The energy dissipation within the cell is *EQ*.

C The external resistance is *EQ*.

D The total energy dissipation in the cell and the external circuit is *EQ*.

May/June 2015 (12)

31 Which unit is **not** used in either the definition of the coulomb or the definition of the volt?

A ampere

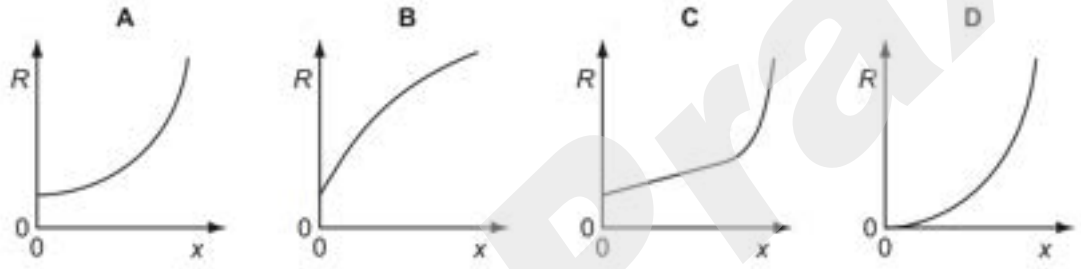
B joule

C ohm

D second

32 When a thin metal wire is stretched, it becomes longer and thinner. This causes a change in the resistance of the wire. The volume of the wire remains constant.

Which graph could represent the variation with extension x of the resistance R of the wire?



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Which statement is correct?

A The energy dissipation in the external circuit is EQ.

B The energy dissipation within the cell is EQ.

C The external resistance is EQ.

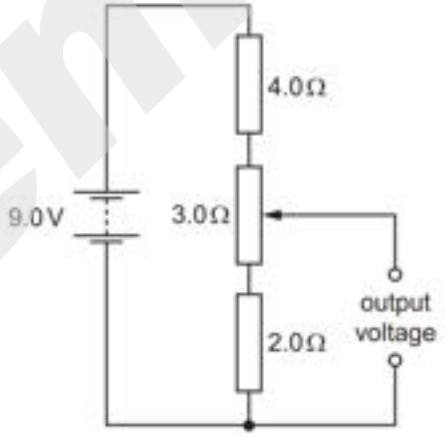
D The total energy dissipation in the cell and the external circuit is EQ.

35 Each of Kirchhoff's two laws presumes that some quantity is conserved.

Which row states Kirchhoff's **first** law and names the quantity that is conserved?

	statement	quantity
A	the algebraic sum of currents into a junction is zero	charge
B	the algebraic sum of currents into a junction is zero	energy
C	the e.m.f. in a loop is equal to the algebraic sum of the product of current and resistance round the loop	charge
D	the e.m.f. in a loop is equal to the algebraic sum of the product of current and resistance round the loop	energy

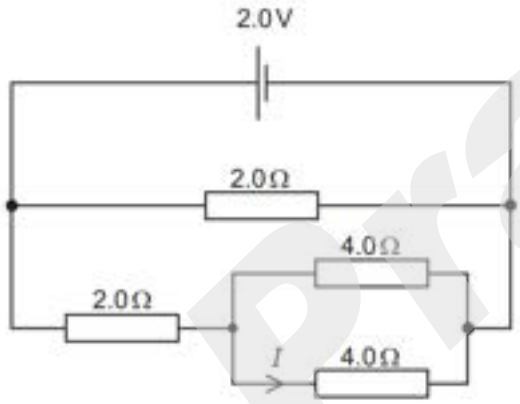
36 A potential divider circuit consists of fixed resistors of resistance 2.0Ω and 4.0Ω connected in series with a 3.0Ω resistor fitted with a sliding contact. These are connected across a battery of e.m.f. 9.0V and zero internal resistance, as shown.



What are the maximum and the minimum output voltages of this potential divider circuit?

	maximum voltage / V	minimum voltage / V
A	4.0	2.0
B	5.0	2.0
C	9.0	0
D	9.0	2.0

37 A cell of e.m.f. 2.0 V and negligible internal resistance is connected to a network of resistors as shown.



What is the current I?

