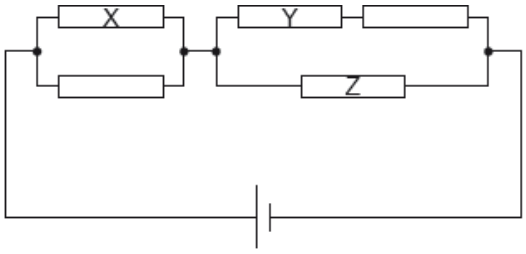
SL Paper 1

Five resistors of equal resistance are connected to a cell as shown.



What is correct about the power dissipated in the resistors?

A. The power dissipated is greatest in resistor X.

B. The power dissipated is greatest in resistor Y.

C. The power dissipated is greatest in resistor Z.

D. The power dissipated is the same in all resistors.

Markscheme

C

Examiners report

[N/A]

The electromotive force (emf) of a cell is defined as

A. the power supplied by the cell per unit current from the cell.

B. the force that the cell provides to drive electrons round a circuit.

C. the energy supplied by the cell per unit current from the cell.

D. the potential difference across the terminals of the cell.

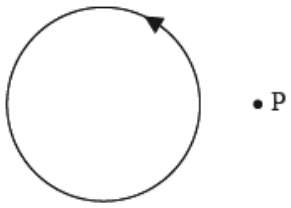
Markscheme

A

Examiners report

At both levels the most popular response was D, with A, the correct answer, being the least popular. It must be stressed that candidates are expected to learn rigorous definitions.

A current is established in a coil of wire in the direction shown.



The direction of the magnetic field at point P is

A. out of the plane of the paper.

B. into the plane of the paper.

C. to the left.

D. to the right.

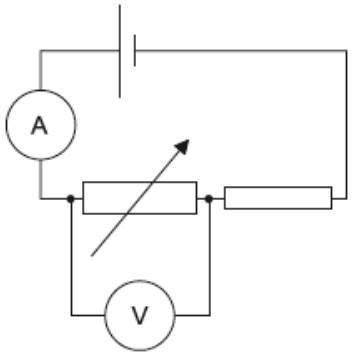
Markscheme

B

Examiners report

[N/A]

A cell with negligible internal resistance is connected as shown. The ammeter and the voltmeter are both ideal.



What changes occur in the ammeter reading and in the voltmeter reading when the resistance of the variable resistor is increased?

	Change in ammeter reading	Change in voltmeter reading
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

Markscheme

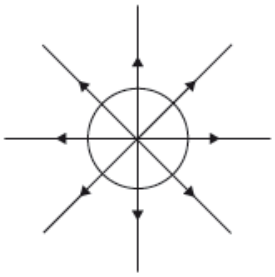
C

Examiners report

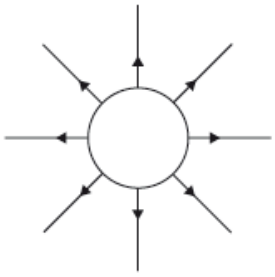
[N/A]

Which diagram best represents the electric field due to a negatively charged conducting sphere?

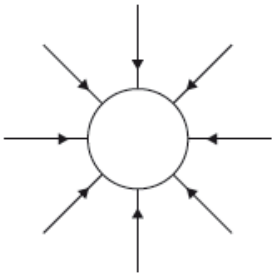
A.



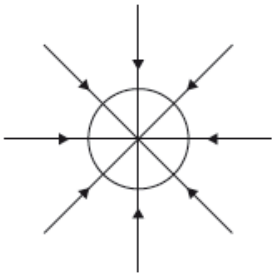
B.



C.



D.



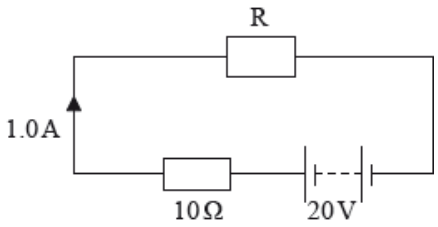
Markscheme

C

Examiners report

[N/A]

The circuit shows a resistor R connected in series with a battery and a resistor of resistance $10\ \Omega$. The emf of the battery is 20 V and it has negligible internal resistance. The current in the circuit is 1.0 A.



Which of the following is the resistance of R?

A. $1.0\ \Omega$

B. $2.0\ \Omega$

C. $10\ \Omega$

D. $20\ \Omega$

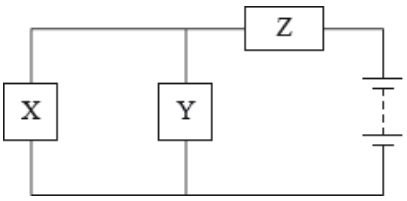
Markscheme

C

Examiners report

[N/A]

Three identical resistors are connected to a battery as shown.



Which of the following is a correct statement?

A. The current through X is greater than that through Z.

B. The potential difference across Z is greater than that across Y.

C. The potential difference across resistor X and Y together is the same as that across Z.

D. The current through Z is less than the total current through X and Y.

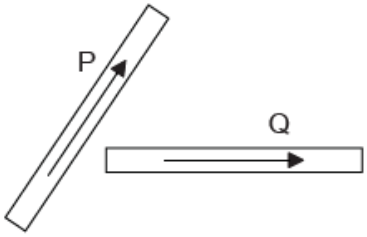
Markscheme

B

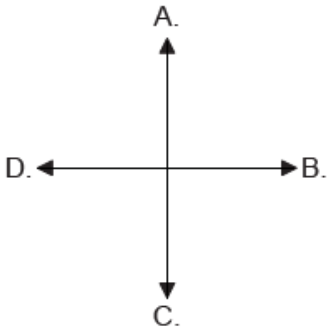
Examiners report

[N/A]

The diagram shows two current-carrying wires, P and Q, that both lie in the plane of the paper. The arrows show the conventional current direction in the wires.



The electromagnetic force on Q is in the same plane as that of the wires. What is the direction of the electromagnetic force acting on Q?



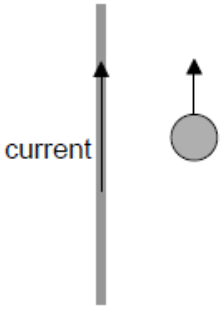
Markscheme

A

Examiners report

[N/A]

A positively-charged particle moves parallel to a wire that carries a current upwards.



What is the direction of the magnetic force on the particle?

A. To the left

B. To the right

C. Into the page

D. Out of the page

Markscheme

A

Examiners report

[N/A]

An electron travelling at speed v perpendicular to a magnetic field of strength B experiences a force F.

What is the force acting on an alpha particle travelling at $2v$ parallel to a magnetic field of strength $2B$?

A. 0

B. $2F$

C. $4F$

D. $8F$

Markscheme

A

Examiners report

[N/A]

An electron is accelerated through a potential difference of 2.5 MV. What is the change in kinetic energy of the electron?

A. 0.4μJ

B. 0.4 nJ

C. 0.4 pJ

D. 0.4 fJ

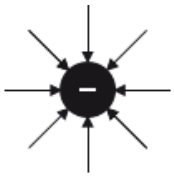
Markscheme

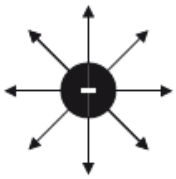
C

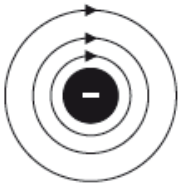
Examiners report

[N/A]

Which of the following diagrams illustrates the electric field pattern of a negatively charged sphere?

A. 

B. 

C. 

D. 

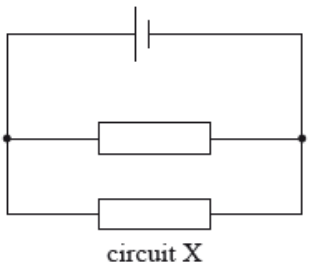
Markscheme

A

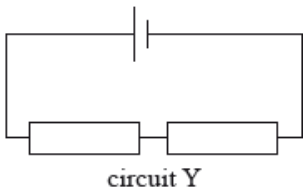
Examiners report

[N/A]

In the circuits below the cells have the same emf and zero internal resistance. The resistors all have the same resistance.



circuit X



circuit Y

Which of the following gives the ratio $\frac{\text{power dissipated in X}}{\text{power dissipated in Y}}$?

A. $\frac{1}{4}$

B. $\frac{1}{2}$

C. 2

D. 4

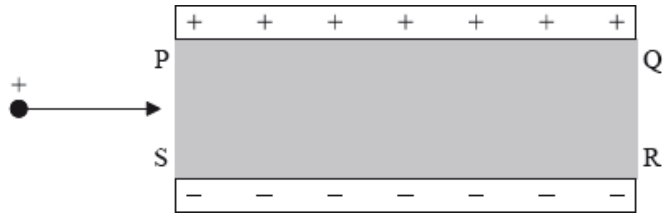
Markscheme

D

Examiners report

[N/A]

A positively charged particle enters the space between two charged conducting plates, with a constant velocity directed parallel to the plates, as shown.



The top plate is positively charged and the bottom plate is negatively charged. There is a magnetic field in the shaded region PQRS. The particle continues to move in a horizontal straight line between the plates. Which of the following correctly describes the magnetic field direction?

A. Into plane of paper

B. Out of plane of paper

C. Up

D. Down

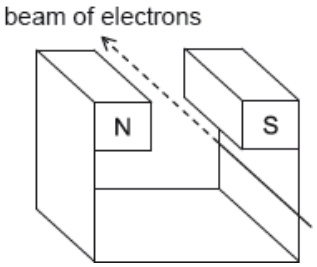
Markscheme

A

Examiners report

[N/A]

A beam of electrons moves between the poles of a magnet.



What is the direction in which the electrons will be deflected?

A. Downwards

B. Towards the N pole of the magnet

C. Towards the S pole of the magnet

D. Upwards

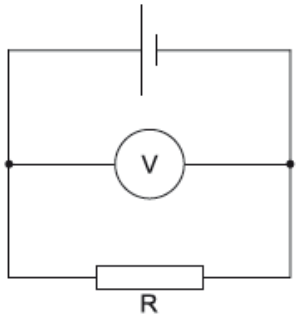
Markscheme

D

Examiners report

[N/A]

A cell has an emf of 4.0 V and an internal resistance of 2.0 Ω. The ideal voltmeter reads 3.2 V.



What is the resistance of R?

A. 0.8 Ω

B. 2.0 Ω

C. 4.0 Ω

D. 8.0 Ω

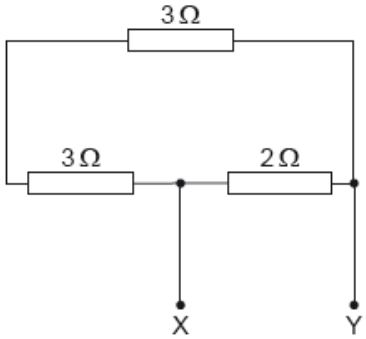
Markscheme

D

Examiners report

[N/A]

Three resistors are connected as shown. What is the value of the total resistance between X and Y?



A. 1.5 Ω

B. 1.9 Ω

C. 6.0 Ω

D. 8.0 Ω

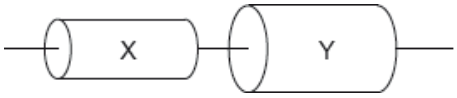
Markscheme

A

Examiners report

[N/A]

Two resistors X and Y are made of uniform cylinders of the same material. X and Y are connected in series. X and Y are of equal length and the diameter of Y is twice the diameter of X.



The resistance of Y is *R*.

What is the resistance of this series combination?

A. $\frac{5R}{4}$

B. $\frac{3R}{2}$

C. 3*R*

D. 5*R*

Markscheme

D

Examiners report

[N/A]

A metal wire X with length *L* and radius *r* has a resistance *R*. A wire Y of length 4*L* made from the same material as X has the same resistance *R*. What is the radius of Y?

A. 2*r*

B. 4*r*

C. $\frac{r}{2}$

D. $\frac{r}{4}$

Markscheme

A

Examiners report

The vast majority of candidates understood, correctly, that the radius had to be larger – but many chose B, incorrectly thinking that the radius, rather than the cross-sectional area, changes proportionately with the length for two wires of common resistance.

A cylindrical resistor of length l is made from a metal of mass m. It has a resistance R.

Two resistors, each of length $2l$ and mass $\frac{m}{2}$, are then created from the same volume of the metal.

What is the resistance of the two resistors when connected in parallel?

A. R

B. $2R$

C. $4R$

D. $8R$

Markscheme

C

Examiners report

Think proportionality.

There were a few G2 comments suggesting that this question was too complex and took too much time, but this is only the case if candidates reach for equations before considering proportionality.

