Chapter # 19

Electric Quantities

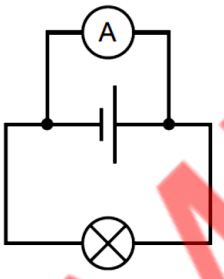
Electric Current

Q-1: Which row is correct?

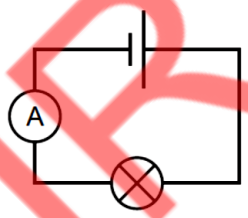
	definition of current I	direction of conventional current
A	$I = \frac{Q}{t}$	from positive terminal to negative terminal
B	$I = \frac{Q}{t}$	from negative terminal to positive terminal
C	$I = Q \times t$	from positive terminal to negative terminal
D	$I = Q \times t$	from negative terminal to positive terminal

Q-2: In which circuit is the ammeter measuring the flow of charge through the lamp?

A



B



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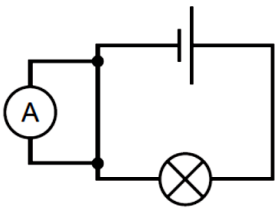

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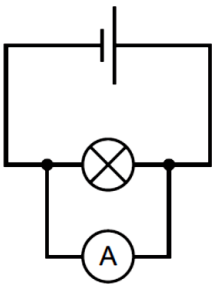
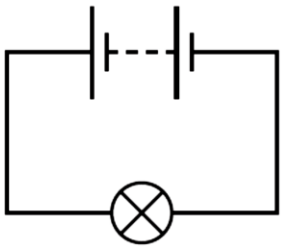
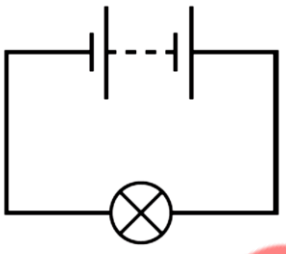


Q-3: In circuit 1, a negative charge flows in a clockwise direction. The bulb is bright.
In circuit 2, the battery is reversed as shown. The bulb is equally bright.



circuit 1



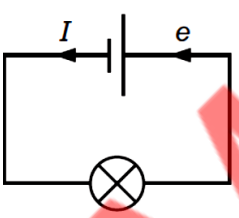
circuit 2

Which charge flows in circuit 2 and in which direction?

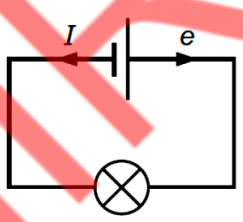
	charge	direction
A	negative	anticlockwise
B	negative	clockwise
C	positive	anticlockwise
D	positive	clockwise

Q-4: A lamp is connected to a cell. Which circuit diagram shows the direction of conventional current *I* and also the direction of flow of electrons *e*?

A



B



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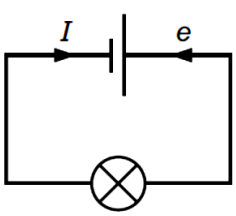
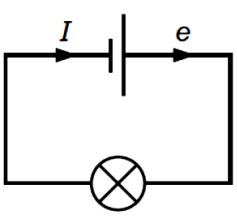


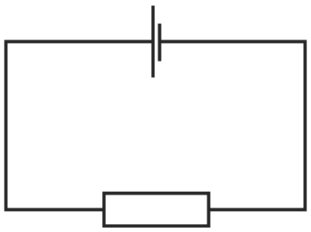
D



Q-5: A car battery delivers 150 kC to a circuit before it needs recharging. Two headlamps connected in parallel to the battery are switched on. There is a current of 4.0 A in each lamp. How much time passes before the battery needs recharging?

A 2.6 hours
B 5.2 hours
C 7.8 hours
D 10.4 hours

Q-6: The electrical circuit shown consists of a cell connected to a resistor



What are the directions of the electron flow and of the conventional current in the resistor?

	electron flow	conventional current
A	→	→
B	→	←
C	←	←
D	←	→

Q-7: A lightning flash carries 40 C of charge and lasts for 5.0 ms. What is the average current in the flash?

A 0.20 A **B** 8.0 A **C** 200 A **D** 8000 A

Q-8: A charge of 45 C flows through an electric appliance in 3.0 minutes. What is the average current in the appliance?

A 0.25 A **B** 4.0 A **C** 15 A **D** 135 A

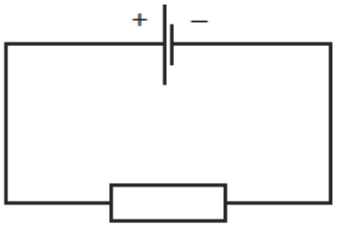
Q-9: The current in a car headlamp is 2.0 A. The headlamp is switched on for 4.0 minutes. How much charge passes through the headlamp?

A 8.0 C **B** 30 C **C** 120 C **D** 480 C

Q-10: Which of the following is equivalent to one coulomb?

A one ampere second
B one volt ampere
C one ampere per volt
D one volt per ampere

Q-11: The diagram shows a simple electric circuit.



Which row describes the charge on an electron and the direction of electron flow through the resistor?

	charge on an electron	direction of electron flow
A	negative	– to +
B	negative	+ to –
C	positive	– to +
D	positive	+ to –

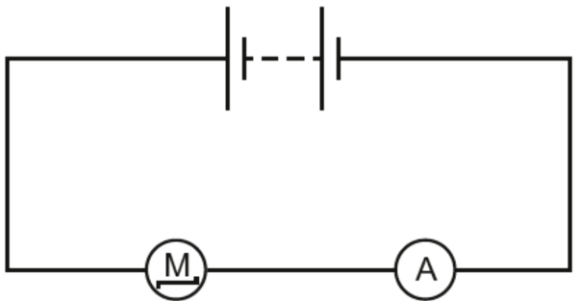
Q-12: During a thunderstorm, a lightning flash occurs when charge flows between a cloud and the Earth. On average, 20 C of charge flows during each flash and there are three flashes every minute. What is the average current between the cloud and the Earth during the thunderstorm?

A 1.0 A **B** 36 A **C** 60 A **D** 1800 A

Q-13: A charge of 7.5 C flows through a resistor in 5.0 s. A student has ammeters with different ranges that he can use to measure the current in the resistor. Which ammeter range is the most appropriate?

A 0 - 1 A **B** 0 - 2 A **C** 0 - 5 A **D** 0 - 40 A

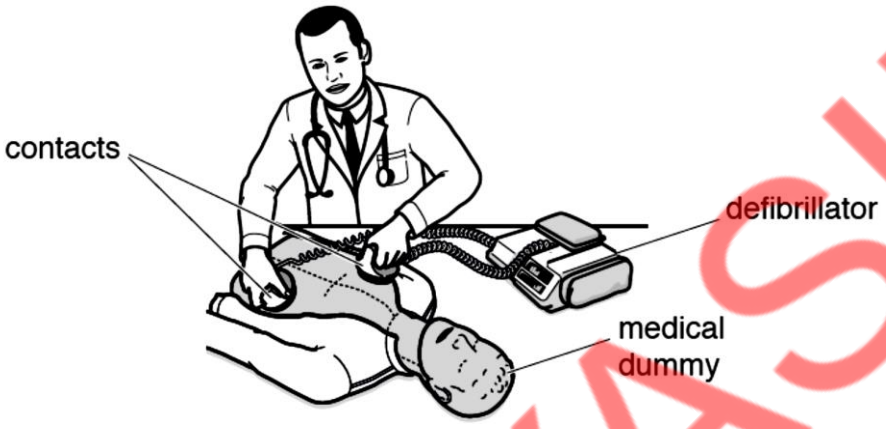
Q-14: a) Following Fig. shows a circuit.



On Fig., draw **two** clearly labelled arrows to show the direction of the electron flow and the direction of the conventional current in the circuit.

b) The current in the motor is 13 A. The charge on an electron is 1.6×10^{-19} C. Calculate the number of electrons that pass through the motor every second.

Q-15: A defibrillator is a machine that sends an electrical charge through the heart of a patient whose heart is not beating correctly. Doctors learn to use a defibrillator by practising on a medical dummy. Fig. 1 shows the two contacts of a defibrillator attached to a medical dummy.



The contacts that touch the dummy are made from metal, and when the defibrillator is being used, one contact becomes strongly negatively charged and the other contact becomes strongly positively charged. The handles of the contacts are made from plastic, which is an electrical insulator.

a) **i)** State how the structure of an electrical insulator differs from the structure of a conductor.

ii) Suggest why the handles are made from an electrical insulator.

b) Explain, in terms of the particles involved, how one contact becomes negatively charged and how the other contact becomes positively charged.

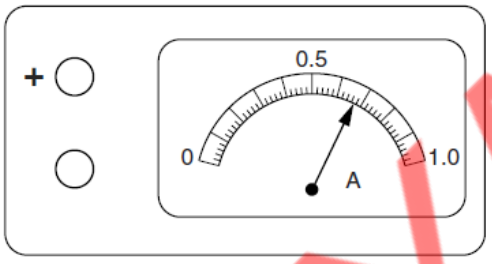
c) The defibrillator passes a charge of 9.1×10^{-3} C through the medical dummy in 6.5×10^{-4} s. Calculate the average current in the dummy.

Q-16: A student investigates the use of ammeters in a circuit.

a) State the quantity measured with an ammeter.

b) Explain why it is important for an ammeter to have a low resistance.

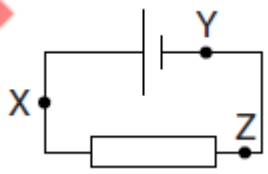
c) Fig. 1 shows an analogue ammeter.