A 0.25A **B** 0.33A **C** 0.50A **D** 1.5A

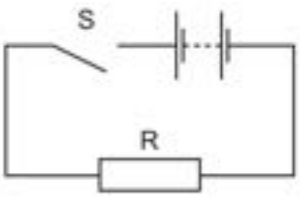
May/June 2015 (13)

32 A pedal bicycle is fitted with an electric motor. The rider switches on the motor for a time of 3.0 minutes. A constant current of 3.5A in the electric motor is provided from a battery with a terminal voltage of 24 V.

What is the energy supplied by the battery?

A 84 J **B** 250 J **C** 630 J **D** 15000 J

33 The diagram shows a simple circuit.



Which statement is correct?

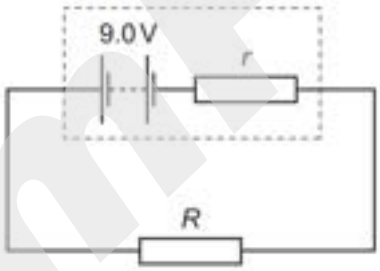
A When switch S is closed, the electromotive force (e.m.f.) of the battery falls because work is done against the internal resistance of the battery.

B When switch S is closed, the e.m.f. of the battery falls because work is done against the resistance of R.

C When switch S is closed, the potential difference across the battery falls because work is done against the internal resistance of the battery.

D When switch S is closed, the potential difference across the battery falls because work is done against the resistance of R.

34 A simple circuit is formed by connecting a resistor of resistance *R* between the terminals of a battery of electromotive force (e.m.f.) 9.0 V and constant internal resistance *r*.



A charge of 6.0 C flows through the resistor in a time of 2.0 minutes causing it to dissipate 48 J of thermal energy.

What is the internal resistance *r* of the battery?

A 0.17 Ω **B** 0.33 Ω **C** 20 Ω **D** 160 Ω

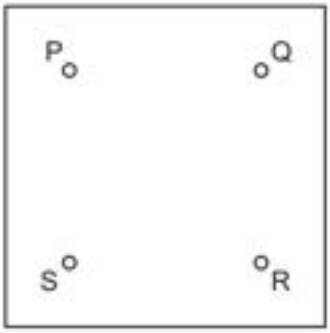
35 A source of e.m.f. 9.0 mV has an internal resistance of 6.0 Ω.

It is connected across a galvanometer of resistance 30 Ω.

What is the current in the galvanometer?

A 250 μA **B** 300 μA **C** 1.5 mA **D** 2.5 mA

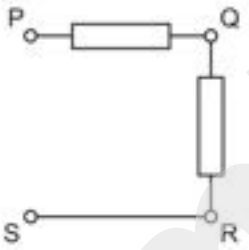
36 A box with four terminals P, Q, R and S contains two identical resistors.



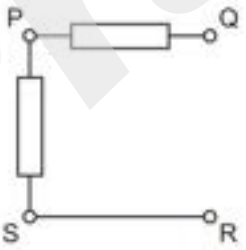
When a battery of electromotive force (e.m.f.) E and negligible internal resistance is connected across PS, a high-resistance voltmeter connected across QR reads $\frac{E}{2}$.

Which diagram shows the correct arrangement of the two resistors inside the box?

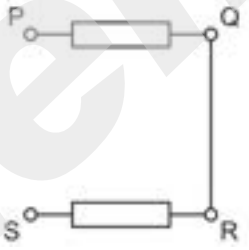
A



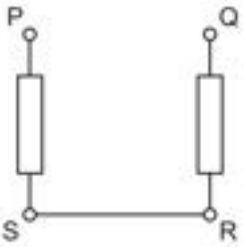
B



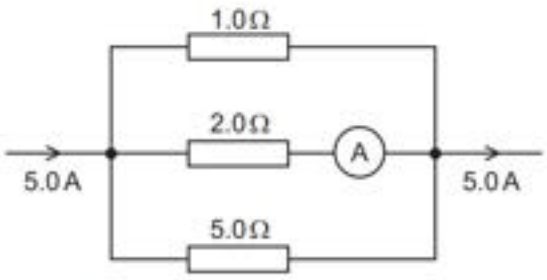
C



D



37 The diagram shows part of a current-carrying circuit. The ammeter has negligible resistance.



What is the reading on the ammeter?

A 0.7A **B** 1.3A **C** 1.5A **D** 1.7A

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31 The diagram shows a graph.