A simple sketch will show that if the new resistors are placed side by side (ie in parallel) then the new length is twice the previous length (leading to a doubling of the resistance) and half its cross-sectional area (leading to a further doubling of the resistance). So the correct response is C.

Two rectangular blocks, X and Y, of the same material have different dimensions but the same overall resistance. Which of the following equations is correct?

A. resistivity of $X \times \text{length of } X = \text{resistivity of } Y \times \text{length of } Y$

B. $\frac{\text{length of } X}{\text{cross sectional area of } X} = \frac{\text{length of } Y}{\text{cross sectional area of Y}}$

C. resistivity of $X \times \text{cross sectional area of } X = \text{resistivity of } Y \times \text{cross sectional area of } Y$

D. $\frac{\text{length of } X}{\text{cross sectional area of } Y} = \frac{\text{length of } Y}{\text{cross sectional area of } X}$

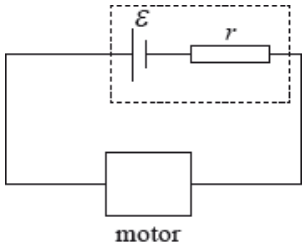
Markscheme

B

Examiners report

[N/A]

A cell of $\text{emf}\ \varepsilon$ and internal resistance r delivers current to a small electric motor.



450 C of charge flows through the motor and 9000 J of energy are converted in the motor. 1800 J are dissipated in the cell. The emf of the cell is

A. 4.0 V.

B. 16 V.

C. 20 V.

D. 24 V.

Markscheme

D

Examiners report

[N/A]

A resistor of resistance $12\ \Omega$ is connected in series with a cell of negligible internal resistance. The power dissipated in the resistor is P. The resistor is replaced with a resistor of resistance $3.0\ \Omega$. What is the power dissipated in this resistor?

A. $0.25\ P$

B. P

C. $2.0\ P$

D. $4.0\ P$

Markscheme

D

Examiners report

[N/A]

A proton is accelerated from rest through a potential difference of 1000 V. What is the potential difference through which an alpha particle must be accelerated to gain the same kinetic energy as the accelerated proton?

A. 4000 V
B. 2000 V
C. 500 V
D. 250 V

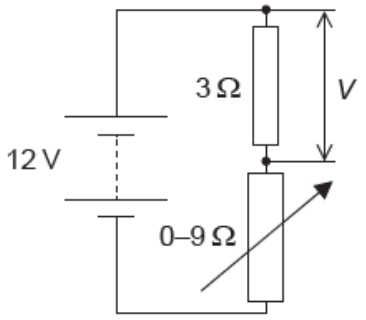
Markscheme

C

Examiners report

B was the most popular response, presumably as the candidates were thinking ‘twice the charge, twice the potential difference’. A moment’s back checking, however, would show that this would lead to an alpha particle with four times the energy of the proton; therefore the correct response must be C.

In the circuit shown, the fixed resistor has a value of 3 Ω and the variable resistor can be varied between 0 Ω and 9 Ω.



The power supply has an emf of 12 V and negligible internal resistance. What is the difference between the maximum and minimum values of voltage *V* across the 3 Ω resistor?

A. 3 V

B. 6 V

C. 9 V

D. 12 V

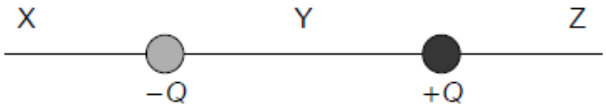
Markscheme

C

Examiners report

[N/A]

The diagram shows two equal and opposite charges that are fixed in place.



At which points is the net electric field directed to the right?

A. X and Y only

B. Z and Y only

C. X and Z only

D. X, Y and Z

Markscheme

C

Examiners report

[N/A]

A wire carrying a current I is at right angles to a uniform magnetic field of strength *B*. A magnetic force *F* is exerted on the wire. Which force acts when the same wire is placed at right angles to a uniform magnetic field of strength 2*B* when the current is $\frac{I}{4}$?

A. $\frac{F}{4}$

B. $\frac{F}{2}$

C. *F*

D. 2*F*

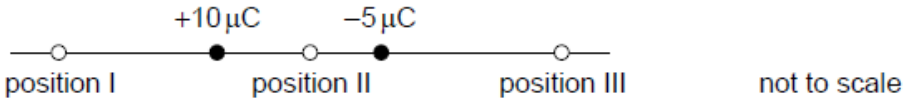
Markscheme

B

Examiners report

[N/A]

A –5μC charge and a +10μC charge are a fixed distance apart.



Where can the electric field be zero?

A. position I only
B. position II only
C. position III only
D. positions I, II and III

Markscheme

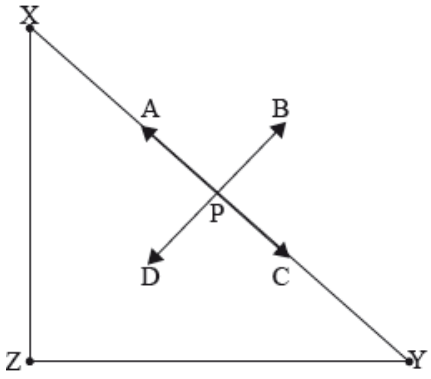
C

Examiners report

[N/A]

Three positive point charges of equal magnitude are held at the corners X, Y and Z of a right-angled triangle. The point P is at the midpoint of XY.

Which of the arrows shows the direction of the electric field at point P?



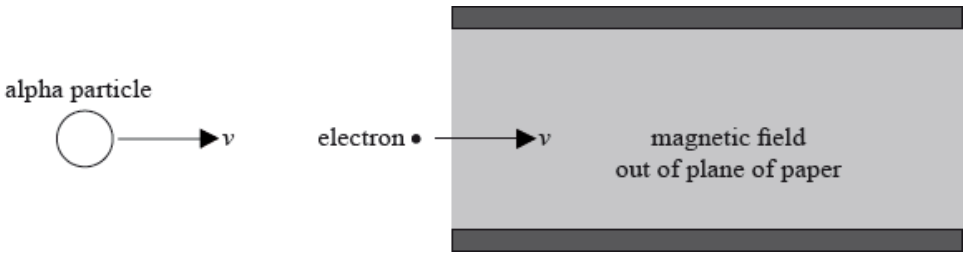
Markscheme

B

Examiners report

[N/A]

An electron enters the vacuum between two oppositely charged plates with velocity v. The electron is followed by an alpha particle moving with the same initial velocity as the electron. A uniform magnetic field is directed out of the plane of the paper.



The electron's path is undeflected. The path of the alpha particle will be

A. deflected out of the plane of the paper.

B. undeflected.

C. deflected upward.

D. deflected downward.

Markscheme

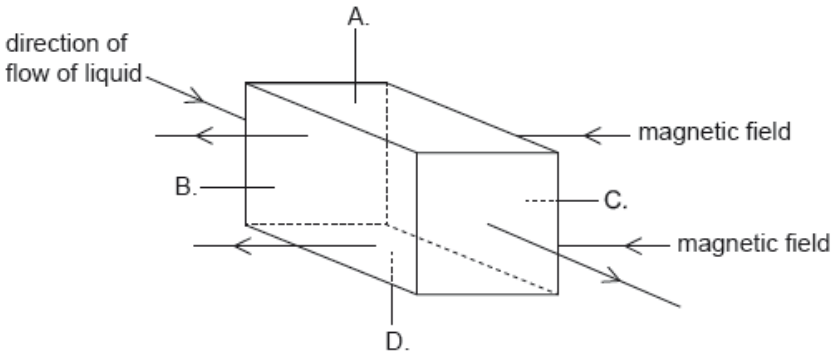
B

Examiners report

A surprising number of students were confused by this question, with the evidence being that many were simply guessing. Crossing an electric and a magnetic field is the basis of selecting the velocity of charged particles as can be readily seen by equating Bqv to qE. The charge cancels which means that if the electron is undeflected then the alpha particle will also be undeflected.

A liquid that contains negative charge carriers is flowing through a square pipe with sides A, B, C and D. A magnetic field acts in the direction shown across the pipe.

On which side of the pipe does negative charge accumulate?



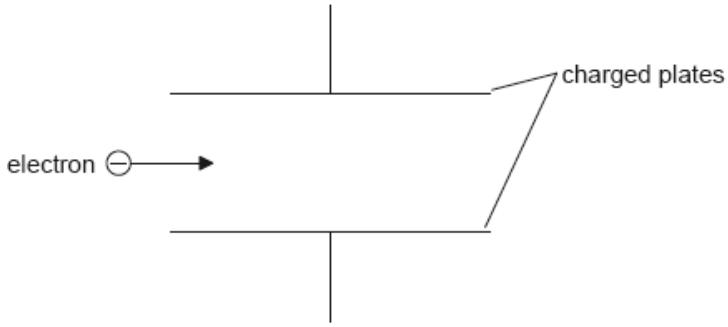
Markscheme

A

Examiners report

[N/A]

An electron enters the region between two charged parallel plates initially moving parallel to the plates.



The electromagnetic force acting on the electron

A. causes the electron to decrease its horizontal speed.

B. causes the electron to increase its horizontal speed.

C. is parallel to the field lines and in the opposite direction to them.

D. is perpendicular to the field direction.

Markscheme

C

Examiners report

[N/A]

Two resistors, made of the same material, are connected in series to a battery. The length of resistor X is twice that of resistor Y, and X has twice the cross-sectional area of Y.

Which of the following gives $\frac{\text{resistance of X}}{\text{resistance of Y}}$?

A. $\frac{1}{4}$

B. $\frac{1}{2}$

C. 1

D. 4

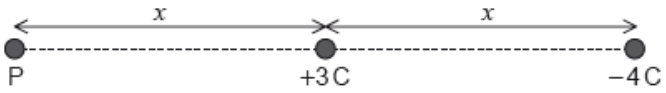
Markscheme

C

Examiners report

[N/A]

A $+3\ \text{C}$ charge and a $-4\ \text{C}$ charge are a distance x apart. P is a distance x from the $+3\ \text{C}$ charge on the straight line joining the charges.



What is the magnitude of the electric field strength at P?

A. $\frac{1}{\pi\varepsilon_0 x^2}$

B. $\frac{1}{2\pi\varepsilon_0 x^2}$

C. $\frac{1}{4\pi\varepsilon_0 x^2}$

D. $\frac{1}{7\pi\varepsilon_0 x^2}$

Markscheme

B

Examiners report

Although it is convenient to use k in the equation for coulombic attraction, candidates need to be able to unpack this as $\frac{1}{4\pi\varepsilon_0}$.

What is the definition of electric current?

A. The ratio of potential difference across a component to the resistance of the component

B. The power delivered by a battery per unit potential difference

C. The rate of flow of electric charge

D. The energy per unit charge dissipated in a power supply

Markscheme

C

Examiners report

[N/A]

The magnetic field produced by a current in a straight wire is in

A. the same direction as the current.
B. the opposite direction to the current.
C. the same plane as the wire.
D. any plane perpendicular to the wire.

Markscheme

D

Examiners report

[N/A]

Which of the following will **not** give rise to a magnetic field?

A. A moving electron
B. A moving neutron
C. A proton and electron moving away from each other
D. A proton and electron moving towards each other

Markscheme

B

Examiners report

One electronvolt is equal to

A. 1.6×10^{-19} C.
B. 1.6×10^{-19} J.
C. 1.6×10^{-19} V.
D. 1.6×10^{-19} W.

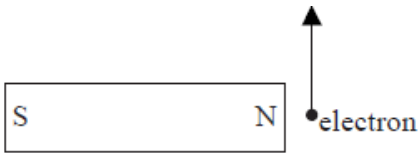
Markscheme

B

Examiners report

[N/A]

An electron passes the north pole of a bar magnet as shown below.



What is the direction of the magnetic force on the electron?

A. Into the page
B. Out of the page
C. To the left
D. To the right

Markscheme

B

Examiners report

[N/A]

Two electrodes, separated by a distance *d*, in a vacuum are maintained at a constant potential difference. An electron, accelerated from one electrode to the other, gains kinetic energy E_k.

The distance between the electrodes is now changed to $\frac{1}{3}d$.

What is the gain in kinetic energy of an electron that is accelerated from one electrode to the other?

