Current Electricity – 2023 Nov AS Physics 9702

1. Nov/2023/Paper_ 9702/11/No.30

The current I in a conductor is given by the equation shown.

$$I = Anvq$$

What does the letter n represent in this equation?

A charge carried per charge carrier

B number of charge carriers per unit area

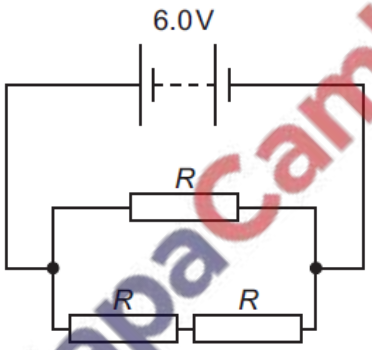
C number of charge carriers per unit volume

D total mass of charge carriers per unit volume

2. Nov/2023/Paper_ 9702/11/No.31

In the circuit shown, the battery has an electromotive force (e.m.f.) of 6.0 V and negligible internal resistance.

The three resistors each have resistance R.



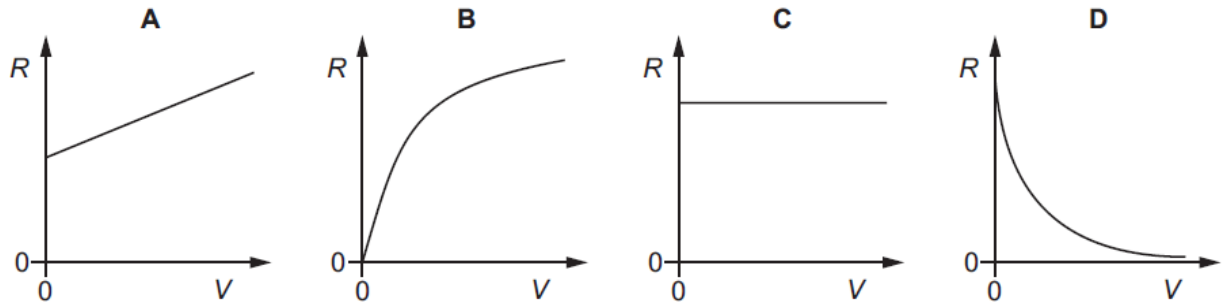
The total power dissipated in the resistor network is 24 W.

What is the value of R?

A 0.50 Ω **B** 1.0 Ω **C** 1.5 Ω **D** 2.3 Ω

3. Nov/2023/Paper_ 9702/11/No.32

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



4. Nov/2023/Paper_ 9702/11/No.33

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

What is the resistivity of the putty?

A 0.033 Ωm **B** 0.10 Ωm **C** 0.42 Ωm **D** 5.2 Ωm

5. Nov/2023/Paper_ 9702/11/No.34

Which statement about the electromotive force (e.m.f.) of a cell is **always** correct?

A The e.m.f. is the energy converted from electrical to other forms in the cell.

B The e.m.f. is the energy provided by the cell per unit charge passing through it.

C The e.m.f. is the potential difference across the internal resistance of the cell.

D The e.m.f. is the potential difference across the terminals of the cell.

6. Nov/2023/Paper_ 9702/11/No.35

Kirchhoff's first and second laws are a consequence of the conservation of which quantities?

A charge and energy

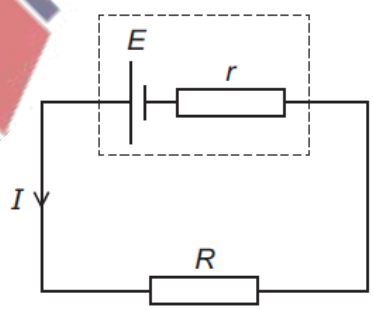
B charge and resistance

C mass and energy

D mass and resistance

7. Nov/2023/Paper_ 9702/11/No.36

A circuit contains a cell of electromotive force E and internal resistance r connected to a resistor of resistance R. The current in the circuit is I.