For a uniform metallic wire, what could the graph **not** represent?

	y-axis	*x*-axis
A	current	potential difference
B	resistance	length
C	resistance	temperature in °C
D	potential difference	current

32 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

33 The Atlantic torpedo is a large electric fish capable of generating a voltage of 220 V between its tail and its head. This drives a pulse of current of 15 A lasting for a time of 2.0 ms. The fish produces 200 pulses per second.

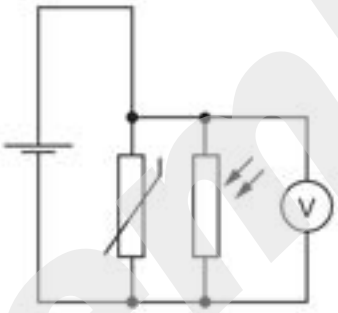
What is the average power output of the fish?

A 33 W **B** 1.3 kW **C** 3.3 kW **D** 6.6 kW

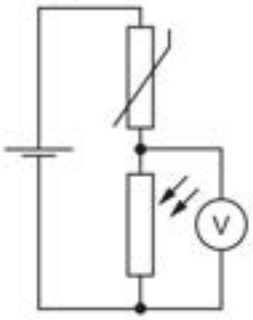
34 A thermistor and another component are connected to a constant voltage supply. A voltmeter is connected across one of the components. The temperature of the thermistor is then reduced but no other changes are made.

In which circuit will the voltmeter reading increase?

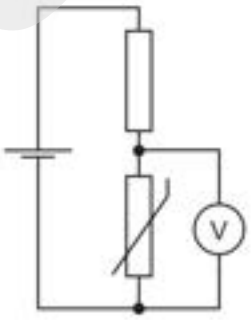
A



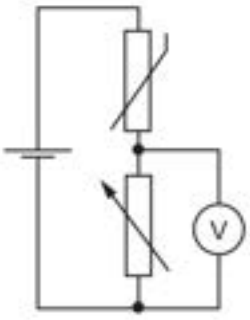
B



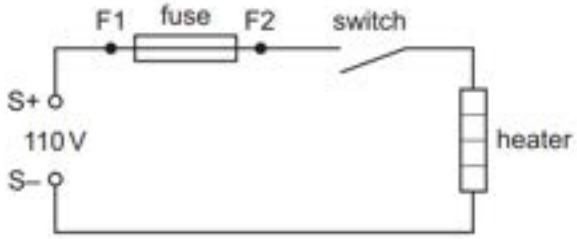
C



D



35 A 110 V d.c. supply is connected to a heater, a fuse and a switch, as shown.



Owing to a fault in the system, power is not supplied to the heater. A technician diagnoses the fault using a voltmeter.

He closes the switch and connects his meter between the positive supply terminal S+ and the fuse terminal F2. The voltmeter reads 110 V.

Which diagnosis is correct?

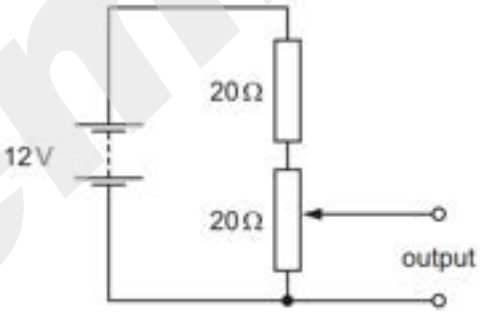
A The fuse has melted.

B The fuse has not melted and there is a short circuit in the heater.

C The fuse has not melted and there is no path for current through the heater.

D The fuse has not melted and the switch has operated correctly.

36 The diagram shows a potentiometer and a fixed resistor connected across a 12 V battery of negligible internal resistance.



The fixed resistor and the potentiometer each have resistance 20 Ω. The circuit is designed to provide a variable output voltage.

What is the range of output voltages?

A 0 – 6 V **B** 0 – 12 V **C** 6 – 12 V **D** 12 – 20 V

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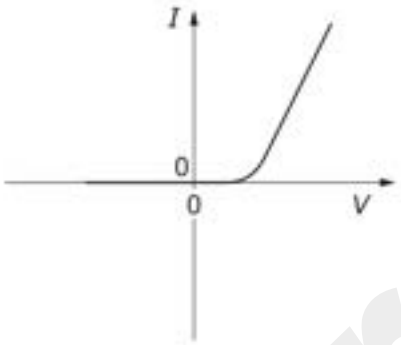
33 Which unit is equivalent to a coulomb (C)?