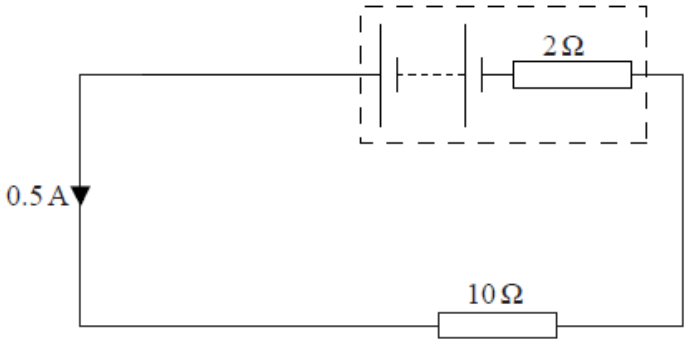
A. $\frac{E_k}{3}$
B. E_k
C. $3E_k$
D. $9E_k$

Markscheme

B

Examiners report

A battery of internal resistance 2 Ω is connected to an external resistance of 10 Ω. The current is 0.5 A.



What is the emf of the battery?

A. 1.0 V
B. 5.0 V
C. 6.0 V
D. 24.0 V

Markscheme

C

Examiners report

[N/A]

A battery of emf 6.0V is connected to a 2.0Ω resistor. The current in the circuit is 2.0A. The internal resistance of the battery is

A. zero.

B. 1.0 Ω.

C. 3.0 Ω.

D. 4.0 Ω.

Markscheme

B

Examiners report

[N/A]

Coulomb's law refers to electric charges that are

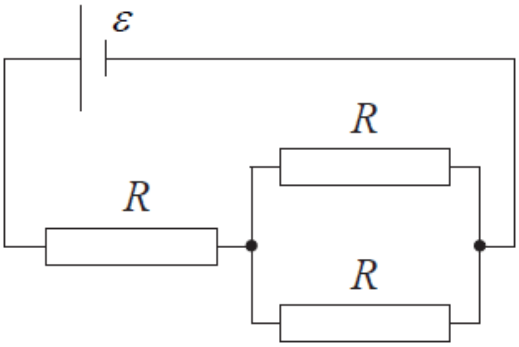
A. on any charged objects.
B. charged hollow spheres.
C. charged solid spheres.
D. point charges.

Markscheme

D

Examiners report

An electric circuit consists of three identical resistors of resistance *R* connected to a cell of emf *ε* and negligible internal resistance.



What is the magnitude of the current in the cell?

A. $\frac{\varepsilon}{3R}$

B. $\frac{2\varepsilon}{3R}$

C. $\frac{3\varepsilon}{2R}$

D. $\frac{3\varepsilon}{R}$

Markscheme

B

Examiners report

[N/A]

Three resistors of resistance R are connected in parallel across a cell of electromotive force (emf) V that has a negligible internal resistance. What is the rate at which the cell supplies energy?

A. $\frac{V^2}{3R}$

B. $\frac{V^2}{9R}$

C. $\frac{9V^2}{R}$

D. $\frac{3V^2}{R}$

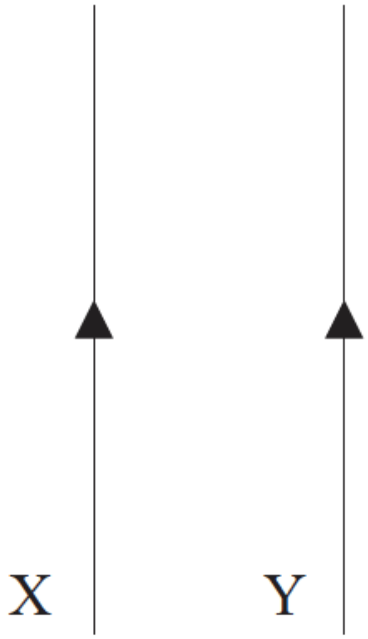
Markscheme

D

Examiners report

[N/A]

The diagram shows two long wires X and Y carrying identical currents in the same direction.



The direction of the force experienced by Y is

A. to the left.
B. to the right.
C. into the plane of the page.
D. out of the plane of the page.

Markscheme

A

Examiners report

[N/A]

A copper wire with length *L* and radius *r* has a resistance *R*.

What is the radius of a copper wire with length $\frac{L}{2}$ and resistance R?

A. $2r$

B. $\sqrt{2}r$

C. $\frac{r}{\sqrt{2}}$

D. $\frac{r}{2}$

Markscheme

C

Examiners report

[N/A]

The ampere is defined in terms of

A. power dissipated in a wire of known length, cross-sectional area and resistivity.

B. potential difference across a resistance of known value.

C. number of electrons flowing past a point in a circuit in a given time.

D. force per unit length between parallel current-carrying conductors.

Markscheme

D

Examiners report

The majority of candidates chose the number of electrons flowing past a point in a given time as the definition of the ampere when the correct answer is in terms of a force between parallel currents.

An electron has a kinetic energy of 4.8×10^{-10}J. What is the equivalent value of this kinetic energy?

A. 3.0 eV
B. 3.0 keV
C. 3.0 MeV
D. 3.0 GeV

Markscheme

D

Examiners report

The GeV prefix was apparently unknown by a significant number of candidates at both levels.

A cell is connected in series with a resistor and supplies a current of 4.0 A for a time of 500 s. During this time, 1.5 kJ of energy is dissipated in the cell and 2.5 kJ of energy is dissipated in the resistor.

What is the emf of the cell?

A. 0.50 V

B. 0.75 V

C. 1.5 V

D. 2.0 V

Markscheme

D

Examiners report

[N/A]

Which of the following is a statement of Ohm's law?

A. The resistance of a conductor is constant.

B. The current in a conductor is inversely proportional to the potential difference across the conductor provided the temperature is constant.

C. The resistance of a conductor is constant provided that the temperature is constant.

D. The current in a conductor is proportional to the potential difference across it.

Markscheme

C

Examiners report

Many candidates were distracted by D and there were quite a few comments from teachers suggesting that this should be accepted. But D is not true as in most cases the varying current will change the temperature of the wire causing a change in resistance. It is only true in the case that temperature is kept constant – and that is the correct statement of Ohm's Law. C is an alternative statement of Ohm's law, given that resistance is calculated from V/I in any

particular situation.

A cylindrical conductor of length l, diameter D and resistivity ρ has resistance R. A different cylindrical conductor of resistivity 2ρ, length $2l$ and diameter $2D$ has a resistance

A. $2R$

B. R

C. $\frac{R}{2}$

D. $\frac{R}{4}$

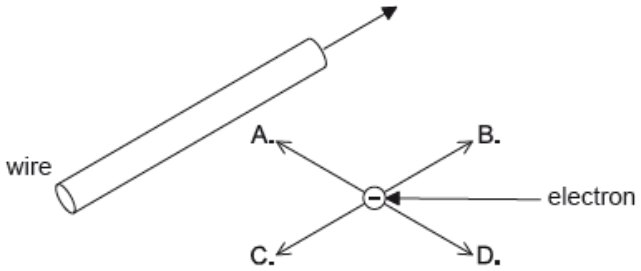
Markscheme

B

Examiners report

[N/A]

An electron is moving parallel to a straight current-carrying wire. The direction of conventional current in the wire and the direction of motion of the electron are the same. In which direction is the magnetic force on the electron?



Markscheme

D

Examiners report

The conventional current is opposite in direction to the electron flow. So here we have essentially anti-parallel currents and the candidates should know that such currents keep well away from each other, ie they repel, leaving D as the correct response.

A resistor X of resistance *R* is made of wire of length *L* and cross-sectional area *A*. Resistor Y is made of the same material but has a length 4*L* and a cross-sectional area 2*A*. X and Y are connected in series. What is the total resistance of the combination?

A. 1.5*R*
B. 2*R*
C. 3*R*
D. 9*R*

Markscheme

C

Examiners report

[N/A]

A cylindrical resistor of volume *V* and length *l* has resistance *R*. The resistor has a uniform circular cross-section. What is the resistivity of the material from which the resistor is made?

A. $\frac{V}{Rl^2}$

B. $\frac{V^2R}{l}$

C. $\frac{VR}{l^2}$

D. $\frac{V^2}{Rl}$

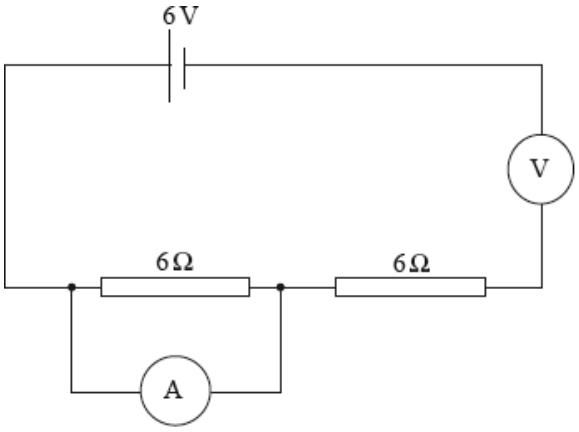
Markscheme

C

Examiners report

[N/A]

Two $6\ \Omega$ resistors are connected in series with a 6 V cell. A student **incorrectly** connects an ammeter and a voltmeter as shown below.



The readings on the ammeter and on the voltmeter are

	Ammeter reading / A	Voltmeter reading / V
A.	0.0	0.0
B.	0.0	6.0
C.	1.0	0.0
D.	1.0	6.0

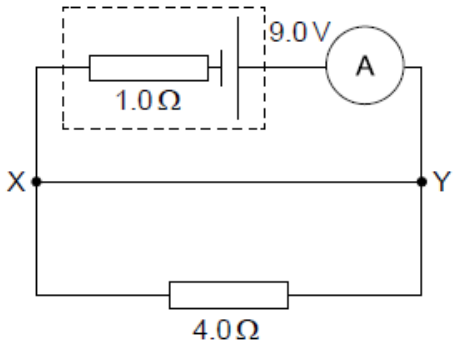
Markscheme

B

Examiners report

The responses to this question indicated that many candidates were unfamiliar with circuit electricity, a topic which is suitable for teaching from a practical perspective. An ideal voltmeter would have a very high (infinite) resistance.

A circuit contains a cell of electromotive force (emf) 9.0 V and internal resistance 1.0 Ω together with a resistor of resistance 4.0 Ω as shown. The ammeter is ideal. XY is a connecting wire.



What is the reading of the ammeter?

A. 0 A

B. 1.8 A

C. 9.0 A

D. 11 A

Markscheme

C

Examiners report

[N/A]

Which of the following is the SI unit of gravitational field strength?

A. N
B. N m
C. Nkg^{-1}
D. Nm^2kg^{-2}

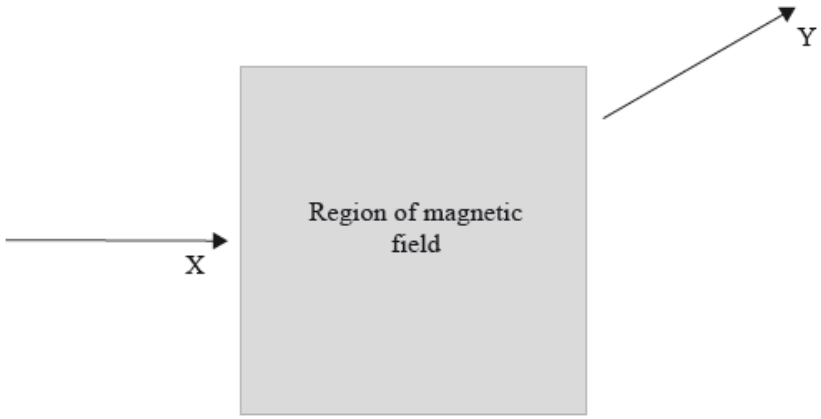
Markscheme

C

Examiners report

[N/A]

An electron travelling in the direction shown by the arrow X, enters a region of uniform magnetic field. It leaves the region of field in the direction shown by the arrow Y.



The direction of the magnetic field is

A. in the direction of X.

B. into the plane of the paper.

C. in the opposite direction to X.

D. out of the plane of the paper.

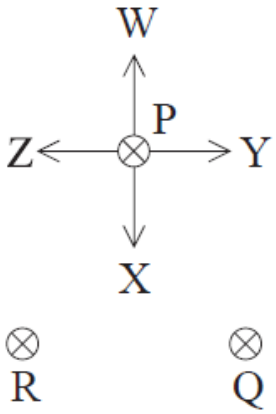
Markscheme

D

Examiners report

[N/A]

Three wires, P, Q and R, carry equal currents directed into the plane of the paper.



Which arrow correctly identifies the direction of the magnetic force on wire P?