State the reading on the ammeter.

d) A school has both digital and analogue ammeters. Suggest one advantage of using a digital ammeter rather than an analogue ammeter.

e) Fig. 2 shows a simple circuit.



A student connects three similar ammeters at X, at Y and at Z. The ammeters give slightly different readings.

i) Explain why all the ammeters should give the same reading.

ii) Suggest a reason for the slight differences in the three readings.

Electromotive Force/Potential Difference

Q-17: Which statement defines the electromotive force (e.m.f.) of a cell?

A the current in the cell when 1.0 C of charge flows in 1.0 s
B the current supplied by the cell to drive 1.0 C of charge around a complete circuit
C the energy supplied by the cell to drive 1.0 C of charge around a complete circuit
D the energy supplied by the cell to drive 1.0 A of current around a complete circuit

Q-18: Which quantity is defined as the energy transferred by a cell in driving unit charge around a complete circuit?

A current **B** electromotive force (e.m.f.) **C** power **D** resistance

Q-19: Quantity X and quantity Y have the same unit Z.
X is the energy dissipated by a battery in driving unit charge round the complete circuit.
Y is the work done in a component in driving unit charge through the component.
What are X, Y and Z?

	X	Y	Z
A	electromotive force	potential difference	coulomb
B	electromotive force	potential difference	volt
C	potential difference	electromotive force	coulomb
D	potential difference	electromotive force	volt

Q-20: A battery consists of three identical cells in parallel. What is the unit of electromotive force (e.m.f.) and to what is the e.m.f. of the battery equal?

	unit	e.m.f. of the battery is equal to
A	J/C	the sum of the e.m.f.s of the three cells
B	J/C	the e.m.f. of one of the cells
C	N/V	the sum of the e.m.f.s of the three cells
D	N/V	the e.m.f. of one of the cells

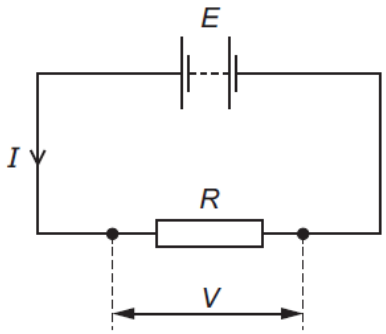
Q-21: What is stored in a battery and what is its unit?

	quantity	unit
A	current	A
B	current	As
C	energy	J
D	energy	J/s

Q-22: Which unit is the same as a volt?

A ampere / ohm **B** ampere / watt **C** ohm / ampere **D** watt / ampere

Q-23: The diagram shows a simple electrical circuit.



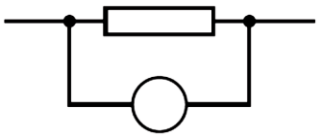
Which statement **cannot** be correct?

A The current *I* is 2 A.
B The e.m.f. *E* is 12 J.
C The p.d. *V* (across the resistor) is 10 V.
D The resistance *R* is 5Ω

Q-24: Each diagram shows part of a circuit. The circle represents an instrument used to measure the potential difference (p.d.) across the resistor.

diagram 1

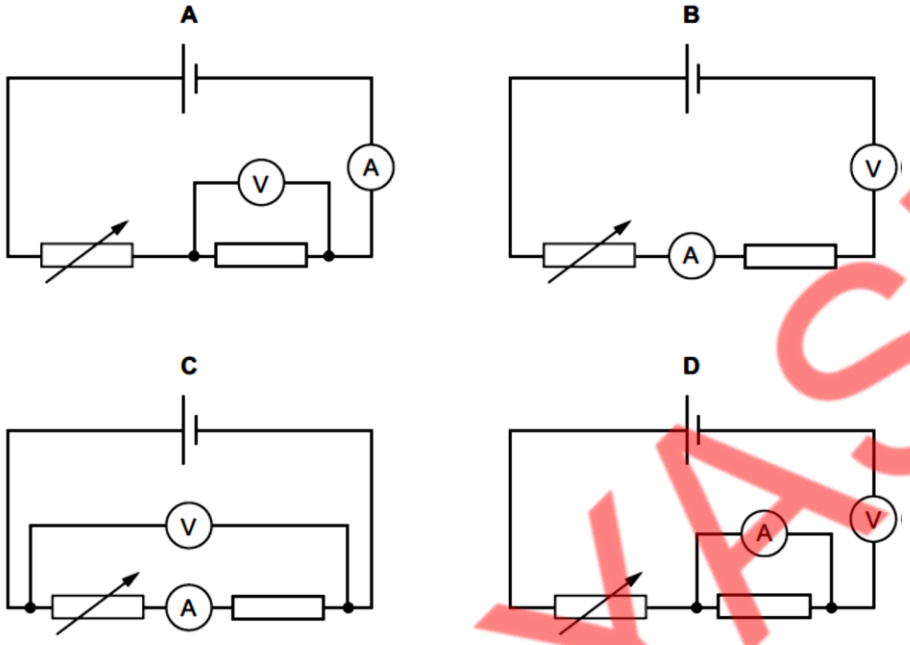
diagram 2



Which row is correct?

	the unit of p.d.	diagram which shows the meter correctly connected
A	amperes	diagram 1
B	amperes	diagram 2
C	volts	diagram 1
D	volts	diagram 2

Q-25: Which circuit is connected to measure the current in the fixed resistor and the potential difference (p.d.) across the same resistor?



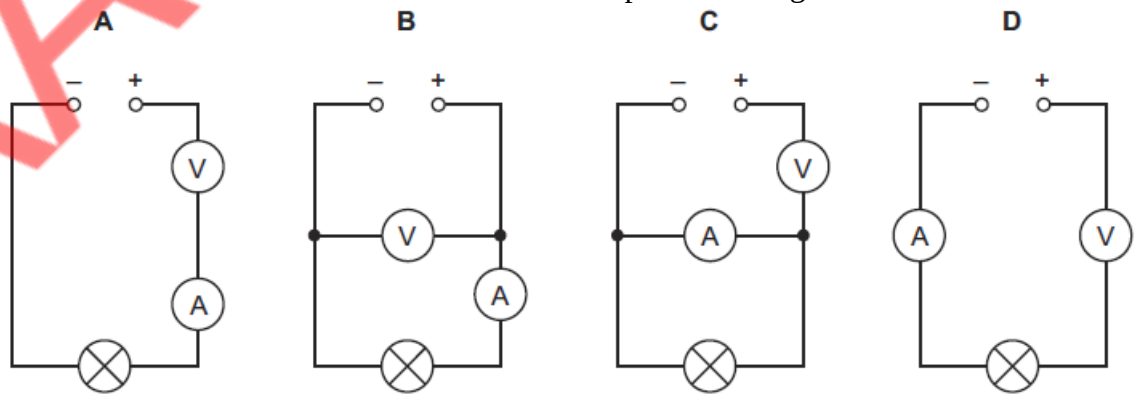
Q-26: What is electromotive force (e.m.f.)?

A Charge / work done
B Charge / time
C work done / charge
D work done / time

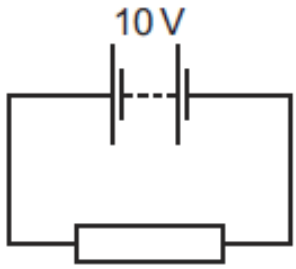
Q-27: Which physical quantity is produced by a calculation where a charge is multiplied by a potential difference (p.d.)?

A current
B electromotive force (e.m.f.)
C energy
D power

Q-28: In a circuit, a voltmeter is used to measure the potential difference across a lamp. An ammeter is used to measure the current in the lamp. Which diagram shows the circuit?



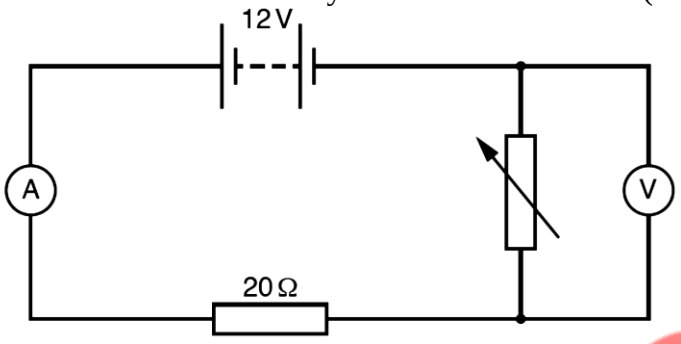
Q-29: A battery of electromotive force (e.m.f.) 10 V is connected to a resistor



A charge of 2.0 coulombs passes through the resistor. How much work is done as the charge passes through the resistor?

A 0.20 J **B** 2.0 J **C** 5.0 J **D** 20 J

Q-30: Fig.1 shows a circuit that includes a battery of electromotive force (e.m.f.) 12 V.



The reading on the ammeter is 0.15 A.

a) Calculate the resistance of the circuit.

b) The variable resistor is adjusted so that its resistance decreases.

i) State what happens to the reading on the ammeter.

ii) State and explain what happens to the reading on the voltmeter.

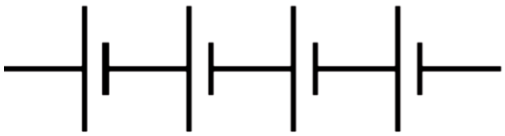
c) The battery is formed from cells of electromotive force (e.m.f.) 1.5 V.

i) Explain, in terms of electrical energy, what is meant by an *electromotive force* (*e.m.f.*) *of 1.5 V.*

ii) State how many 1.5 V cells are connected in series to form the battery.