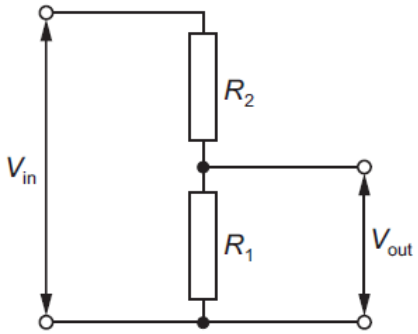


Which equation is correct?

A $E - Ir = IR$ **B** $E = Ir - IR$ **C** $E + Ir = IR$ **D** $E = IR$

8. Nov/2023/Paper_ 9702/11/No.37

A potential divider consists of two resistors of resistances R_1 and R_2 connected in series across a source of potential difference (p.d.) V_{in}. The p.d. across R_1 is V_{out}.

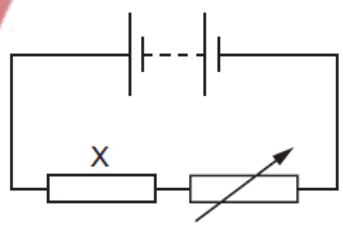


Which changes to R_1 and R_2 will increase the value of V_{out}?

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

9. Nov/2023/Paper_ 9702/12/No.31

In the circuit shown, a fixed resistor X is connected in series with a battery and a variable resistor.



The power dissipated in resistor X is 7.2 W when a current of 3.0 A passes through it.

The variable resistor is adjusted so that the power dissipated in X increases by 50%.

What is the new current in the circuit?

A 2.4 A **B** 3.7 A **C** 4.5 A **D** 14 A

10. Nov/2023/Paper_ 9702/12/No.32

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

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

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

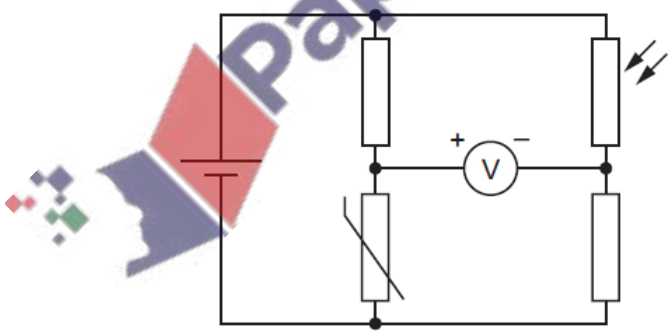
B It is directly proportional to l and inversely proportional to d^2.

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

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

11. Nov/2023/Paper_ 9702/12/No.33

A student sets up a circuit. The circuit diagram shows how the positive and negative terminals of a voltmeter are connected to the circuit. The voltmeter has an initial reading that is positive.

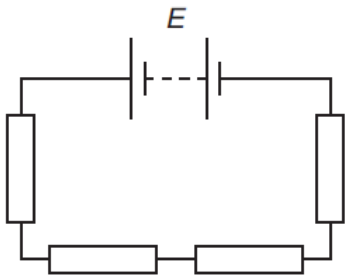


Which changes, if any, in temperature and light intensity would cause the voltmeter reading to **decrease**?

	temperature	light intensity
A	increase	increase
B	no change	decrease
C	decrease	no change
D	decrease	decrease

12. Nov/2023/Paper_ 9702/12/No.34

Some resistors and a battery of electromotive force (e.m.f.) E and negligible internal resistance are connected in series, as shown.



Which statement is correct?

A The e.m.f. across each resistor equals the potential difference across the battery.

B The potential difference across each resistor equals the e.m.f. E of the battery.

C The sum of the e.m.f.s across the resistors equals the potential difference across the battery.

D The sum of the potential differences across the resistors equals the e.m.f. E of the battery.

13. Nov/2023/Paper_ 9702/12/No.35

Kirchhoff's first law is a consequence of the conservation of which physical quantity?