A. W
B. X
C. Y
D. Z

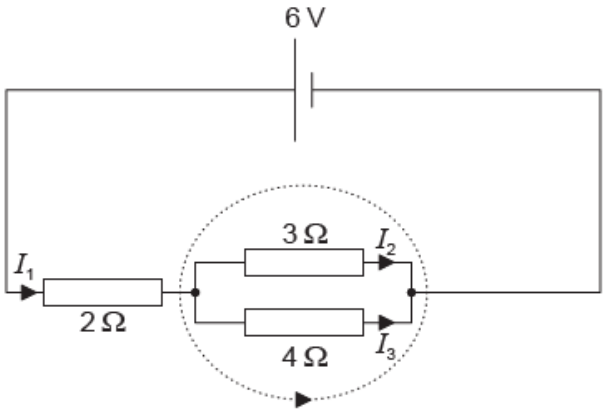
Markscheme

B

Examiners report

The candidates were not sure of how to tackle this. At some stage in their course, however, they should have seen wires carrying a current in the same direction, attracting each other; in which case this question is trivial.

Kirchhoff's laws are applied to the circuit shown.



What is the equation for the dotted loop?

A. $0 = 3I_2 + 4I_3$

B. $0 = 4I_3 - 3I_2$

C. $6 = 2I_1 + 3I_2 + 4I_3$

D. $6 = 3I_2 + 4I_3$

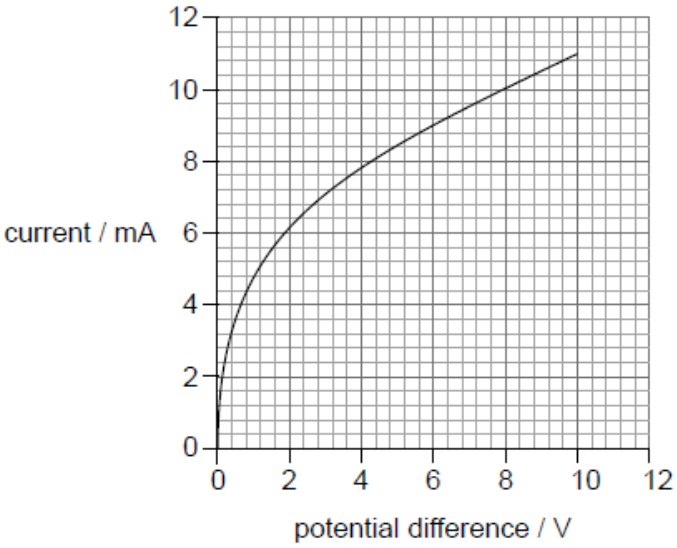
Markscheme

B

Examiners report

[N/A]

The graph shows the variation of current with potential difference for a filament lamp.



What is the resistance of the filament when the potential difference across it is 6.0 V?

A. 0.5 mΩ

B. 1.5 mΩ

C. 670 Ω

D. 2000 Ω

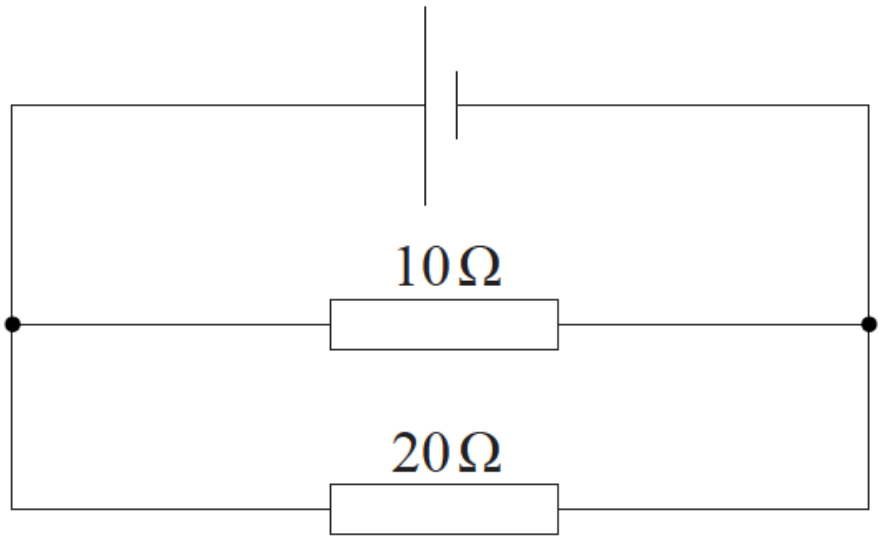
Markscheme

C

Examiners report

[N/A]

Two resistors of resistance 10 Ω and 20 Ω are connected in parallel to a cell of negligible internal resistance.



The energy dissipated in the 10 Ω resistor in one second is *Q*. What is the energy dissipated in one second in the 20 Ω resistor?

A. $\frac{Q}{4}$
B. $\frac{Q}{2}$
C. 2Q
D. 4Q

Markscheme

B

Examiners report

Power is inversely proportional to R when the potential difference is constant (as here) and proportional to R if the current is held constant. Many candidates were confused by this.

With reference to internal energy conversion and ability to be recharged, what are the characteristics of a primary cell?

	Internal energy conversion	Ability to be recharged
A.	chemical to electrical	rechargeable
B.	chemical to electrical	not rechargeable
C.	electrical to chemical	rechargeable
D.	electrical to chemical	not rechargeable

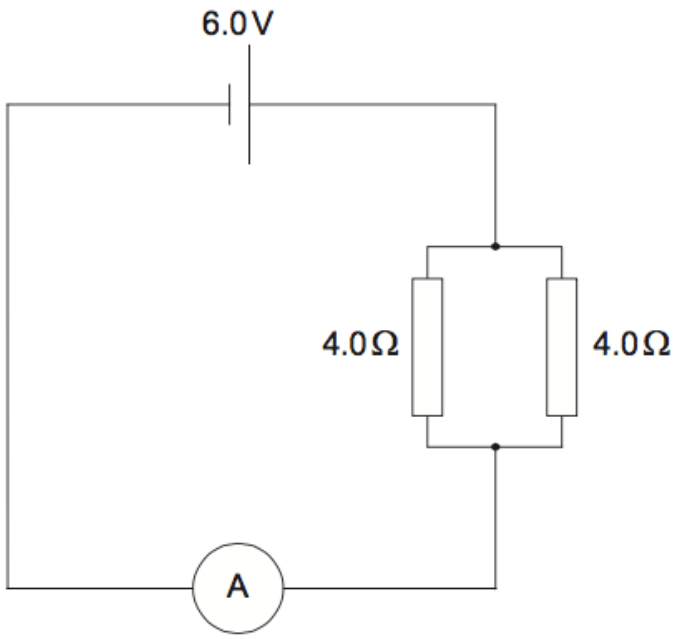
Markscheme

B

Examiners report

[N/A]

A circuit consists of a cell of electromotive force (emf) 6.0V and negligible internal resistance connected to two resistors of 4.0Ω.



The resistance of the ammeter is 1.0 Ω. What is the reading of the ammeter?

A. 2.0A

B. 3.0A

C. 4.5A

D. 6.0A

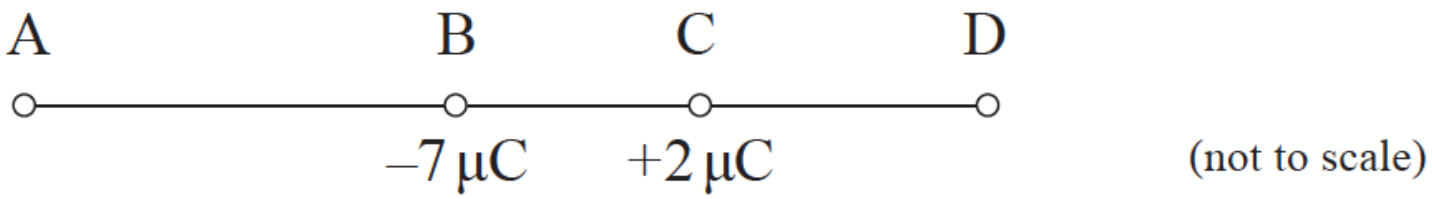
Markscheme

A

Examiners report

[N/A]

Two isolated point charges, -7 μC and +2 μC, are at a fixed distance apart. At which point is it possible for the electric field strength to be zero?

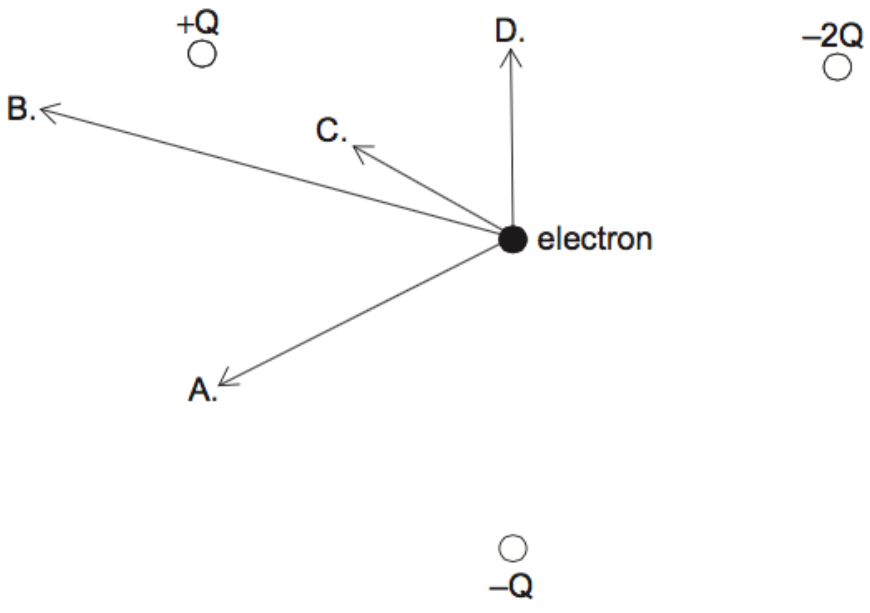


Markscheme

D

Examiners report

Three fixed charges, +Q, –Q and –2Q, are at the vertices of an equilateral triangle. What is the resultant force on an electron at the centre of the triangle?



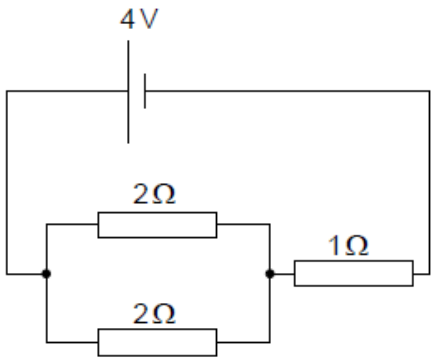
Markscheme

B

Examiners report

[N/A]

A cell of emf 4V and negligible internal resistance is connected to three resistors as shown. Two resistors of resistance 2Ω are connected in parallel and are in series with a resistor of resistance 1Ω.



What power is dissipated in one of the 2Ω resistors and in the whole circuit?

	Power dissipated in 2Ω resistor / W	Power dissipated in whole circuit / W
A.	2	6
B.	1	6
C.	0.5	8
D.	2	8

Markscheme

D

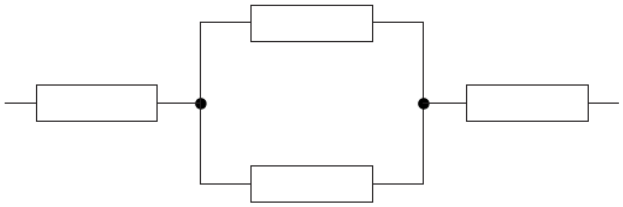
Examiners report

[N/A]

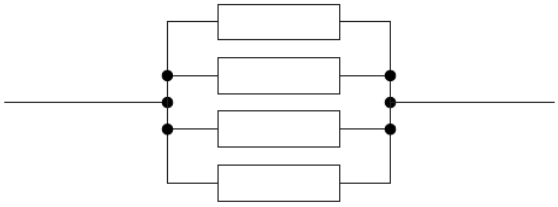
Each of the resistors in the arrangements below has resistance *R*. Each arrangement is connected, in turn, to a power supply of constant emf and negligible internal resistance. In which arrangement is the current in the power supply greatest?

A.

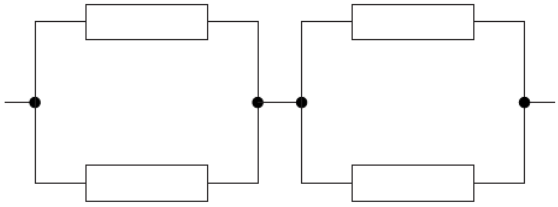
B.



C.



D.