A As **B** Ωs **C** Vs **D** Ws

34 The graph shows the *I*-*V* characteristic of an electrical component.



What is the component?

A a filament lamp

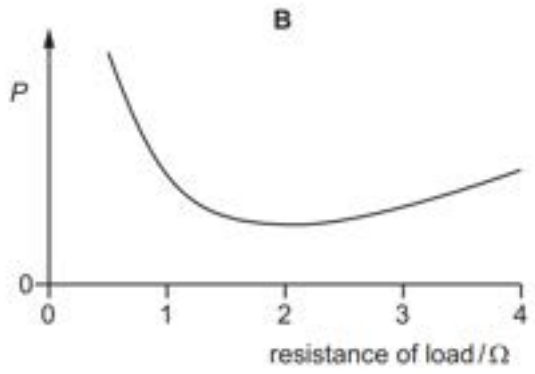
B a metallic conductor at constant temperature

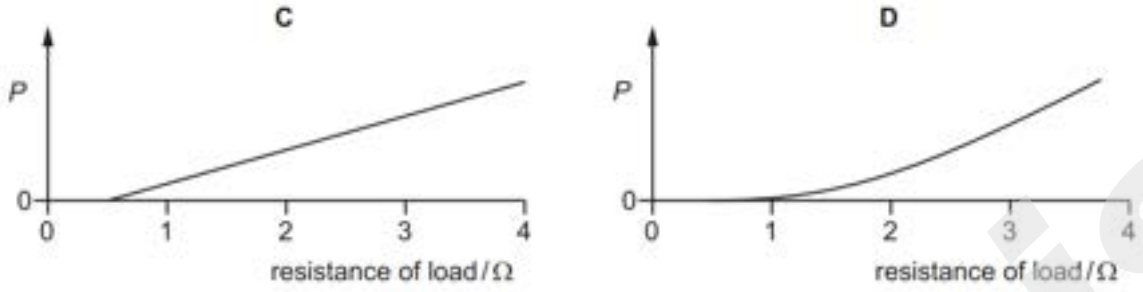
C a semiconductor diode

D a thermistor

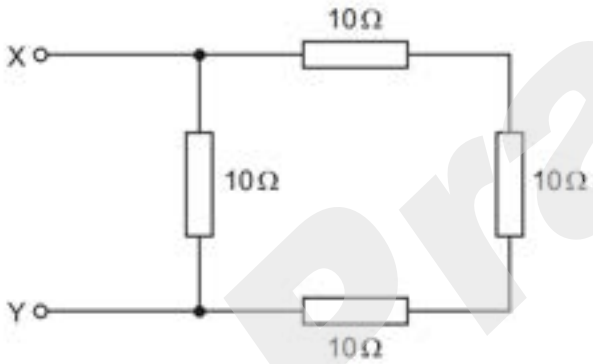
35 A power supply of electromotive force (e.m.f.) 12 V and internal resistance 2 Ω is connected in series with a load resistor. The resistance of the load resistor is varied from 0.5 Ω to 4 Ω.

Which graph shows how the power *P* dissipated in the load resistor varies with the resistance of the load resistor?





36 The diagram shows an arrangement of resistors.



What is the total electrical resistance between X and Y?

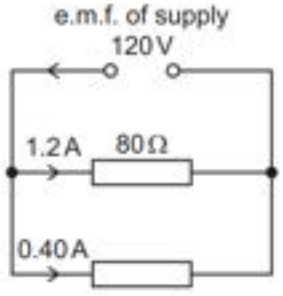
A less than 1Ω

B between 1Ω and 10Ω

C between 10Ω and 30Ω

D 40Ω

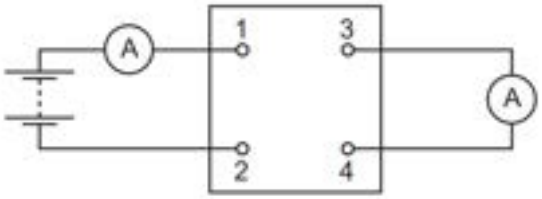
37 The electromotive force of a power supply is 120V. It delivers a current of 1.2A to a resistor of resistance 80Ω and a current of 0.40A to another resistor, as shown.