A charge

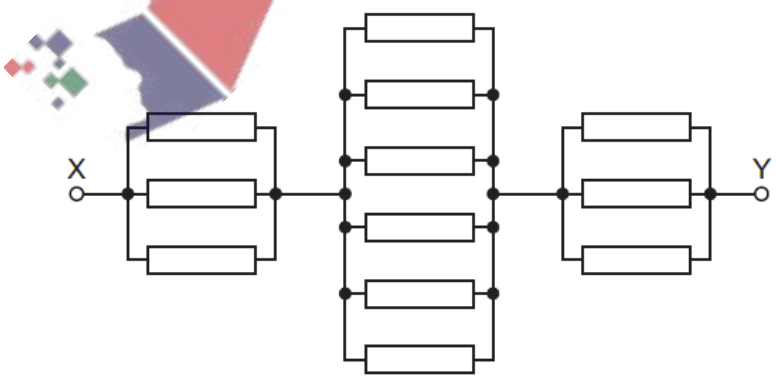
B energy

C linear momentum

D potential difference

14. Nov/2023/Paper_ 9702/12/No.36

The diagram shows a network of resistors. Each resistor has a resistance of 6.0Ω.

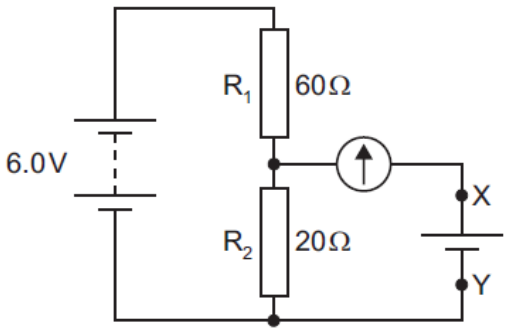


What is the total resistance of the network between points X and Y?

A 3.0Ω **B** 5.0Ω **C** 7.2Ω **D** 18Ω

15. Nov/2023/Paper_ 9702/12/No.37

In the circuit shown, a battery of negligible internal resistance is connected in series with a pair of fixed resistors R_1 and R_2.



The circuit is to be used to test whether the electromotive force (e.m.f.) of a particular cell is 1.5 V. The cell is connected between terminals X and Y in parallel with R_2 and in series with a galvanometer.

Which statement about the test is correct?

A Any non-zero reading on the galvanometer means the cell has an e.m.f. of 1.5 V.

B The battery does not need to have an e.m.f. of 6.0 V.

C The cell may be connected either way round between X and Y.

D The galvanometer does not need a scale calibrated in amperes.

16. Nov/2023/Paper_ 9702/13/No.2

In an electric circuit, an ammeter reads 2 μA.

In a second circuit, the ammeter reads 1 mA.

How many times larger is the current in the second circuit compared with the current in the first circuit?

A 500 **B** 5000 **C** 500 000 **D** 5 000 000

17. Nov/2023/Paper_ 9702/13/No.30

What could **not** be used to create an electric current?

A alpha-particles

B beta-particles

C neutrons

D protons

18. Nov/2023/Paper_ 9702/13/No.31

What is the definition of the potential difference (p.d.) across a component?

A the energy transferred per unit charge

B the energy transferred per unit current

C the power transferred per unit charge

D the power transferred per unit current

19. Nov/2023/Paper_ 9702/13/No.32

The resistance of a filament lamp increases as the current in it increases.

What is the reason for this?

A The charge of each charge carrier increases.

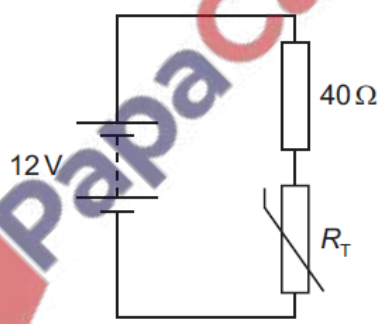
B The potential difference across the filament decreases.

C The power dissipated by the filament decreases.

D The temperature of the filament increases.

20. Nov/2023/Paper_ 9702/13/No.33

A battery of electromotive force (e.m.f.) 12 V and negligible internal resistance is connected to a fixed resistor of resistance 40 Ω and a thermistor of resistance R_T, as shown.



Initially, the temperature of the thermistor is 15 °C and the current in the circuit is 0.10 A.

The temperature of the thermistor then changes, which causes the current to increase to 0.12 A.