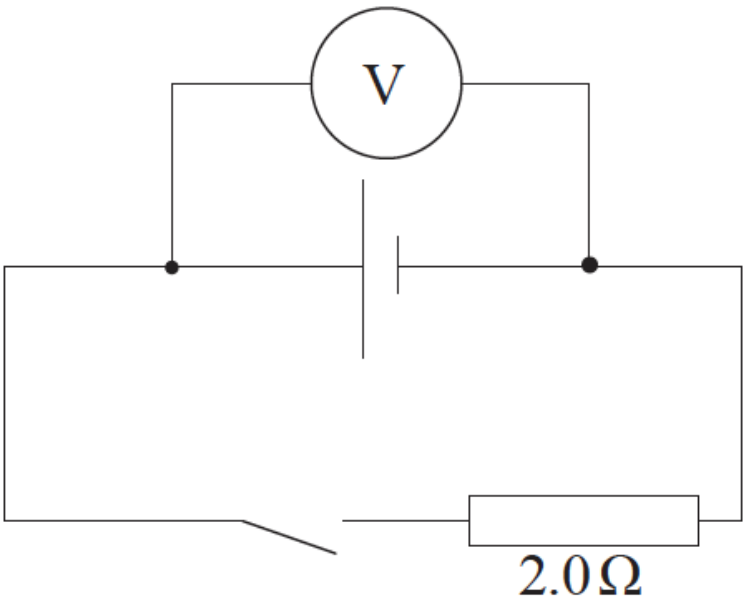
Markscheme

C

Examiners report

This was a simple question yet a good number of candidates opted for A, showing perhaps that they had not read the question carefully (and were answering the question: In which arrangement is the resistance greatest?)

A cell is connected in series with a 2.0Ω resistor and a switch. The voltmeter is connected across the cell and reads 12V when the switch is open and 8.0V when the switch is closed.



What is the internal resistance of the cell?

A. 1.0 Ω
B. 2.0 Ω
C. 3.0 Ω
D. 4.0 Ω

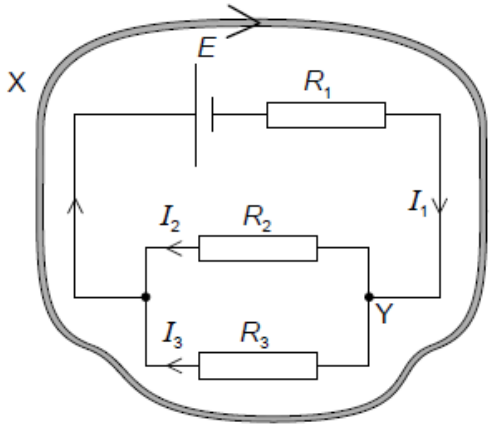
Markscheme

A

Examiners report

[N/A]

An electrical circuit is shown with loop X and junction Y.



What is the correct expression of Kirchhoff's circuit laws for loop X and junction Y?

	Loop X	Junction Y
A.	$-E = I_1R_1 + I_3R_3$	$I_1 = I_2 + I_3$
B.	$-E = I_1R_1 + I_3R_3$	$I_1 + I_2 = I_3$
C.	$E = I_1R_1 - I_3R_3$	$I_1 = I_2 + I_3$
D.	$E = I_1R_1 - I_3R_3$	$I_1 + I_2 = I_3$

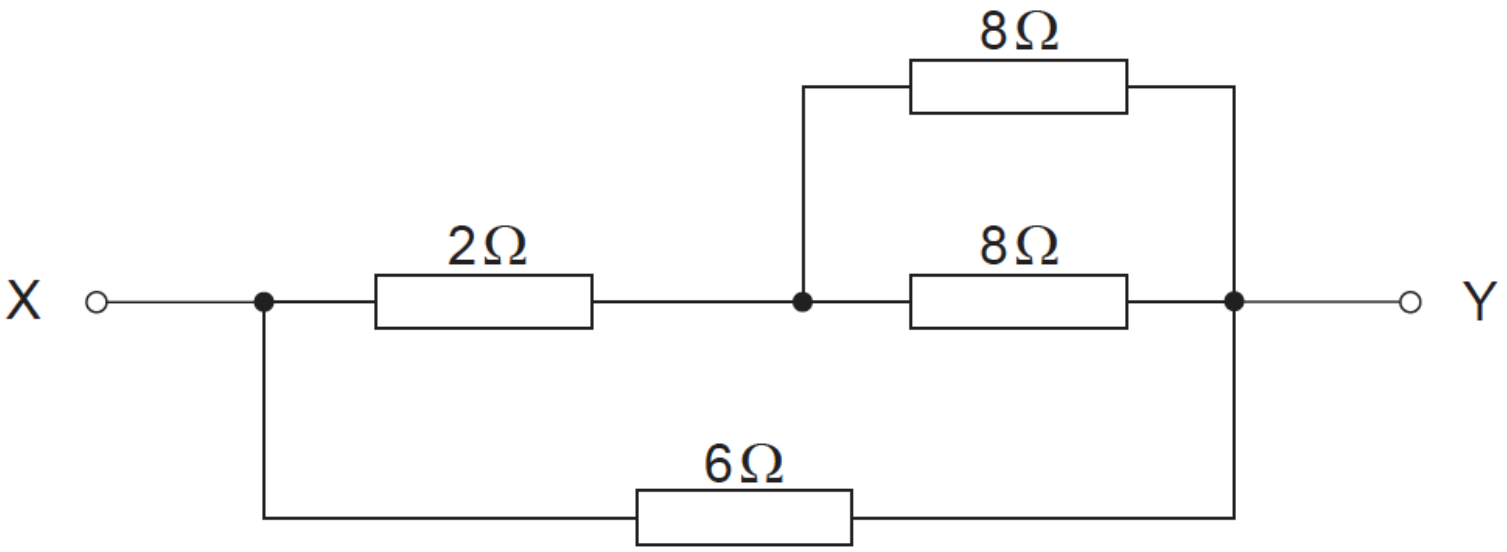
Markscheme

A

Examiners report

[N/A]

Four resistors are connected as shown.



What is the total resistance between X and Y?

A. 3 Ω

B. 4 Ω

C. 6 Ω

D. 24 Ω

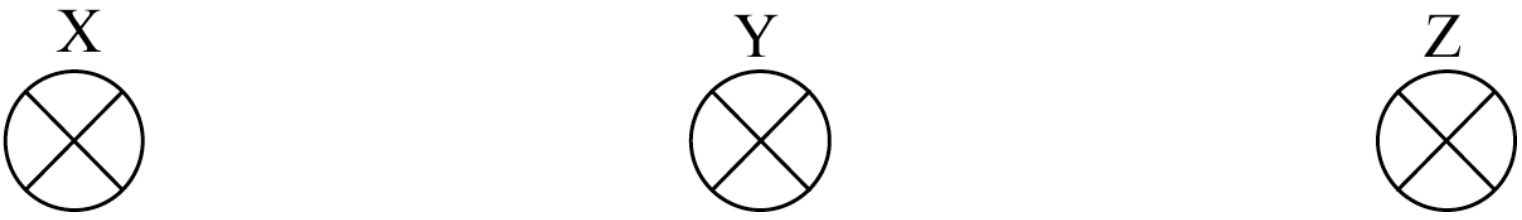
Markscheme

A

Examiners report

[N/A]

Three parallel wires, X, Y and Z, carry equal currents into the page.



Which arrow represents the direction of the magnetic force on wire Z?

A. 

B. 

C. 

D. 

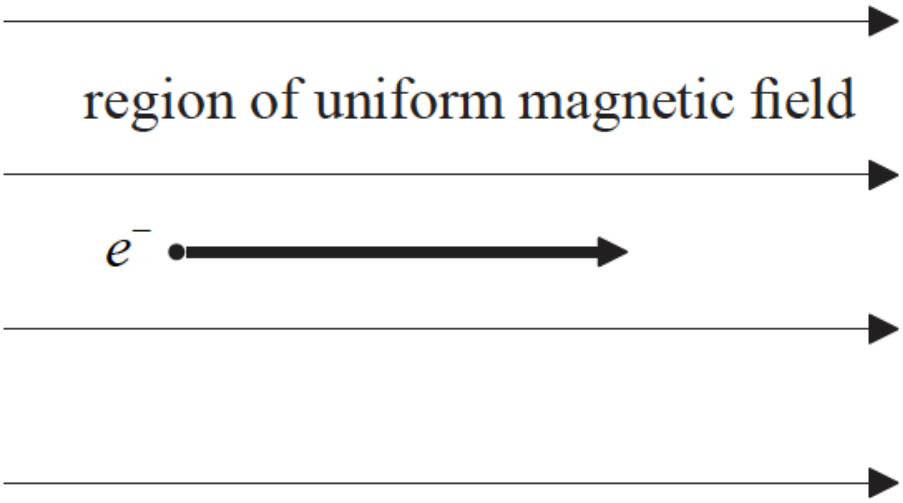
Markscheme

C

Examiners report

This question dealt with electric potential, a topic that is not part of the SL syllabus. The question was therefore deleted. The examination team apologizes for the logistical error of including this HL question in the SL paper as well.

An electron is travelling in a region of uniform magnetic field. At the instant shown, the electron is moving parallel to the field direction.



The magnetic force on the electron is

A. upwards.

B. downwards.

C. to the right.

D. zero.

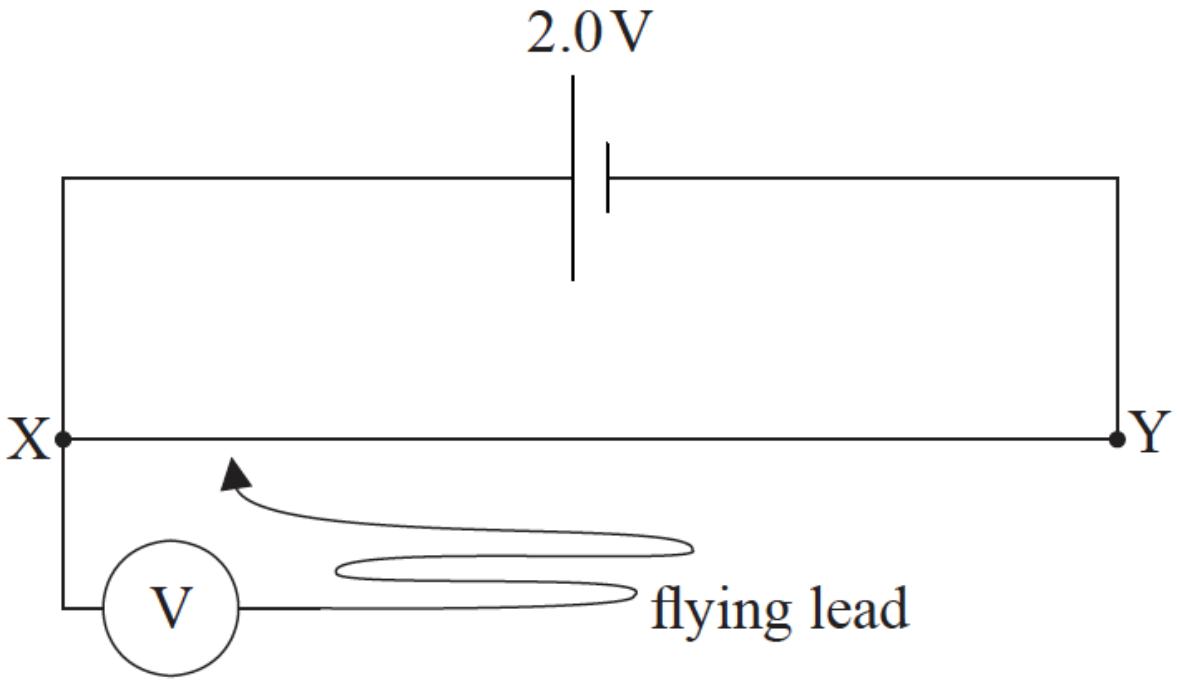
Markscheme

D

Examiners report

[N/A]

A cell with an emf of 2.0 V and negligible internal resistance is connected across a 1.00 m length of uniform resistance wire XY. The free end of the flying lead can be connected to any position on the wire.



What is the voltmeter reading when the flying lead is connected 0.25m from end X?

A. 0.00 V
B. 0.50 V
C. 1.50 V
D. 2.00 V

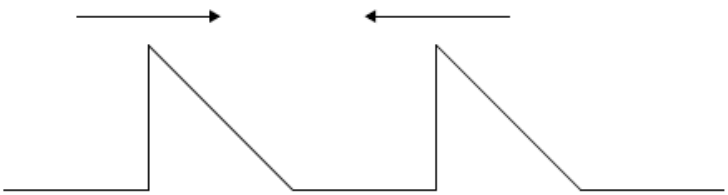
Markscheme

B

Examiners report

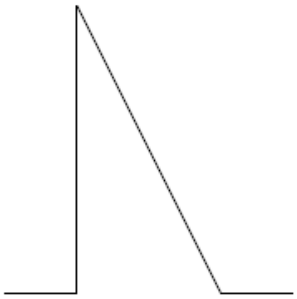
Many candidates opted for D, failing to see that the wire is a resistance wire and will drop voltage along its length.