Combination of Cells

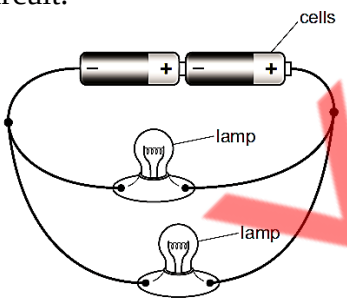
Q-31: Several cells are connected in series, as shown.



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

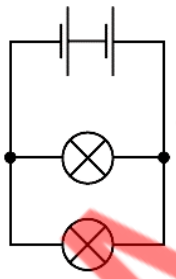
A the average of the e.m.f.s of the separate cells
B the e.m.f. of one of the cells
C the product of the e.m.f.s of the cells
D the sum of the e.m.f.s of the cells

Q-32: The diagram shows a circuit.

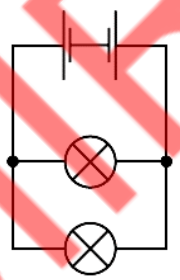


Which circuit diagram shows this circuit?

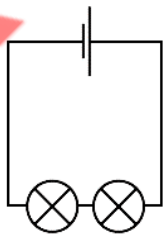
A



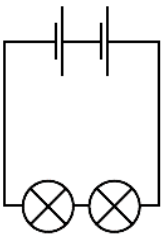
B



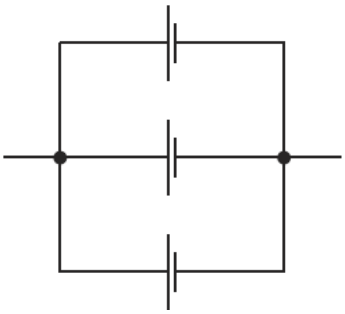
C



D



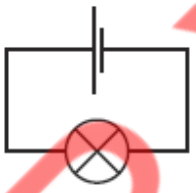
Q-33: The diagram shows a battery of three 1.5 V cells.



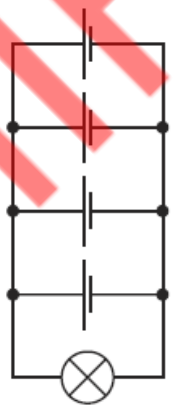
What is an advantage of this arrangement of cells?

A The battery can supply a current for a longer time than a single 1.5 V cell.
B The battery can supply any e.m.f. between 0 V and 4.5 V.
C The battery supplies more energy to each coulomb of charge than a single 1.5 V cell.
D The e.m.f. of the battery is 4.5 V.

Q-34: A lamp, designed to work at 1.5 V, is connected to a cell of electromotive force (e.m.f.) 1.5 V. The lamp lights at normal brightness.



The lamp is now connected to four similar cells, each of e.m.f. 1.5 V, arranged in parallel.



What is the effect of connecting the extra cells in this way?

A The lamp burns out.
B The lamp is dimmer.
C The lamp produces light for a longer time.
D The lamp produces light for a shorter time.

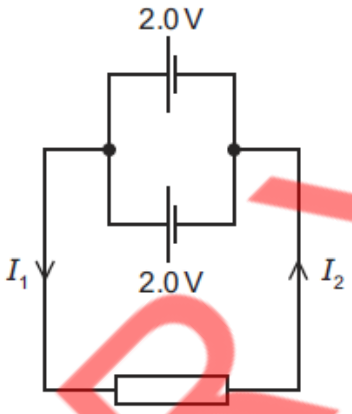
Q-35: Why are batteries sometimes made from several identical cells arranged in parallel?

A The battery has a greater e.m.f. than a single cell on its own.
B The battery has a lower e.m.f. than a single cell on its own.
C The battery lasts longer than a single cell on its own.
D The battery supplies a smaller current than a single cell on its own.

Q-36: Three identical cells are connected in parallel to a resistor. What is the advantage of using three cells in parallel, rather than using a single cell?

A Each cell produces more energy.
B Each cell supplies more charge.
C Each cell takes longer to run down.
D The total electromotive force (e.m.f.) is larger.

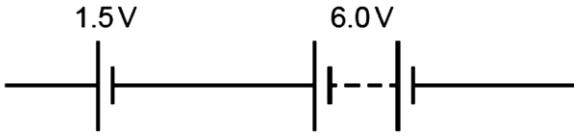
Q-37: The battery in a circuit contains two identical cells connected in parallel.



Which row shows the relationship between currents I_1 and I_2 and gives the electromotive force (e.m.f.) of the battery?

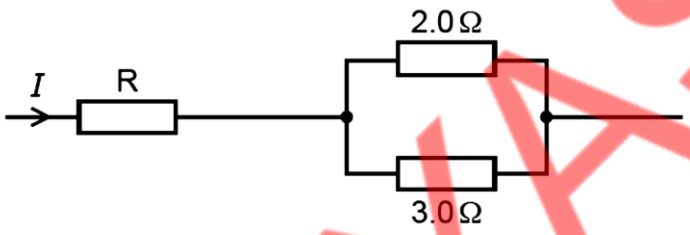
	relationship	e.m.f. / V
A	$I_1 > I_2$	2.0
B	$I_1 > I_2$	4.0
C	$I_1 = I_2$	2.0
D	$I_1 = I_2$	4.0

Q-38: a) Fig. 1 shows a cell of electromotive force (e.m.f.) 1.5 V and a battery of e.m.f. 6.0 V connected in series.



Calculate the combined e.m.f. of the cell and the battery.

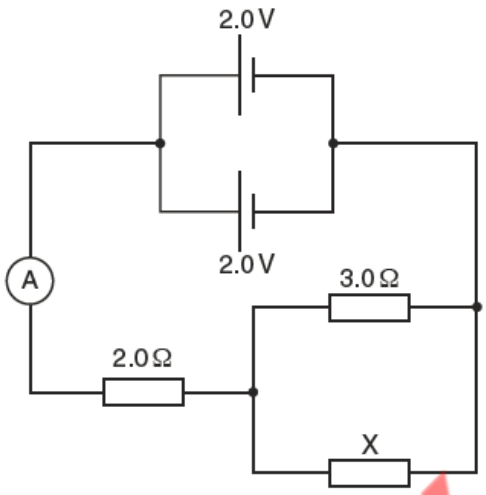
b) The combined resistance of the three resistors shown in Fig. 2 is 4.4 Ω.



i) Calculate the resistance of resistor R.

ii) The current *I* in Fig. 2 is 0.94 A. Calculate the potential difference (p.d.) across the combination of resistors.

Q-39: A student makes a 2.0 V battery by connecting two cells of electromotive force (e.m.f.) 2.0 V in parallel. The battery, an ammeter with different ranges and three different resistors are used to set up the circuit shown in Fig. 1.



a) **i)** Explain what is meant by electromotive force.

ii) State one advantage of using two cells in parallel rather than using a single 2.0 V cell.

b) Resistor X and the 3.0 Ω resistor have a combined resistance that is equal to 2.0 Ω. Calculate

i) the total resistance of the circuit,

ii) the resistance of X.

c) **i)** Determine the reading of the ammeter.

ii) Suggest a suitable range for the ammeter.

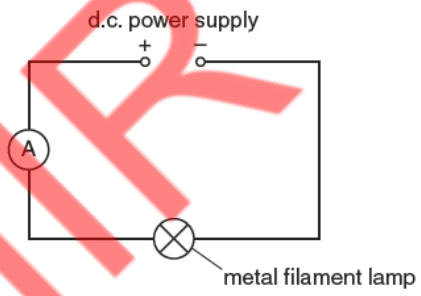
d) The current in the 2.0 Ω resistor is I_2. The current in the 3.0 Ω resistor is I_3. The current in X is I_X. State the equation that relates I_2, I_3 and I_X.

e) State the potential difference (p.d.) across

i) the 2.0 Ω resistor,

ii) the 3.0 Ω resistor.

f) The student sets up a second circuit using a variable d.c. power supply, an ammeter and a 12 V metal filament lamp. The circuit is shown in Fig. 2.



The d.c. power supply is set to 12 V and the ammeter reading is 1.5 A.
The student changes the e.m.f. of the d.c. power supply to 6.0 V. The lamp dims and the ammeter reading changes.

i) State and explain what happens to the resistance of the metal filament of the lamp.

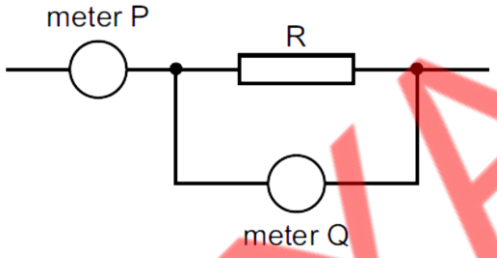
ii) State whether the new ammeter reading is less than, equal to or greater than 0.75 A.

Resistance

Q-40: A student measures the potential difference across a device and the current in the device. Which calculation gives the resistance of the device?

A current + potential difference
B current ÷ potential difference
C potential difference ÷ current
D potential difference × current

Q-41: The diagram shows part of a circuit which contains an ammeter, a voltmeter and a resistor R. The ammeter and the voltmeter are in the correct positions to determine the resistance of R.