What is the internal resistance of the power supply?

A 15Ω **B** 20Ω **C** 60Ω **D** 75Ω

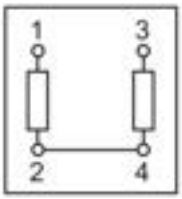
38 The diagram shows a four-terminal box connected to a battery and two ammeters.



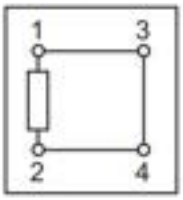
The currents in the two meters are identical.

Which circuit, within the box, will give this result?

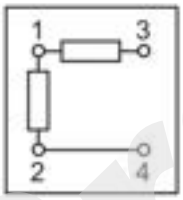
A



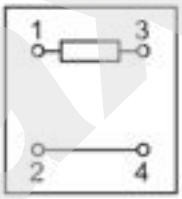
B



C



D



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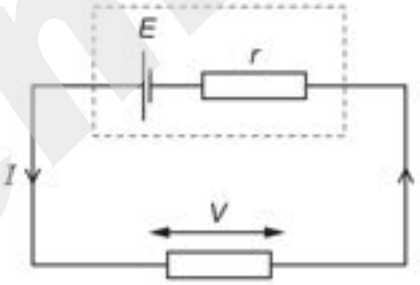
32 A cell of electromotive force E and internal resistance r is connected to an external resistor, as shown.



The current in the circuit is I and the potential difference (p.d.) across the external resistor is V.

In the equation $(E - V) = Ir$, what does the term $(E - V)$ represent?

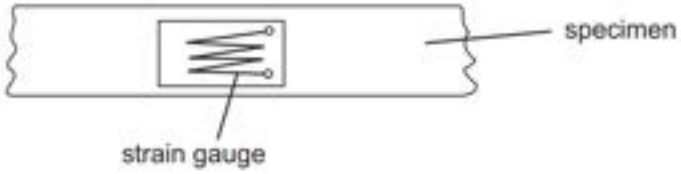
A electrical energy per unit charge lost in the cell

B electrical energy per unit charge lost in the complete circuit

C electrical energy per unit charge lost in the connecting wire

D electrical energy per unit charge lost in the external resistor

33 Tensile strain may be measured by the change in electrical resistance of a device called a strain gauge. A strain gauge consists of folded fine metal wire mounted on a flexible insulating backing sheet. The strain gauge is firmly attached to the specimen.



When the strain in the specimen is increased, what happens to the resistance of the wire?

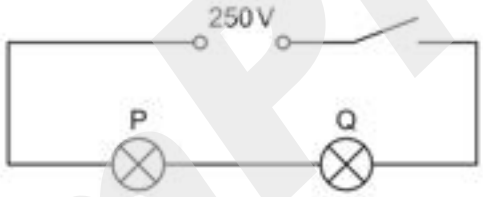
A It decreases, because the length decreases and the cross-sectional area increases.

B It decreases, because the length increases and the cross-sectional area decreases.

C It increases, because the length decreases and the cross-sectional area increases.

D It increases, because the length increases and the cross-sectional area decreases.

34 In the circuit shown, lamp P is rated 250 V, 50 W and lamp Q is rated 250 V, 200 W. The two lamps are connected in series to a 250 V power supply.



Assume that the resistance of each lamp remains constant.

Which statement most accurately describes what happens when the switch is closed?

A Lamp P emits four times as much power as lamp Q.

B Lamp P emits twice as much power as lamp Q.