Two pulses are travelling towards each other.

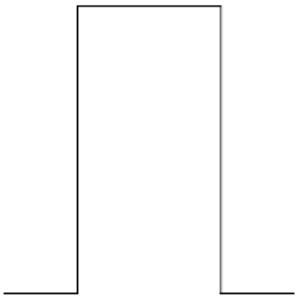


What is a possible pulse shape when the pulses overlap?

A.

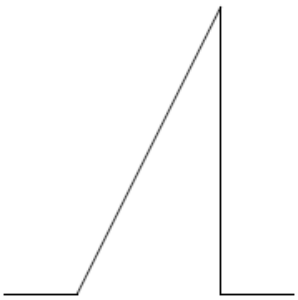


B.



C.

D.



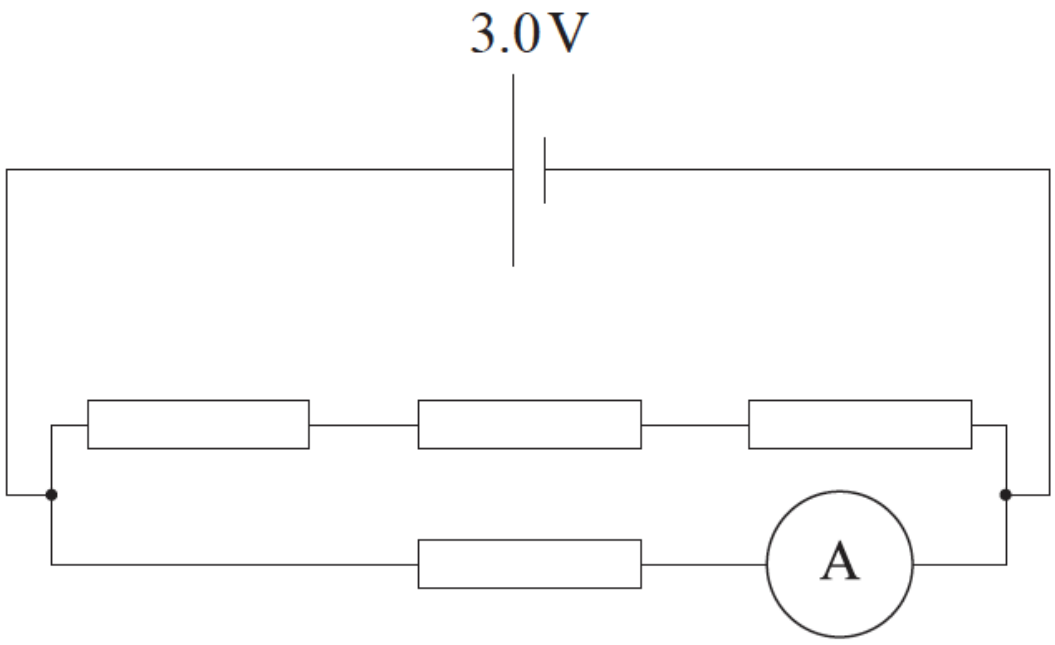
Markscheme

A

Examiners report

[N/A]

Each of the resistors in the circuit has a resistance of 2.0 Ω. The cell has an emf of 3.0 V and negligible internal resistance. The ammeter has negligible resistance.



What is the ammeter reading?

A. 0.4 A
B. 0.5 A
C. 1.5 A
D. 2.0 A

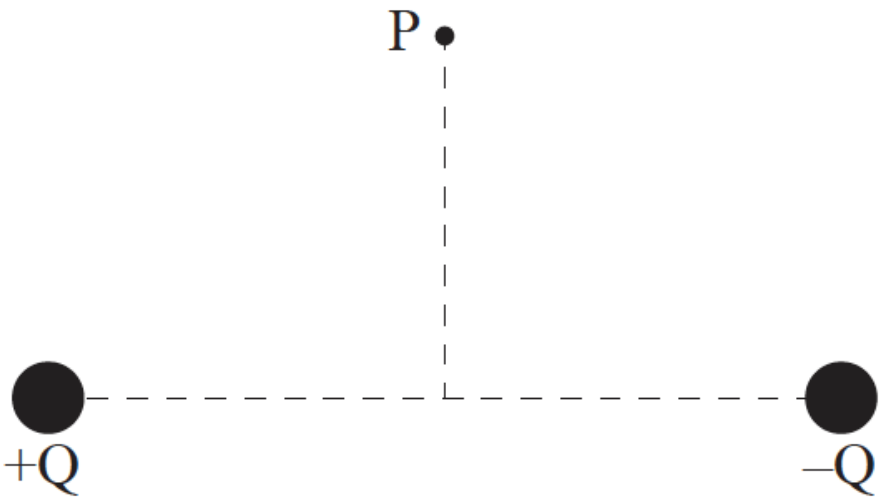
Markscheme

C

Examiners report

[N/A]

Point P is at the same distance from two charges of equal magnitude and opposite sign.



What is the direction of the electric field at point P?

A. 

B. 

C. 

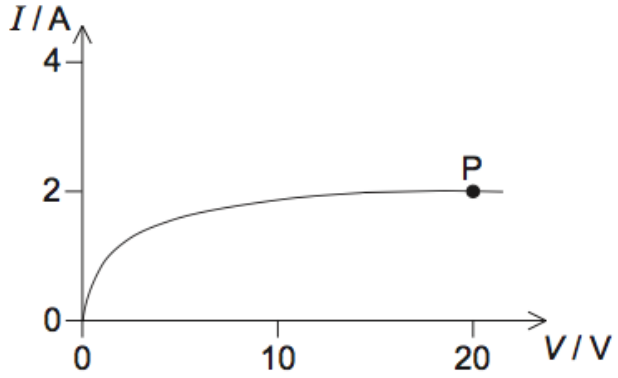
D. 

Markscheme

A

Examiners report

The graph shows the variation of current *I* in a device with potential difference *V* across it.



What is the resistance of the device at P?

A. zero

B. 0.1Ω

C. 10Ω

D. infinite

Markscheme

C

Examiners report

[N/A]

Which of the following gives the resistances of an ideal ammeter and an ideal voltmeter?

	Resistance of ideal ammeter	Resistance of ideal voltmeter
A.	infinite	infinite
B.	zero	infinite
C.	infinite	zero
D.	zero	zero

Markscheme

B

Examiners report

[N/A]

A wire has variable cross-sectional area. The cross-sectional area at Y is double that at X.

At X, the current in the wire is *I* and the electron drift speed is *v*. What is the current and the electron drift speed at Y?

	Current	Drift speed
A.	I	v
B.	I	$\frac{v}{2}$
C.	$2I$	v
D.	$2I$	$\frac{v}{2}$

Markscheme

B

Examiners report

[N/A]

Three parallel wires, X, Y and Z, carry equal currents. The currents in X and Z are directed into the page. The current in Y is directed out of the page.

Which arrow shows the direction of the magnetic force experienced by wire Z?

A. 

B. 

C. 

D. 

Markscheme

A

Examiners report

Which nucleons in a nucleus are involved in the Coulomb interaction and the strong short-range nuclear interaction?

	Coulomb interaction	Strong short-range interaction
A.	protons	protons, neutrons
B.	protons	neutrons
C.	protons	protons
D.	protons, neutrons	neutrons

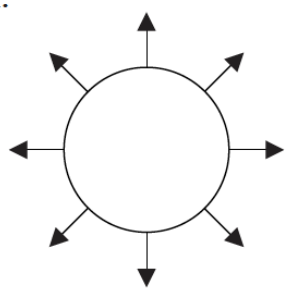
Markscheme

A

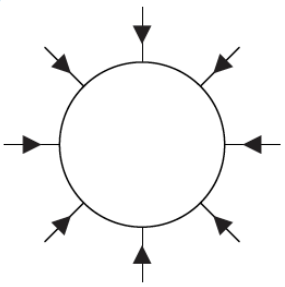
Examiners report

Which of the following is the best representation of the electric field lines around a negatively charged metal sphere?

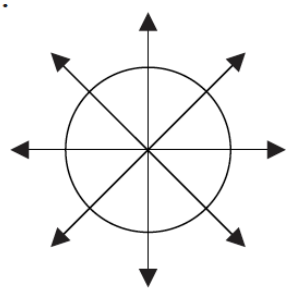
A.



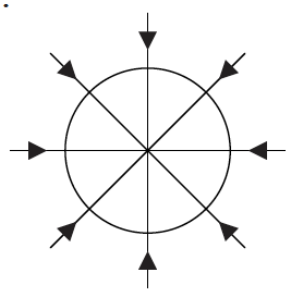
B.



C.



D.



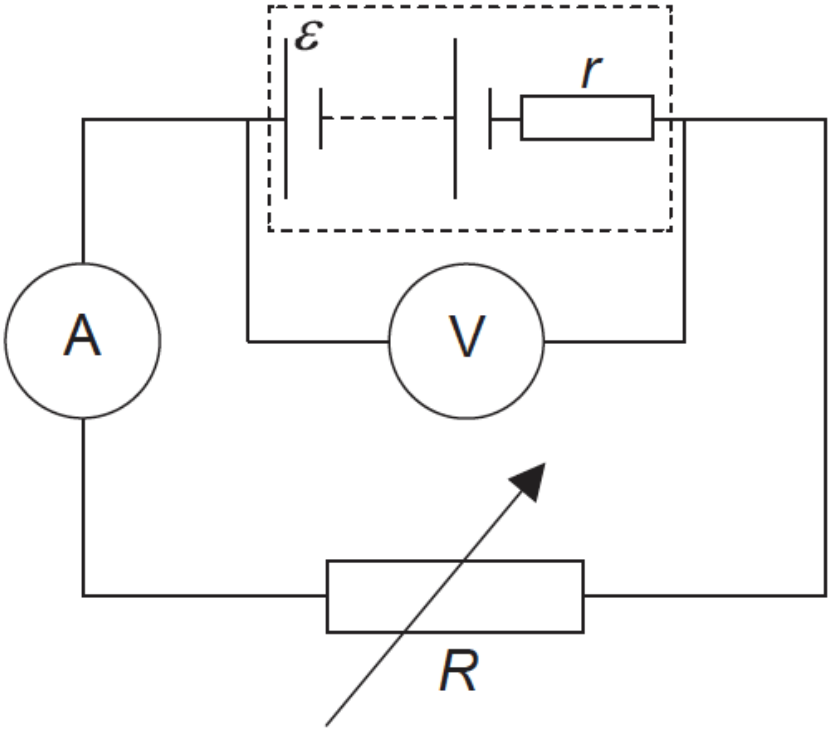
Markscheme

B

Examiners report

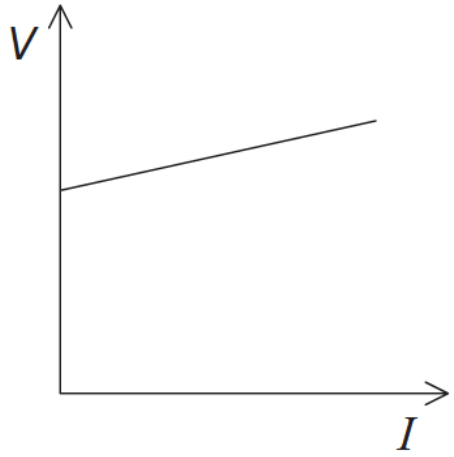
[N/A]

The diagram shows a circuit used to investigate internal resistance of a cell.

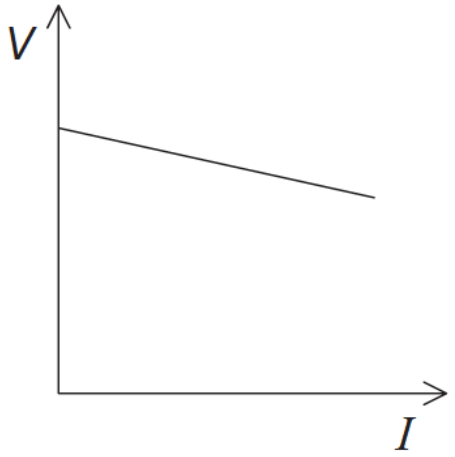


The variable resistor *R* is adjusted and the values of potential difference *V* across the cell and current *I* are recorded. Which graph shows the variation of *V* with *I*?