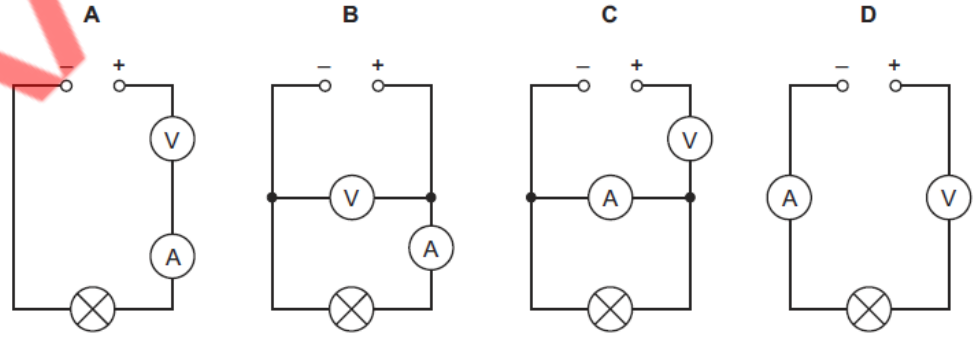
Which expression gives the value of R?

A reading of meter P ÷ reading of meter Q
B (reading of meter P)^2 × reading of meter Q
C reading of meter Q × reading of meter P
D reading of meter Q ÷ reading of meter P

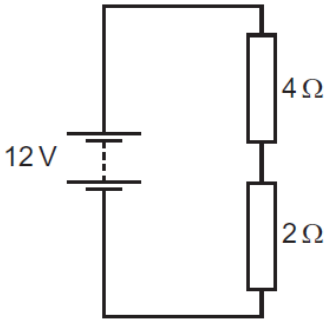
Q-42: A student investigates the resistance of a lamp. Which row states how the meters must be connected?

	ammeter	voltmeter
A	in parallel with the lamp	in parallel with the lamp
B	in parallel with the lamp	in series with the lamp
C	in series with the lamp	in parallel with the lamp
D	in series with the lamp	in series with the lamp

Q-43: In a circuit, a voltmeter is used to measure the potential difference across a lamp. An ammeter is used to measure the current in the lamp. Which diagram shows the circuit?



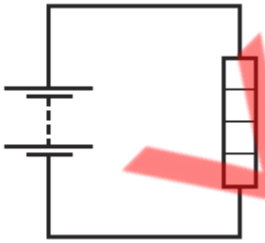
Q-44: A 4 Ω resistor and a 2 Ω resistor are connected to a 12 V battery in a circuit.



What is the current in the 2 Ω resistor?

A 0.5 A **B** 2.0 A **C** 3.0 A **D** 6.0 A

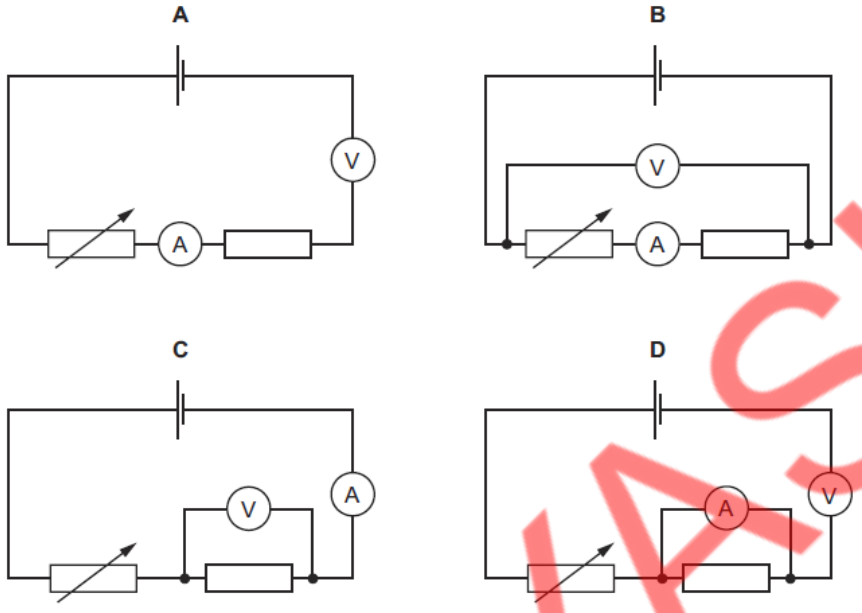
Q-45: An ammeter and a voltmeter are connected into the circuit shown when determining the power produced by a heater



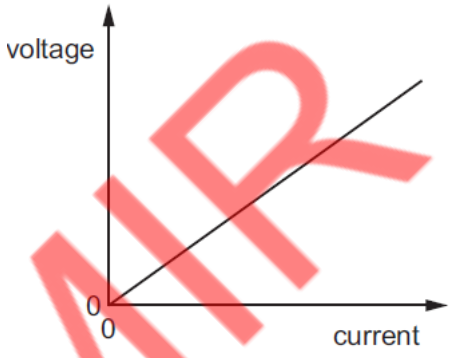
How are these meters connected, in relation to the heater?

	ammeter	voltmeter
A	in parallel	in parallel
B	in parallel	in series
C	in series	in parallel
D	in series	in series

Q-46: Which circuit is connected correctly to measure the current in a fixed resistor and the potential difference (p.d.) across the same resistor?



Q-47: The voltage / current graph for a metal wire is shown.



What does the gradient of this graph represent?

A the charge passing through the wire
B the e.m.f. of the battery connected to the wire
C the energy produced in the wire
D the resistance of the wire

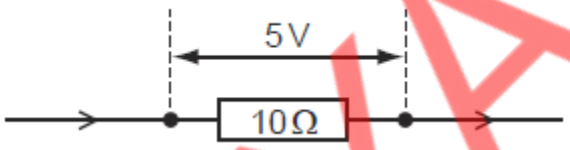
Q-48: Students are asked to describe an experiment to measure the resistance of a metallic conductor. Which description is correct?

A Connect an ammeter in parallel and a voltmeter in series with the conductor then use R =I/V
B Connect an ammeter in parallel and a voltmeter in series with the conductor then use R =V/I
C Connect a voltmeter in parallel and an ammeter in series with the conductor then use R =I/V
D Connect a voltmeter in parallel and an ammeter in series with the conductor then use R =V/I

Q-49: Sets of voltage-current readings are obtained for different electrical components. Which set of readings is for a 100 Ω resistor?

A	voltage / V	–3	–2	–1	0	+1	+2	+3
	current / mA	–30	–15	–5	0	+5	+15	+30
B	voltage / V	–3	–2	–1	0	+1	+2	+3
	current / mA	–30	–20	–10	0	+10	+20	+30
C	voltage / V	–3	–2	–1	0	+1	+2	+3
	current / mA	–60	–40	–20	0	+20	+40	+60
D	voltage / V	–3	–2	–1	0	+1	+2	+3
	current / mA	–60	–45	–30	0	+30	+45	+60

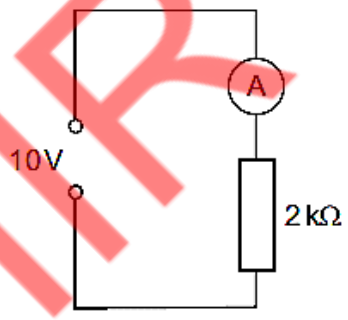
Q-50: The potential difference (p.d.) across a 10 Ω resistor is 5 V.



How much charge passes through the 10 Ω resistor in 30 seconds?

A 2 C **B** 15 C **C** 60 C **D** 1500 C

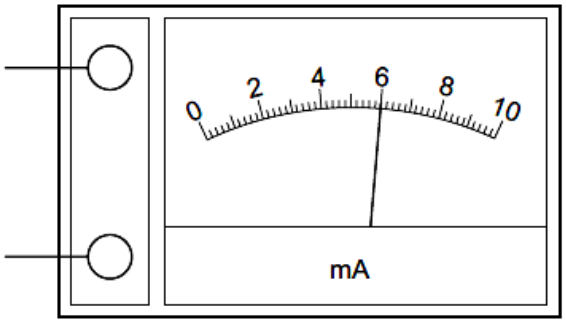
Q-51: The diagram shows an ammeter connected in a circuit.



What is the current in the ammeter?

A 5 mA **B** 20 mA **C** 0.2 A **D** 5 A

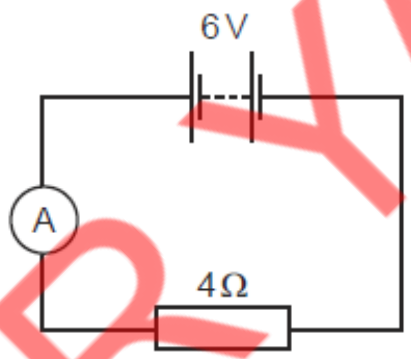
Q-52: An ammeter is used to measure the current in a 300 Ω resistor. The ammeter is shown below.



What is the potential difference across the resistor?

A 0.050 V **B** 1.8 V **C** 50 V **D** 1800 V

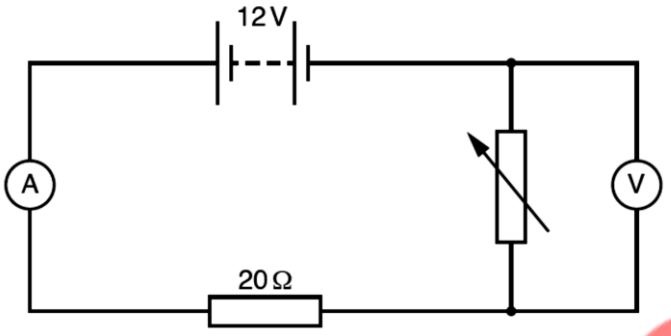
Q-53: A 6 V supply is connected in series with an ammeter and a 4 Ω resistor.