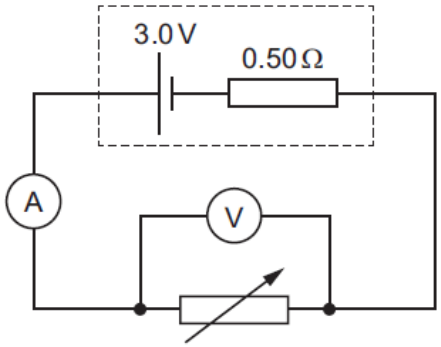
How does the temperature of the thermistor change and what is R_T at the new temperature?

	temperature of thermistor	R_T at new temperature / Ω
A	increases	60
B	decreases	60
C	increases	100
D	decreases	100

21. Nov/2023/Paper_ 9702/13/No.34

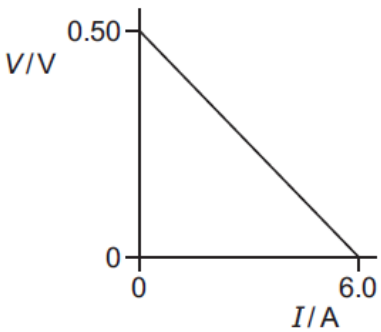
A cell of electromotive force (e.m.f.) 3.0 V and internal resistance 0.50 Ω is connected to a variable resistor, a voltmeter and an ammeter, as shown. The resistance of the variable resistor is varied.

The reading on the ammeter I and the reading on the voltmeter V are recorded.

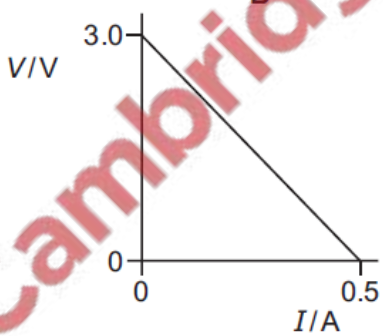


Which graph shows how V varies with I?

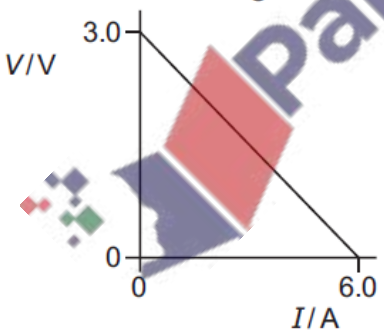
A



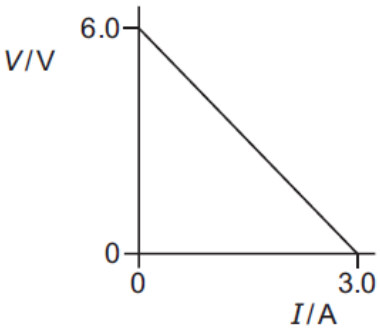
B



C

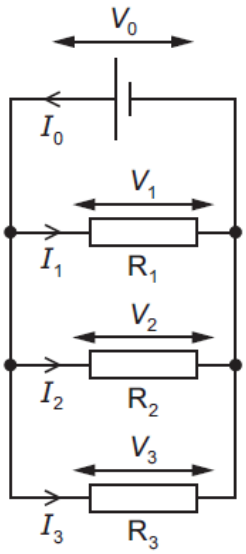


D



22. Nov/2023/Paper_ 9702/13/No.35

Three resistors, R_1, R_2 and R_3, are connected in parallel to a cell. The currents in the resistors are I_1, I_2 and I_3. The potential differences across the resistors are V_1, V_2 and V_3. The current in the cell is I_0. The potential difference across the cell is V_0, as shown.



Which equation can be obtained by applying Kirchhoff's second law to the circuit?