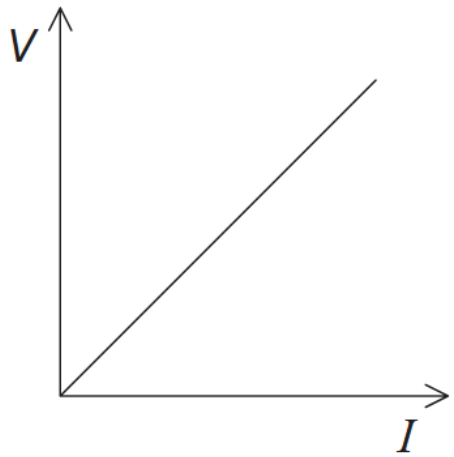
A.



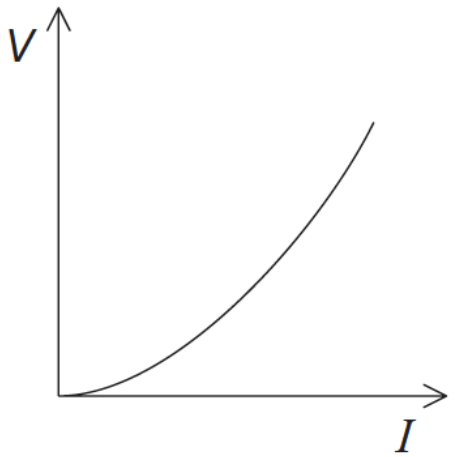
B.



C.



D.



Markscheme

B

Examiners report

[N/A]

An ideal ammeter is used to measure the current in a resistor. Which of the following gives the resistance of an ideal ammeter and the way it is connected to the resistor?

	Resistance	Connection
A.	infinite	in parallel
B.	infinite	in series
C.	zero	in parallel
D.	zero	in series

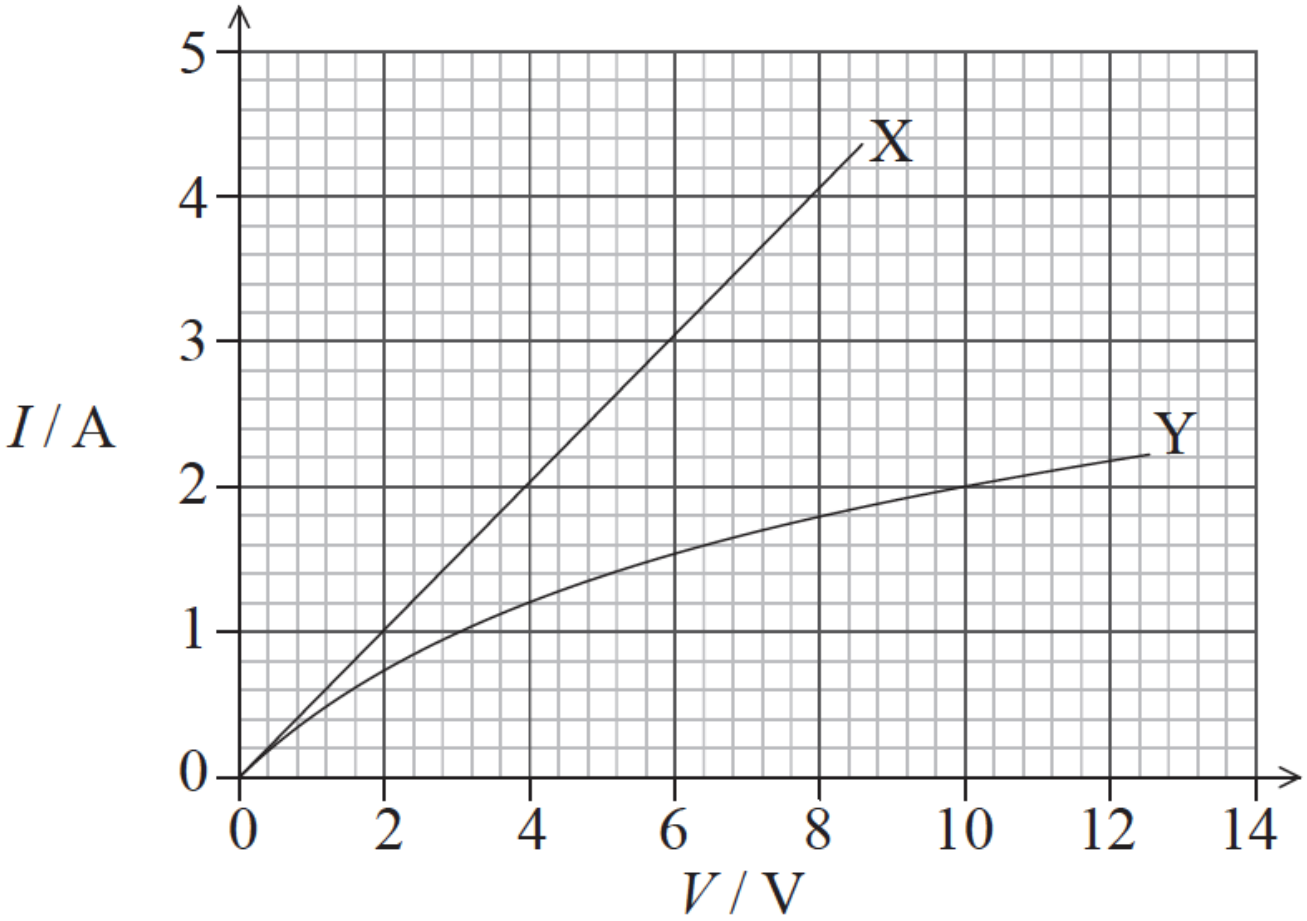
Markscheme

D

Examiners report

[N/A]

The graph shows the *I*–*V* characteristics of two resistors.



When resistors X and Y are connected in series, the current in the resistors is 2.0 A. What is the resistance of the series combination of X and Y?

A. 7.0 Ω

B. 1.3 Ω

C. 1.1 Ω

D. 0.14 Ω

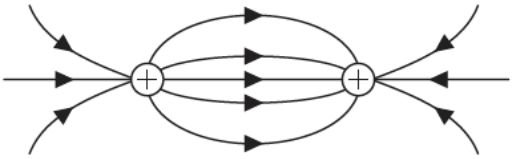
Markscheme

A

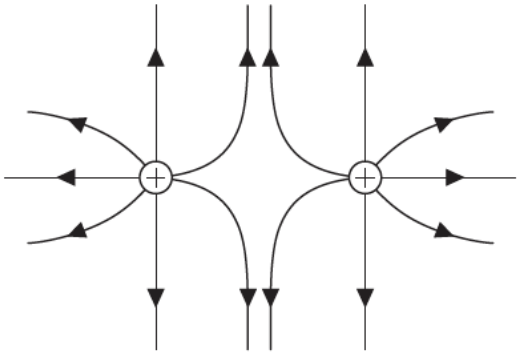
Examiners report

Which diagram represents the pattern of electric field lines of two small positive point charges held at the positions shown?

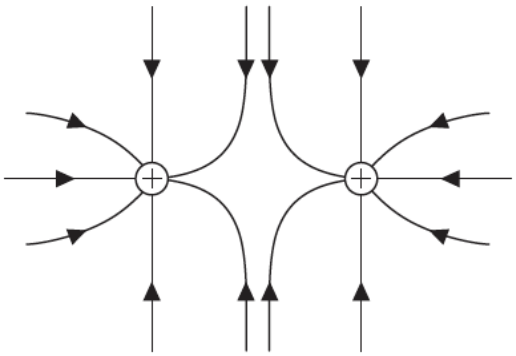
A.



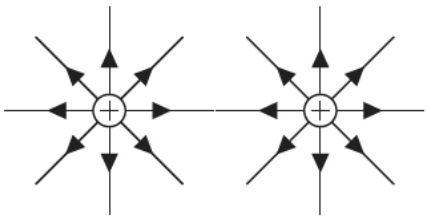
B.



C.



D.



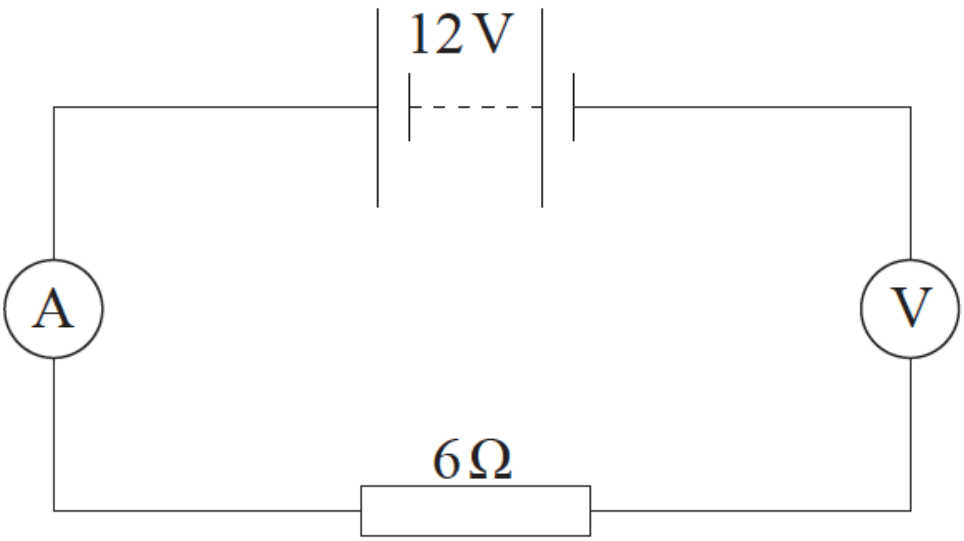
Markscheme

B

Examiners report

[N/A]

A battery of emf 12 V and negligible internal resistance is connected to a resistor of constant resistance 6 Ω, an ideal ammeter and an ideal voltmeter.



What is the reading on the ammeter and on the voltmeter?

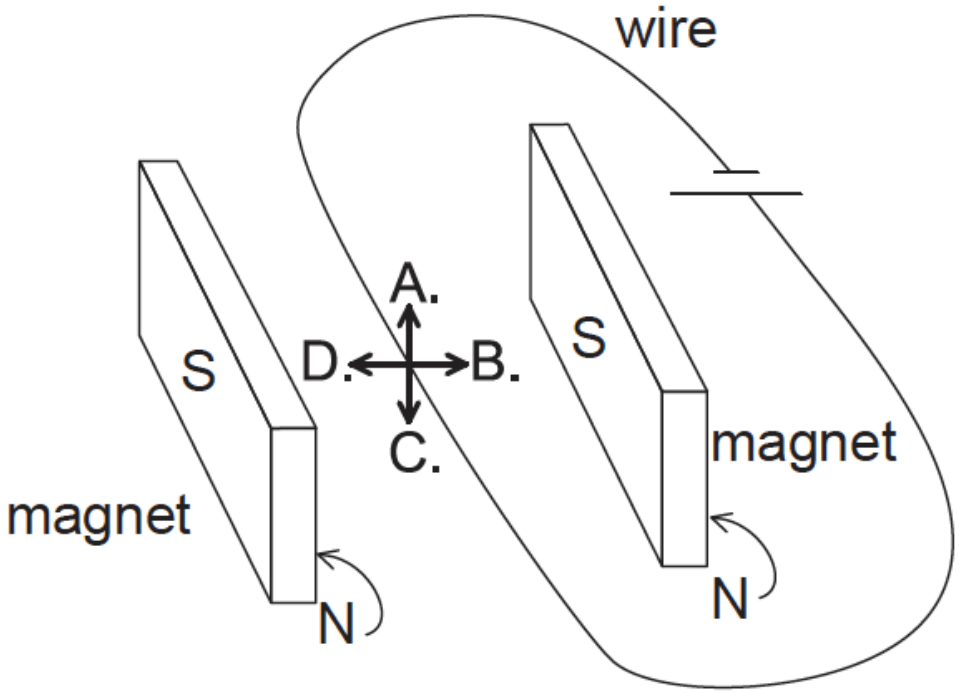
	Ammeter reading / A	Voltmeter reading / V
A.	2.0	0
B.	2.0	12
C.	0	0
D.	0	12

Markscheme

D

Examiners report

A long, straight, current-carrying wire is placed between a pair of magnets as shown. What is the direction of the force on the wire?