What is the reading on the ammeter?

A 0.67 A **B** 1.5 A **C** 10 A **D** 24 A

Q-54: Fig 1 shows a circuit that includes a battery of electromotive force (e.m.f.) 12 V.



The reading on the ammeter is 0.15 A.

a) Calculate the resistance of the circuit.

b) The variable resistor is adjusted so that its resistance decreases.

i) State what happens to the reading on the ammeter.

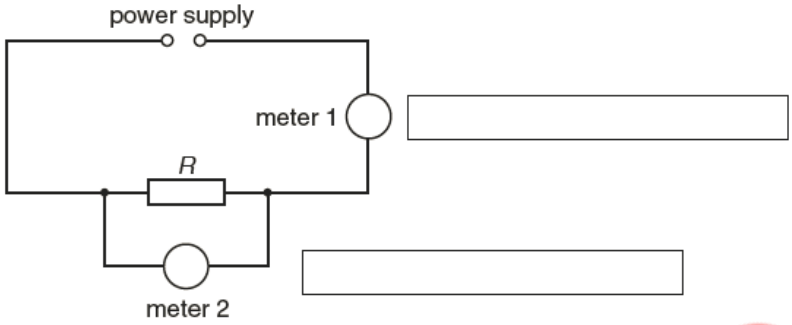
ii) State and explain what happens to the reading on the voltmeter.

c) The battery is formed from cells of electromotive force (e.m.f.) 1.5 V.

i) Explain, in terms of electrical energy, what is meant by an *electromotive force* (*e.m.f.*) *of 1.5 V*.

ii) State how many 1.5 V cells are connected in series to form the battery.

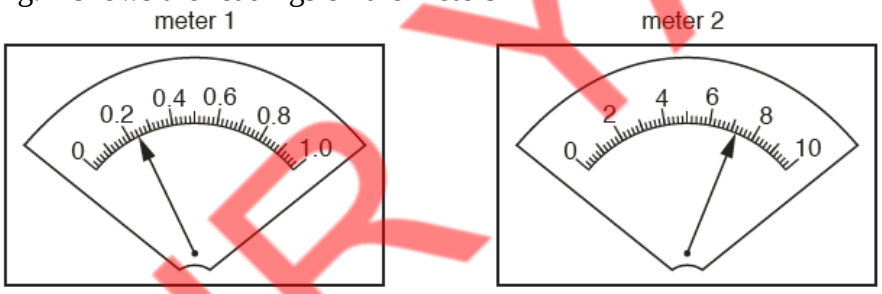
Q-55: A student determines the resistance R of a resistor. Fig. 1 shows the circuit used.



a) He uses two meters. In the boxes above, write the names of the meters.

b) State the quantities that are measured by these meters.

c) Fig. 2 shows the readings on the meters

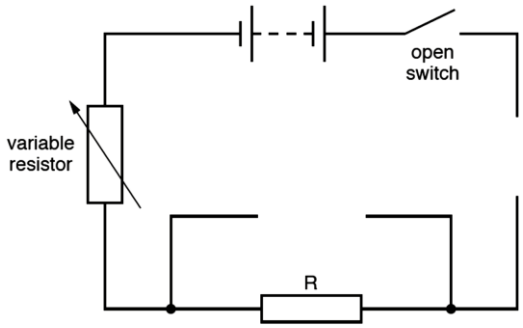


Record the readings below.

d) Use your readings to find the value of the resistance R using the equation
R = V / I

e) Describe a precaution the student should take to ensure that the value for R is accurate.

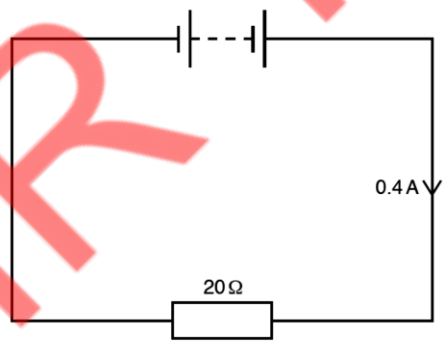
Q-56: a) A student does an experiment to determine the resistance of a fixed resistor, R. The student draws an incomplete diagram of the circuit, as shown in Fig. 1.



i) On Fig. 1, draw the missing circuit symbols.

ii) Describe how the student could use the circuit to determine a reliable value for the resistance of R.

b) Fig. 2 shows a 20 Ω resistor connected to a power supply.

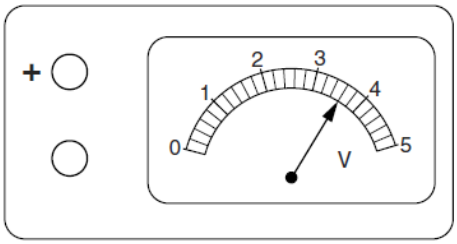


A second 20 Ω resistor is connected in series with the first. State and explain how this affects the current in the circuit.

Q-57: A student uses a voltmeter.

a) State the quantity measured with a voltmeter.

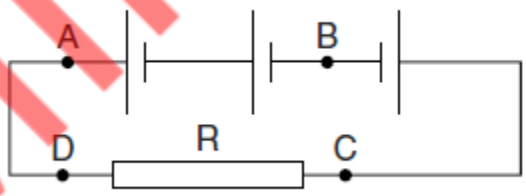
b) Fig. 1 shows an analogue voltmeter.



State the reading on the voltmeter.

c) A school has both digital and analogue voltmeters.
Suggest one advantage of using a digital voltmeter rather than an analogue voltmeter.

d) The student is asked to connect three 2.0 V cells in series with a resistor R of resistance 100 Ω. The student sets up the circuit as shown in Fig. 2.



i) State the reading on the voltmeter when it is connected across

1. AD, reading =

2. AB, reading =

3. DC. reading =

ii) R is replaced by a resistor of resistance 1000 Ω. There is no change in the reading on the voltmeter across DC. Explain this.

Q-58: a) Describe an experiment to measure the resistance of a resistor using an ammeter and a voltmeter.
Your account should include
• a circuit diagram,
• the readings taken,
• a method of taking a range of readings,
• a method of determining the resistance from the readings.

b) Describe one way to improve the accuracy of the result.

Resistivity

Q-59: A piece of wire is 40 cm long and has a diameter of 2.0 mm. Its resistance is 0.30 Ω. Which wire of the same material has a resistance of 0.15 Ω?

	length / cm	diameter / mm
A	20	1.0
B	20	4.0
C	80	1.0
D	80	4.0

Q-60: Copper wire is available in fixed lengths but in various diameters *d*. Each diameter has a different resistance *R*. Which relationship between *R* and *d* is correct?

A *R* is directly proportional to *d*.
B *R* is directly proportional to d^2.
C *R* is inversely proportional to *d*.
D *R* is inversely proportional to d^2.

Q-61: Four wires are made of the same metal.
Which wire has the greatest resistance?

A a 100 cm long wire with a diameter of 3.0 mm
B a 100 cm long wire with a diameter of 6.0 mm
C a 10 cm long wire with a diameter of 3.0 mm
D a 10 cm long wire with a diameter of 6.0 mm

Q-62: Four wires made of the same metal have different lengths and different diameters.
Which wire has the lowest resistance?

	length	diameter
A	long	large
B	long	small
C	short	large
D	short	small

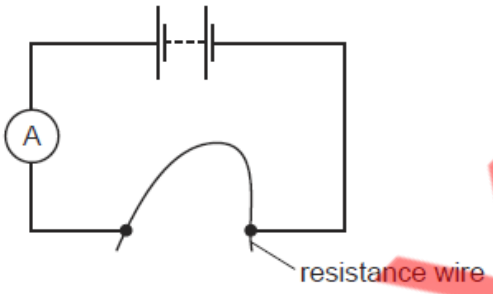
Q-63: A piece of wire has a resistance of 16 Ω. Another wire made from the same metal has four times the length and twice the cross-sectional area. What is the resistance of the wire?

A 8 Ω **B** 32 Ω **C** 96 Ω **D** 128 Ω

Q-64: A wire of length 0.50 m and cross-sectional area 1.0×10^{-6} m^2 has a resistance of 0.75 Ω. Another wire of the same material has a length of 2.0 m and a cross-sectional area of $0.50 \times 10^{-6} m^2$. What is the resistance of the longer wire?

A 0.094 Ω **B** 0.38 Ω **C** 1.5 Ω **D** 6.0 Ω

Q-65: A length of resistance wire is used as a resistor in a simple circuit



Four separate changes are made to the wire.
Which change will not reduce the value of the resistance of the wire?

A It is covered in an insulating sleeve.
B Its cross-sectional area is increased.
C Its length is decreased.
D Its temperature is decreased.