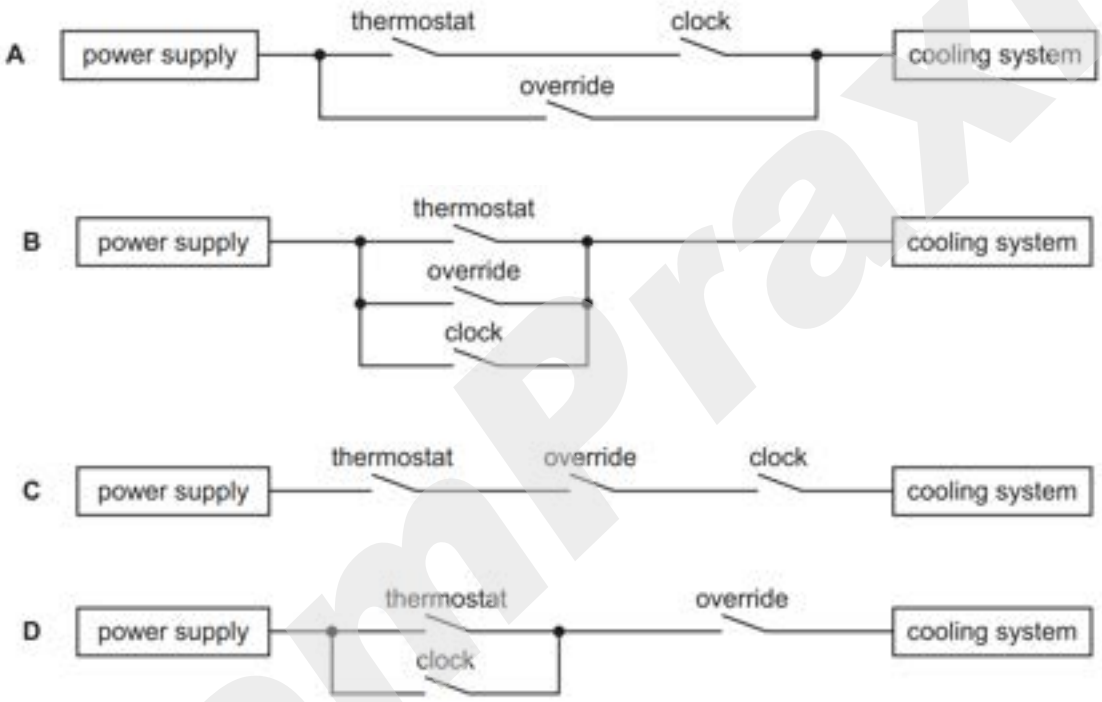
C Lamp Q emits four times as much power as lamp P.

D Lamp Q emits twice as much power as lamp P.

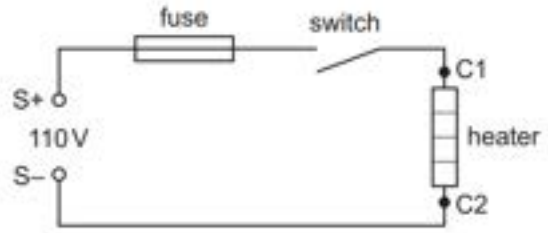
35 The cooling system in many houses is controlled by three electrical switches. These are:

- a thermostat switch that closes when the temperature rises to a given value,
- a clock switch that closes at times when cooling may be required,
- an override switch that closes to turn on the system when exceptional temperature rises occur.

Which diagram shows the switches correctly connected between the power supply and the cooling system?



36 A 110V supply of negligible internal resistance is connected to a heater through a fuse and a switch.



Terminals S+ and S– are the positive and negative terminals of the supply. Points C1 and C2 at either side of the heater are accessible for fault-finding.

A voltmeter is connected between S– and C1.

With the circuit working correctly, the voltmeter reading is noted with the switch closed.

A fault occurs and the voltmeter is again connected between S– and C1 with the switch closed.

Which fault would result in the same two voltmeter readings?

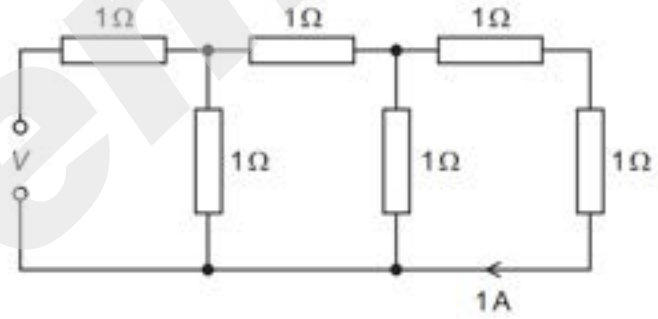
A a break in the wire of the heater

B a broken switch that cannot close correctly

C a melted fuse

D a short circuit in the heater

37 A network of resistors, each of resistance 1Ω, is connected as shown.



The current passing through the end resistor is 1A.

What is the potential difference (p.d.) *V* across the input terminals?

A 2V **B** 5V **C** 8V **D** 13V