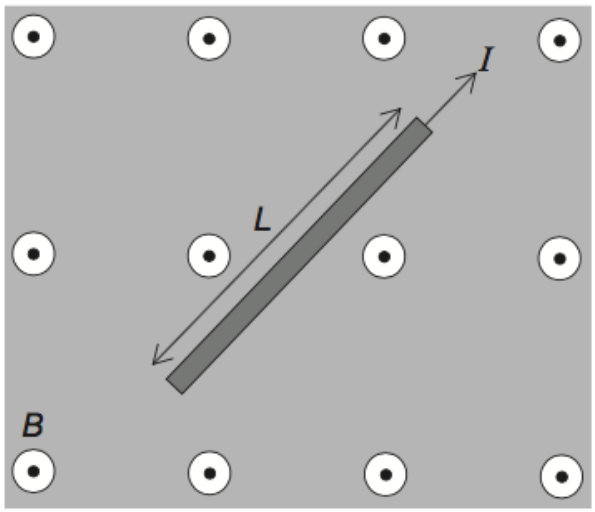
Markscheme

C

Examiners report

[N/A]

A wire carrying a current *I* is placed in a region of uniform magnetic field *B*, as shown in the diagram.



The direction of the field *B* is out of the page and the length of the wire is *L*. What is correct about the direction and magnitude of the force acting on the wire?

	Direction	Magnitude
A.		equal to *BIL*
B.		smaller than *BIL*
C.		equal to *BIL*
D.		smaller than *BIL*

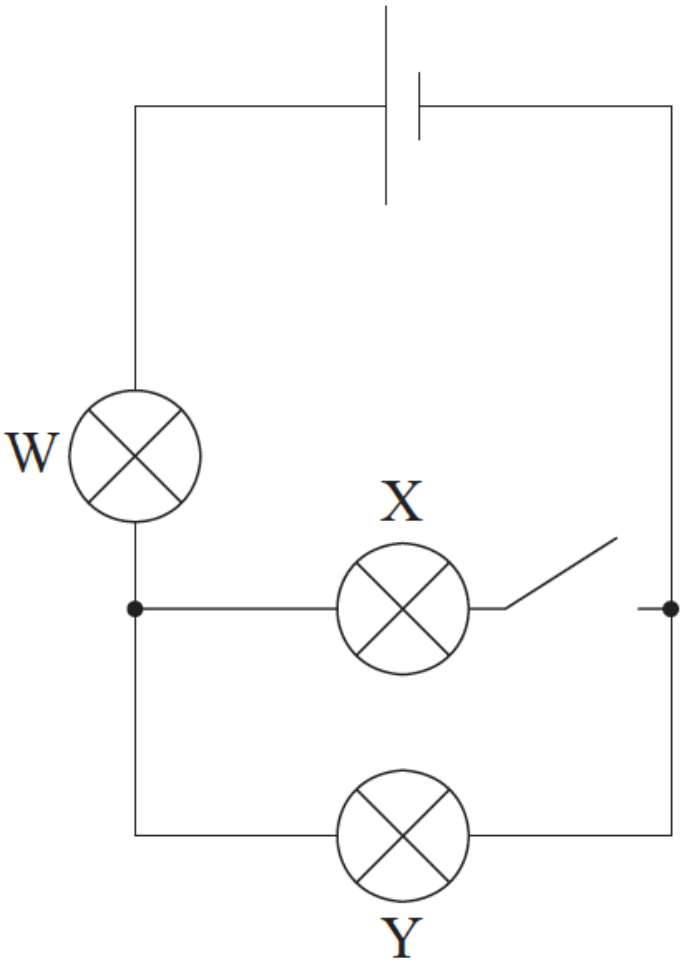
Markscheme

A

Examiners report

[N/A]

Three identical filament lamps W, X and Y are connected in the circuit as shown. The cell has negligible internal resistance.



When the switch is closed, all the lamps light. Which of the following correctly describes what happens to the brightness of lamp W and lamp Y when the switch is opened?

	Lamp W	Lamp Y
A.	decreases	decreases
B.	increases	decreases
C.	decreases	increases
D.	increases	increases

Markscheme

C

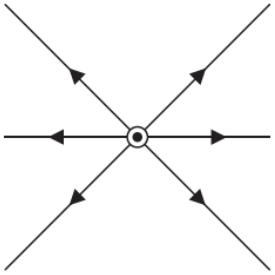
Examiners report

As these are identical lamps we can assume that their brightness depends either on the current through them or on the voltage across them, whichever is easier to find. (Note that if they had been non-identical lamps, then we would have had to find the power, VI, to detect the brightness).

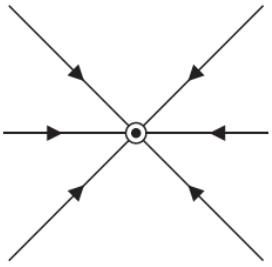
Opening the switch will increase the total resistance of the circuit, reducing the current through W. Hence B and D can be eliminated. And opening the switch will also increase the voltage across Y – from about V/3 to V/2. Hence C.

A long straight wire carries an electric current perpendicularly out of the paper. Which of the following represents the magnetic field pattern due to the current?

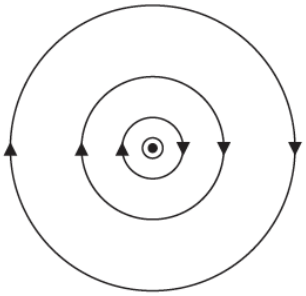
A.



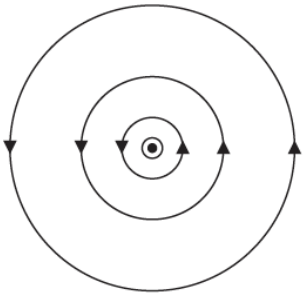
B.



C.



D.

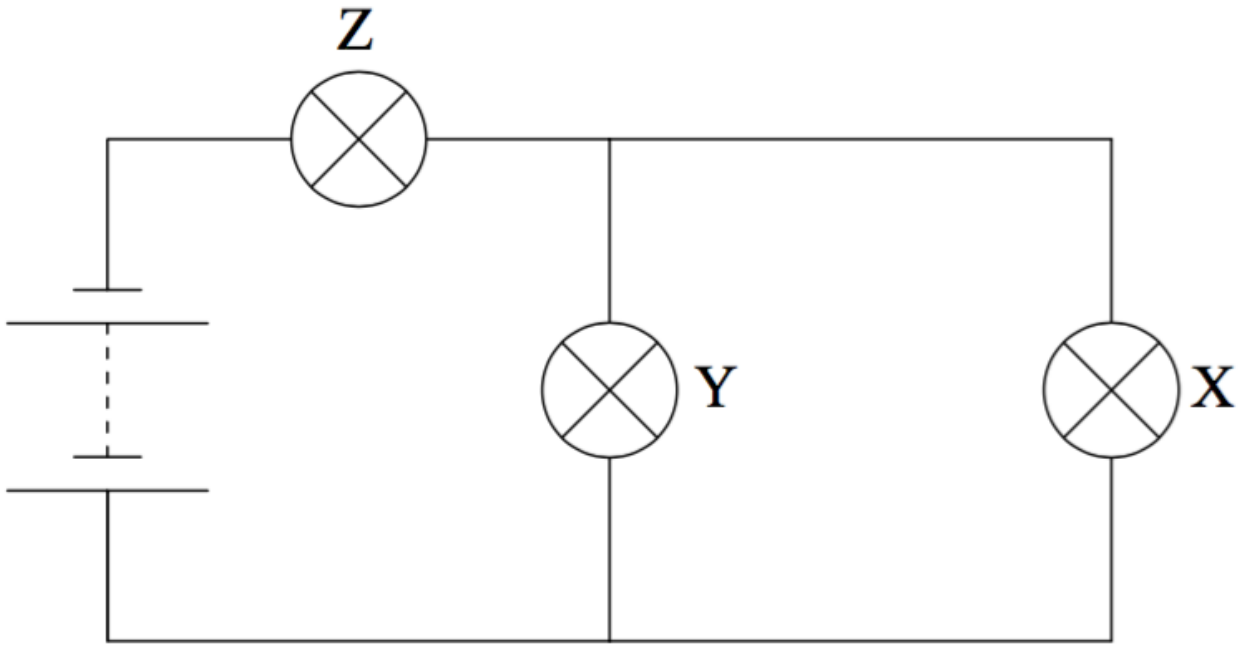


Markscheme

D

Examiners report

Three identical filament lamps, X, Y and Z, are connected as shown to a battery of negligible internal resistance.



The filament of lamp X breaks. Which of the following correctly describes the change in brightness of lamp Y and of lamp Z?

	Lamp Y	Lamp Z
A.	increase	increase
B.	decrease	increase
C.	increase	decrease
D.	decrease	decrease

Markscheme

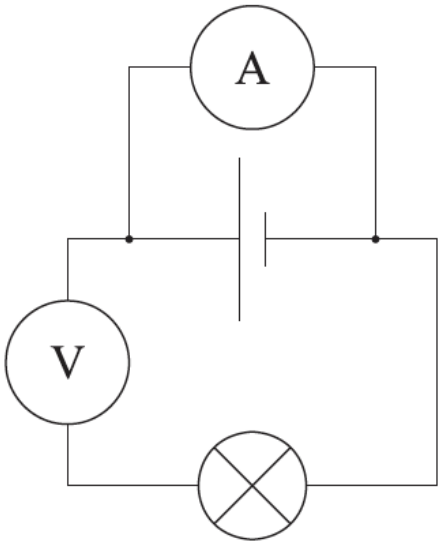
C

Examiners report

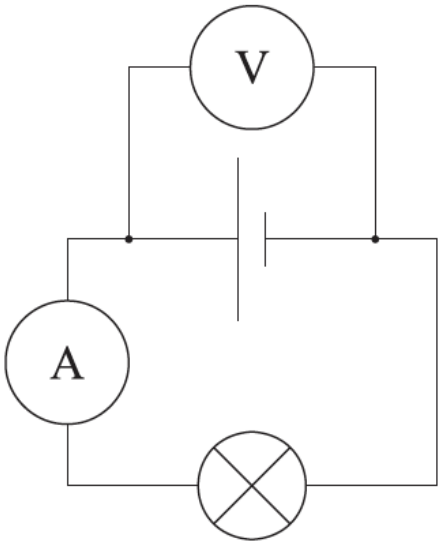
Most candidates chose A – an intuitive guess, but an incorrect one. When X breaks then the resistance in the circuit increases hence Z will be dimmer. Hence only C or D could be correct. And since Y has half the battery voltage across it, rather than a third previously, it has increased in brightness.

A lamp is connected to an electric cell and it lights at its working voltage. The lamp is then connected to the same cell in a circuit with an ideal ammeter and an ideal voltmeter. Which circuit allows the lamp to light at the original brightness?

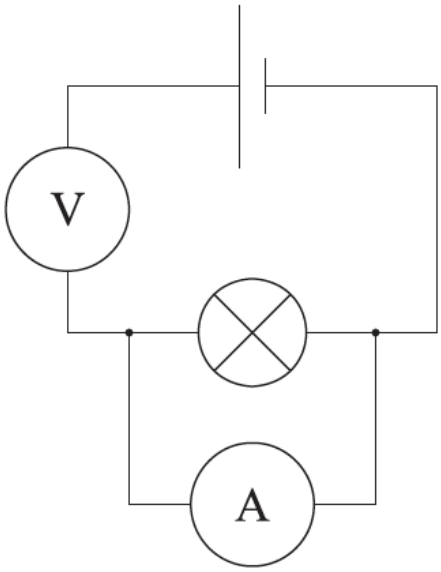
A.



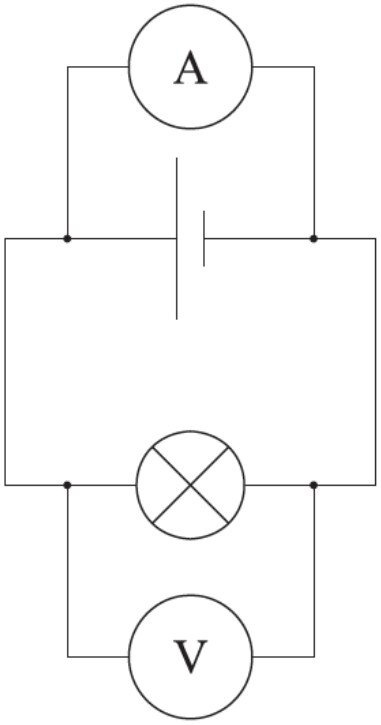
B.



C.



D.



Markscheme

B

Examiners report

[N/A]

Which of the following is the correct way of connecting an ammeter and of connecting a voltmeter in a circuit designed to measure the characteristics of a thermistor?

	Ammeter	Voltmeter
A.	in series with thermistor	in series with thermistor
B.	in parallel with thermistor	in series with thermistor
C.	in series with thermistor	in parallel with thermistor
D.	in parallel with thermistor	in parallel with thermistor

Markscheme

C

Examiners report