Q-66: Which changes both cause a decrease in the resistance of a copper wire?

	size of wire	temperature of wire
A	decrease in length	lower
B	increase in length	lower
C	decrease in thickness	higher
D	increase in thickness	higher

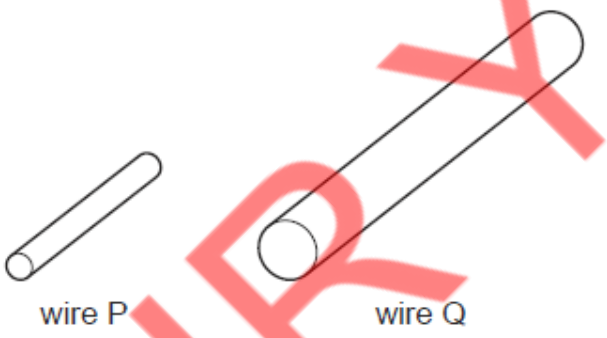
Q-67: A piece of wire has a resistance of 16 Ω. The wire is 20 cm long and has a cross-sectional area of 2.0 $mm^{2.}$ Which wire of the same material has a resistance of 8.0 Ω?

	length / cm	cross-sectional area / mm^2
A	10	1.0
B	10	4.0
C	20	1.0
D	20	4.0

Q-68: A cylinder of conducting material has resistance R. A second cylinder of the same material is twice as long but has half the cross-sectional area. What is the resistance of the second cylinder?

A R/2 **B** R **C** 2R **D** 4R

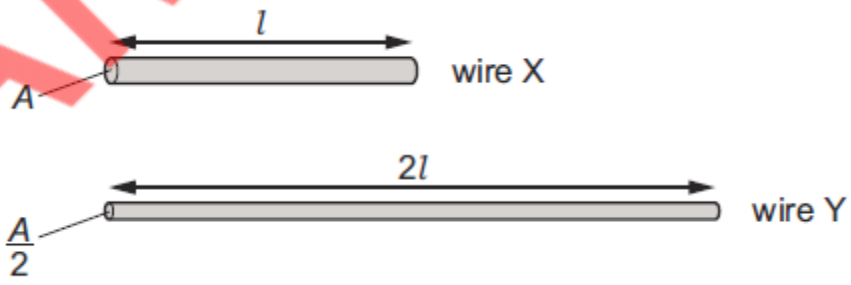
Q-69: The resistance of a cylindrical wire P is 80 Ω. A second wire Q is made from the same material. The cross-sectional area of Q is four times that of P. The length of Q is twice the length of P.



What is the resistance of Q?

A 10 Ω **B** 40 Ω **C** 160 Ω **D** 640 Ω

Q-70: A copper wire X has resistance R. Another copper wire Y has twice the length and half the crosssectional area of X.



What is the resistance of Y?

A R/2 **B** R **C** 2R **D** 4R

Q-71: a) State, in terms of their structure, why metals are good conductors of electricity.

b) A cylindrical metal wire W_1, of length l and cross-sectional area A, has a resistance of 16 Ω. A second cylindrical wire W_2 having length $l/2$ and cross-sectional area 2 A, is made from the same metal.
Determine

i) the resistance of W_2,

ii) the effective resistance of W_1 and W_2 when connected in parallel.

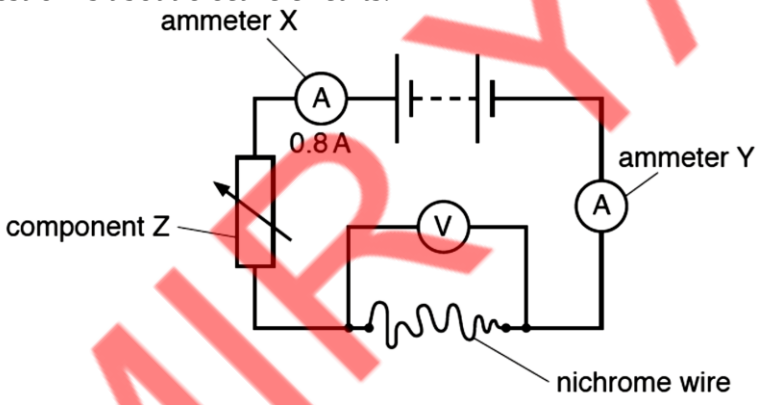
c) The parallel pair of resistors in **(b)(ii)** is connected to a battery that is made from three cells in series, each of electromotive force (e.m.f.) E. There is a current in each resistor.

i) State the e.m.f. of the battery.

ii) The current in the battery is I_B, the current in W_1 is I_1 and the current in W_2 is I_2. Place a tick (3) in **one** box to indicate how these three currents are related.

- ☐ $I_1 > I_2 > I_B$
- ☐ $I_1 > I_B > I_2$
- ☐ $I_2 > I_1 > I_B$
- ☐ $I_2 > I_B > I_1$
- ☐ $I_B > I_1 > I_2$
- ☐ $I_B > I_2 > I_1$
- ☐ $I_1 = I_2 = I_B$

Q-72: Fig. 1 shows a circuit used by a student to test a metal wire made of nichrome. This question is about electric circuits.



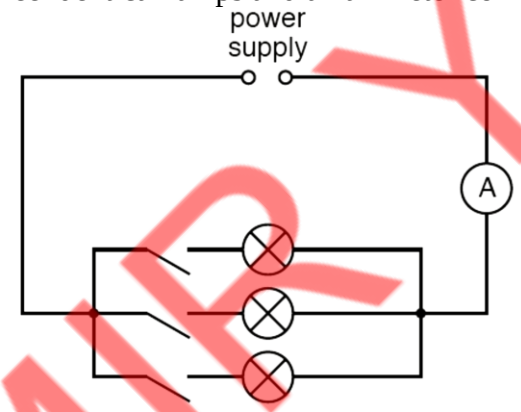
a) State the name of component Z.

b) The current reading on ammeter X is 0.8 A. State the reading on ammeter Y.

c) The current in the nichrome wire is 0.8 A. The potential difference (p.d.) across the nichrome wire is 4.5 V. Calculate the resistance of the nichrome wire.

d) The student tests a different nichrome wire, which is thicker than the wire in **(c)**, but of the same length. When testing this wire, the current in the wire is different from the value given in **(c)**. State and explain the difference in current.

Q-73: Fig. 1 shows three identical lamps and an ammeter connected to a power supply.



The switches are closed. Each lamp is rated at 60 W and operates at its normal working voltage of 110 V.

a) Calculate:

i) the current in each lamp

ii) the current in the ammeter

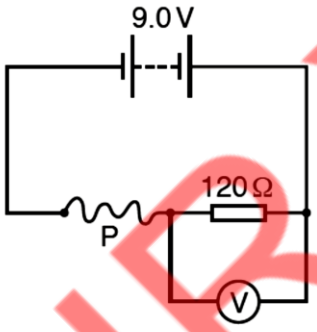
iii) the voltage of the power supply.

b) **i)** Calculate the resistance of the filament of one of the lamps when working normally.

ii) Another lamp X has a filament with twice the resistance of each lamp in the circuit of Fig. 7.1. The material and the temperature of the filament in lamp X is the same as the filaments in the lamps in Fig. 7.1.
In Table 7.1, tick any box in the right-hand column that shows a possible difference between the filament of lamp X and a filament of one of the lamps in the circuit.

X has half the length	
X has twice the length	
X has one quarter the area of cross-section	
X has half the area of cross-section	
X has two times the area of cross-section	
X has four times the area of cross-section	

Q-74: A 9.0 V battery is connected to a 120 Ω resistor in series with wire P.
Fig. 1 shows a voltmeter connected across the 120 Ω resistor.



a) State the energy changes that are taking place in the circuit.

b) The reading on the voltmeter is 2.4 V.
Calculate:

i) the current in the 120 Ω resistor

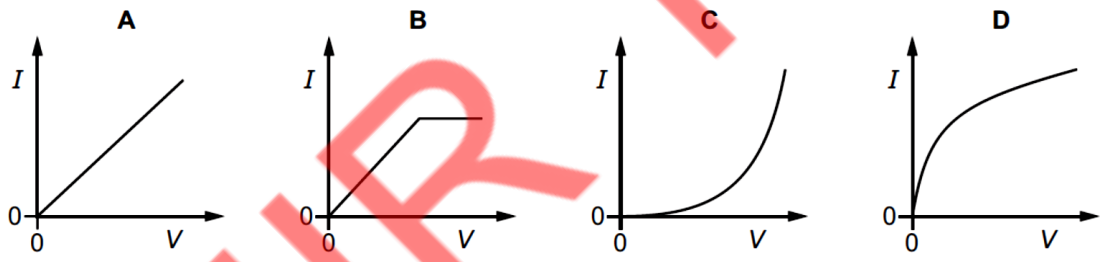
ii) the potential difference (p.d.) across wire P

iii) the resistance of wire P.

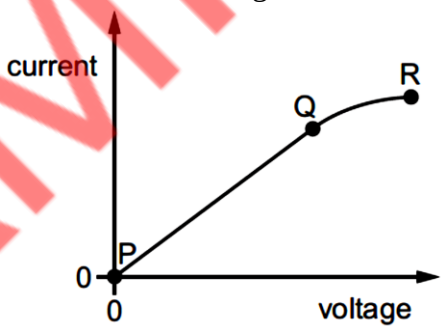
c) Wire P has a diameter d and a length l. A second piece of wire Q is made of the same material as P. The diameter of wire Q is $0.50 \times d$ and its length is $5.0 \times l$. Calculate the resistance of wire Q.

Ohm's Law

Q-75: Which graph shows the current–voltage characteristic for a filament lamp?



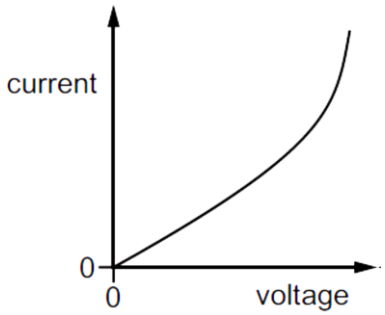
Q-76: The graph shows the current–voltage characteristic for a conductor.



Where on the graph can Ohm's law be applied to the conductor?

A at Q only **B** between P and Q
C between P and R **D** between Q and R

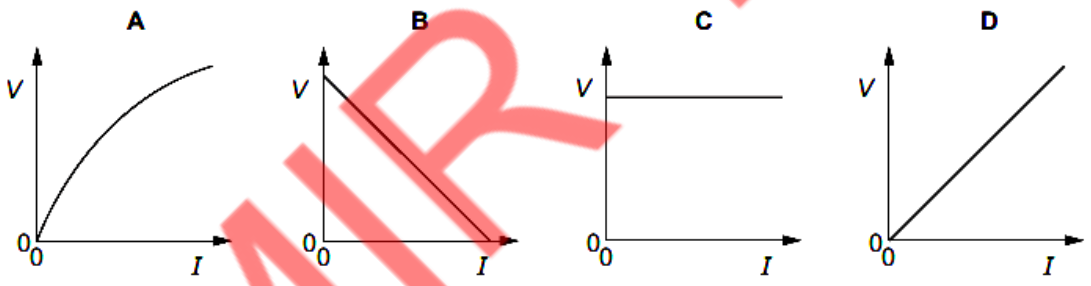
Q-77: The graph shows the current–voltage relationship for a circuit component X.



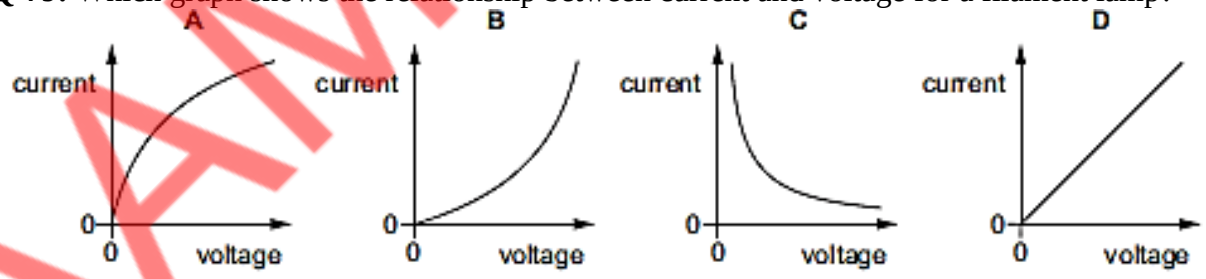
What happens to the resistance of X and what happens to the temperature of X as the voltage increases?

	resistance of X	temperature of X
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

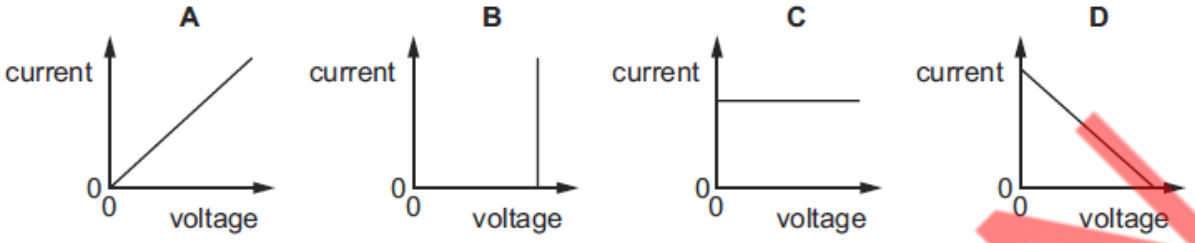
Q-78: A thermistor warms up as the current in it increases. Which graph shows how the voltage *V* across the thermistor changes as the current *I* through it is increased?



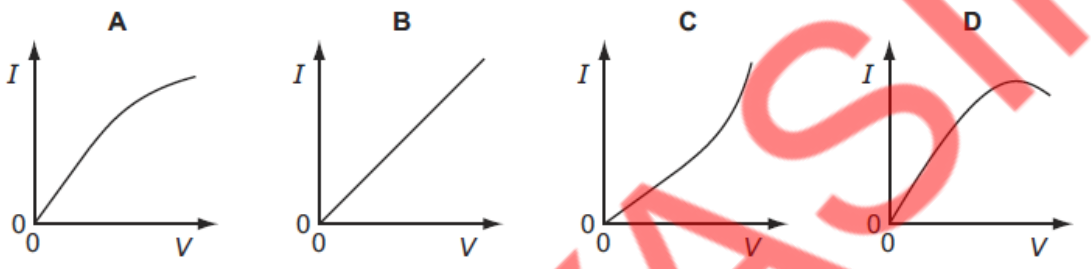
Q-79: Which graph shows the relationship between current and voltage for a filament lamp?



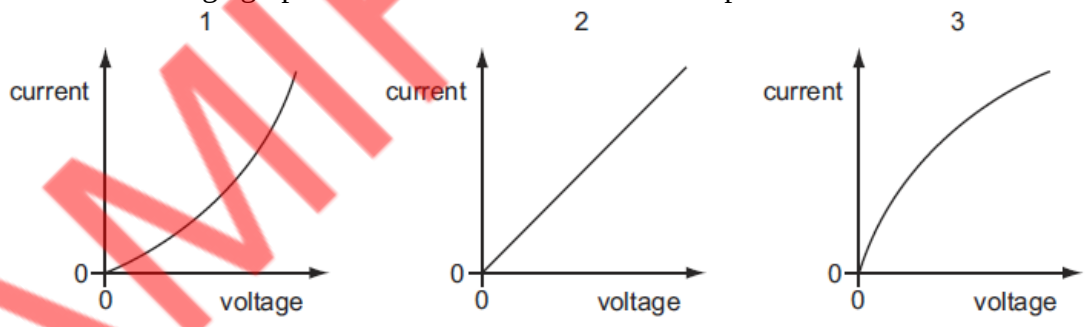
Q-80: The voltage across a resistor of fixed resistance changes. Which graph shows how the current in the resistor changes with the voltage?



Q-81: Which is the current / voltage (I / V) graph of a filament lamp?



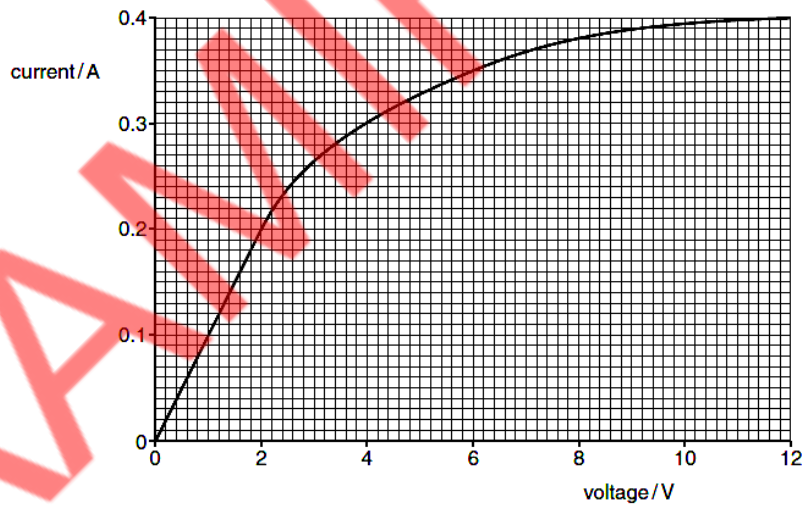
Q-82: The current / voltage graphs are for different electrical components.



Which graph is for a resistor at constant temperature and which is for a filament lamp?

	resistor	lamp
A	1	2
B	2	1
C	2	3
D	3	2

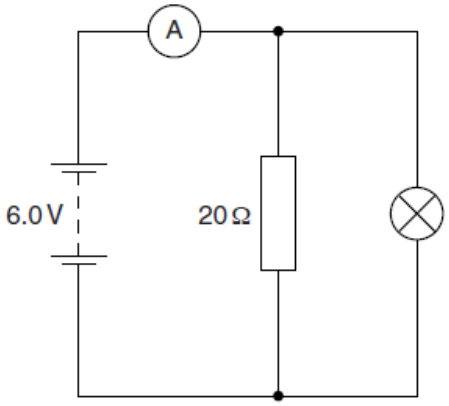
Q-83: Fig. 1 shows the current-voltage graph for a filament lamp



a) **i)** State the range of voltages where the resistance increases.

ii) State why the resistance of the lamp increases as the voltage increases.

b) The filament lamp is connected in the circuit shown in Fig. 2



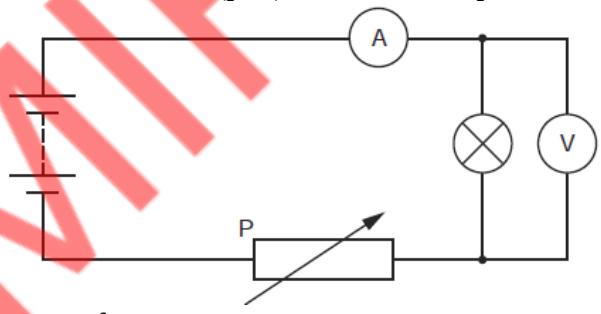
There are currents in the lamp, the 20 resistor and the ammeter.

i) State what is meant by an electric current.

ii) Use Fig. 1 to determine the current in the filament lamp.

iii) Determine the current in the ammeter.

Q-84: Fig. 1 shows a circuit used in an experiment to measure the current in a lamp for different values of the potential difference (p.d.) across the lamp.



a) State the name of component P.

b) On the axes below, sketch a graph of current against p.d. for a filament lamp.

c) **i)** State how the resistance of the lamp changes as the p.d. increases.

ii) Explain how the graph in **(b)** shows the change you have described in **(c)(i)**

Answers

Q-1: A **Q-2: B** **Q-3: A** **Q-4: C** **Q-5: B** **Q-6: D** **Q-7: D**

Q-8: A **Q-9: D** **Q-10: A** **Q-11: A** **Q-12: A** **Q-13: B**

Q-14: a) **anti-clockwise arrow labelled (conventional) current somewhere in circuit**
electron (flow) arrow opposite to (conventional) current

b) **Q = It in any form or (Q =) It OR 13 × 1**
(Q = It =) 13 × 1 (= 13 C)
(n = 13 / 1.6 × 10^{-19} =) 8.1 × 10^{19}

Q-15: a) **i)** **no delocalised / free / mobile electrons in an insulator or electrons fixed (in place) / tightly bound in an insulator B1**

ii) **no charge flows / current in doctor or doctor does not receive an electric shock which might prove fatal / kill / injure / harm doctor or so charge flows / current in patient**

b) electrons move (from one contact to the other) negative contact gains electrons / negative charges and positive contact loses electrons / negative charges

c) (*I* =) *Q* / *t* or $9.1 \times 10^{-3} / 6.5 \times 10^{-4}$ =14 A

Q-16: a) current

b) any one from
(low resistance) does not decrease current (much)
high resistance would decrease the current
(low resistance) ammeter reads a large(r) value (than high R ammeter)
current is high(er)
very little p.d. across it

c) 0.67 A

d) any one from
no parallax error
needle does not stick
easier to read / measure (current)
easier to change range
lower resistance

e) **i)** current is same in series circuit / no junctions / single loop

ii) any one from
meters not identical / exactly the same
zero error in meter
different calibration / calibration error

Q-17: C **Q-18: B** **Q-19: B** **Q-20: B** **Q-21: C** **Q-22: D** **Q-23: B**

Q-24: D **Q-25: A** **Q-26: C** **Q-27: C** **Q-28: B** **Q-29: B**

Q-30: a) (*R* =) *V* ÷ *I* OR 12 ÷ 0.15 80 Ω A1

b) **i)** increases

ii) (voltmeter reading) decreases OR less p.d. across variable resistor
more p.d. across 20Ω/fixed resistor

c) **i)** 1.5 J of (electrical) energy supplied in driving charge around the circuit energy per unit charge OR per coulomb

ii) 8

Q-31: D **Q-32: A** **Q-33: A** **Q-34: C** **Q-35: C** **Q-36: C** **Q-37:C**

Q-38: a) 7.5 V

b) **i)** 1 / Rp = 1 / R1 + 1 / R2 OR (Rp =) R1R2 / (R1 + R2) in any form
(Rp =) 1.2 (Ω)
3.2 Ω

ii) (V =) IR in any form
4.1 V

Q-39: a) i) energy to drive charge around a circuit or terminal p.d. on open circuit energy to drive unit charge around a circuit or energy / charge

ii) lasts longer or lower internal resistance or can replace a cell without switching off or continues to work if one cell is flat ignore more current

(not greater e.m.f. / voltage)

b) i) 4.0 Ω

ii) (1 / R_{tot} =)1 / R_1 + 1 / R_2 or1 / 3 + 1/ X or product /sum or (3 × X)/(3 + X) or

1/X=1/2 – 1/3

6.0 Ω

c) i) (I =) V / R or 2.0 / 4.0

0.50 A

ii) (from) 0 and (to) 0.50 to 5.0 A

d) $I_2 = I_3 + I_X$

e) i) 1.0 V

ii) 1.0 V

f) i) temperature decreases

resistance decreases

ii) greater than 0.75 A (e.c.f. resistance increases in (f)(i))

Q-40: C **Q-41: D** **Q-42: B** **Q-43: B** **Q-44: B** **Q-45: C** **Q-46: C**

Q-47: D **Q-48: D** **Q-49: B** **Q-50: B** **Q-51: A** **Q-52: B** **Q-53: B**

Q-54: a) (*R* =) *V* ÷ *I* OR 12 ÷ 0.15 = 80 Ω

b) i) increases

ii) (voltmeter reading) decreases OR less p.d. across variable resistor

more p.d. across 20Ω/fixed resistor

c) i) 1.5 J of (electrical) energy supplied in driving charge around the circuit

energy per unit charge OR per coulomb

ii) 8

Q-55: a) top box – ammeter

bottom box – voltmeter

b) meter 1 – current

meter 2 – voltage / p.d / emf

c) meter 1 = 0.24 A

meter 2 = 7.2 V

d) R = 30 ohms

e) check zero error / tap to avoid sticking / switch off to prevent overheating / parallax in reading scale / tight connections any other sensible precaution.

Q-56: a) i) correct symbols for:
ammeter
voltmeter
ammeter in series OR voltmeter in parallel

ii) Any five from:
close switch
adjust / change variable resistor to give current in resistor / reading on ammeter
measure / record (pair of) readings on ammeter and voltmeter
description of any check for reliability
idea of adjusting variable resistor to give range of readings
plot a graph
suitable spacing of readings e.g. every 0.05A or 0.1 A
use of V= IR or R = V / I
repeat AND calculate average (value for R)

b) (circuit) resistance increases
BUT (circuit) resistance doubles / becomes 40 Ω (award two marks as assumes previous (1st) marking point) (current) decreases
BUT(current) halves / becomes 0.2 A (award two marks as assumes previous (3rd) marking point)

Q-57: a) emf / potential difference / voltage

b) 3.6 V cao

c) any one from
no parallax error
needle does not stick
easier to read / measure (current)
easier to change range
lower resistance

d) i) 1. 0
2. 4 V
3. 2 V

ii) depends only on the cells / pd or voltage supplied or R increased and current decreased (so IR stays same)

Q-58: a) circuit containing power supply, resistor, ammeter in series
voltmeter across resistor

means of varying current, e.g.
variable resistor
change additional resistor
variable power supply
change/add cells
use of potentiometer
use of V = IR and average
I–V graph and find R

b) **can be credited in (a) if seen**
sensible suggestion, e.g.
check zero on meters
contacts tight / clean wires
avoid parallax in reading meters
keep current low
switch off between readings
use more sensitive meter

Q-59: A **Q-60: D** **Q-61: A** **Q-62: C** **Q-63: B** **Q-64: D** **Q-65: A**

Q-66: A **Q-67: D** **Q-68: D** **Q-69: B** **Q-70:D**

Q-71: a) **(Metals) contain free/mobile electrons/delocalised electrons**

b) **i)** **R α L and R α 1 ÷ A OR R α L ÷ A OR R = 16 × ½ ÷ 2 OR R = 16 ÷ 4**
4.0 Ω

ii) **1 ÷ R = (1 ÷ R1) + (1 ÷ R2) OR R = (R1 × R2) ÷ (R1 + R2) OR (1 ÷ R) = (1 ÷ 4) + (1 ÷ 16) OR (4 × 16) ÷ (4 + 16)**
3.2 Ω

c) **i)** **3E or 3 × E**

ii) **$I_B > I_2 > I_1$ (6th box ticked)**

Q-72: a) **variable resistor or rheostat**

b) **0.8 (A)**

c) **V = IR OR (R =) V ÷ I**
4.5 ÷ 0.8
5.6(25)

d) **(current) increases OR larger**
(as new/thicker wire has) less resistance

Q-73: a) **i)** ***P* = *I V* in any form OR (*I* =) *P* / *V***
(*I* = 60 / 110 =) 0.55 A

ii) **(*I* =) 1.6 A**

iii) **110 V**

b) **i)** ***I* = *V* / *R* in any form OR (*R* =) *V* / *I***
OR (*R* =) V^2 / *P* OR (*R*=) *P* / I^2
(*R* = 110 / 0.55 =) 200 Ω

ii) **2nd box (twice the length)**

4th box (half the area of cross-section)

Q-74: a) **from chemical (energy) to thermal / heat (energy)**
from chemical (energy) to thermal / heat (energy) and as a result of electrical working

b) **i)** **(I =) V / R or 2.4 / 120 = 0.020 A**
ii) **6.6 V**
iii) **330 Ω**

c) **multiplication by 5.0 or $R \propto l$**
multiplication by 2.0 / 4.0 or division by 0.50 / 0.25 or $R \propto 1 / A$ or $R \propto 1 / r$ 2
multiplication by 4.0 or division by 0.25 or 20 × 330
6600 Ω

Q-75: D **Q-76: B** **Q-77: B** **Q-78: A** **Q-79: A** **Q-80: A** **Q-81: A**

Q-82: C

Q-83: a) **i)** **2 to 2.1 (V) to any value between 11 and 12 (V) or above 2/2.1(V)**
ii) **temperature increases / gets hotter**

b) **i)** **(rate of) flow of charge/electrons**
ii) **0.35 A cao**
iii) **(I=) V/R algebraic**
or 6/20
or 6/0.35
0.3(0) (A)
or $1/R_T = 1/20 + 1/17.1$
or (R_T =) 9.2 (Ω) seen
0.65 A

Q-84: a) **ammeter in series with supply // ammeters in series with A and in series with B & C**
A across cell with no switch (condone closed switch) not
B and C in series with switch (closed or open) and cell

b) **i)** **(R =) V/I in any form numerical or algebraic, e.g. 8/50, 8/0.05**
160 Ω
ii) **50 mA // 0.05(0) A**