A $I_0 = I_1 = I_2 = I_3$

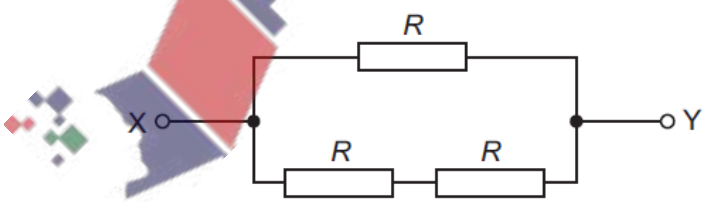
B $I_0 = I_1 + I_2 + I_3$

C $V_0 = V_1 = V_2 = V_3$

D $V_0 = V_1 + V_2 + V_3$

23. Nov/2023/Paper_ 9702/13/No.36

Three resistors, each of resistance R, are connected in a network, as shown.



The total resistance between points X and Y is 8.0 Ω.

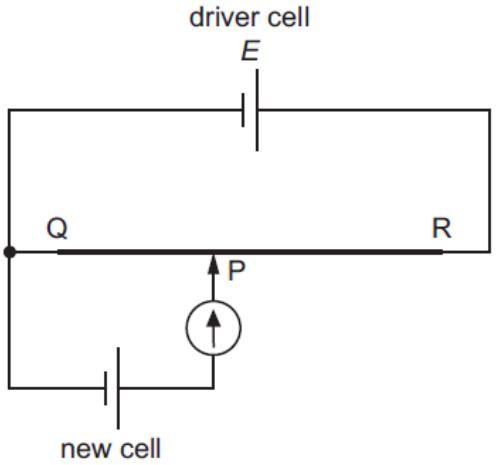
What is the value of R?

A 2.7 Ω **B** 4.0 Ω **C** 5.3 Ω **D** 12 Ω

24. Nov/2023/Paper_ 9702/13/No.37

A potentiometer and a driver cell of electromotive force (e.m.f.) *E* are used to measure the e.m.f. of a new cell.

A sliding contact at P is moved along a resistance wire QR until the reading on the galvanometer is zero.



What is an essential requirement for the e.m.f. of the new cell to be measured accurately?

A The e.m.f. of the driver cell must be less than the e.m.f. of the new cell.

B The galvanometer must have a large resistance.

C The internal resistance of the new cell must be zero.

D The resistance per unit length of the wire QR must be constant.

25. Nov/2023/Paper_ 9702/21/No.6

A battery is connected in a circuit with a light-dependent resistor (LDR), two fixed resistors and a voltmeter, as shown in Fig. 6.1.

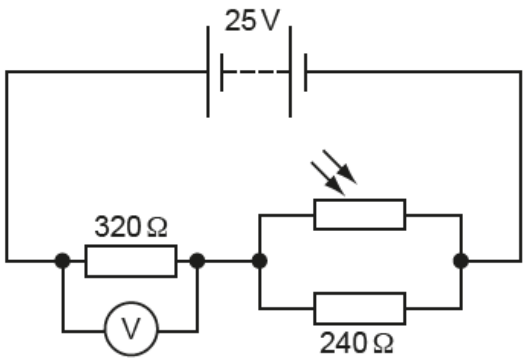


Fig. 6.1

The battery has an electromotive force (e.m.f.) of 25 V and negligible internal resistance.
The resistors have resistances of 320 Ω and 240 Ω.

(a) The voltmeter displays a reading of 16 V.

(i) Show that the current in the battery is 0.050 A.

[1]

(ii) Calculate the resistance of the LDR.

resistance = ... Ω [3]

(iii) Determine the ratio

$$\frac{\text{power dissipated in the LDR}}{\text{power dissipated in the } 240\,\Omega \text{ resistor}}.$$

ratio = ... [2]

(b) The intensity of the light incident on the LDR increases.

State and explain what happens to the voltmeter reading.

.....

.....

.....

..... [3]

[Total: 9]

26. Nov/2023/Paper_ 9702/22/No.6

(a) A metal wire has a resistance per unit length of $0.92\,\Omega\,m^{-1}$. The wire has a uniform cross-sectional area of $5.3 \times 10^{-7}\,m^2$.

Calculate the resistivity of the metal of the wire.

resistivity = ... Ω m [2]

(b) A battery of electromotive force (e.m.f.) E and negligible internal resistance is connected in series with a fixed resistor and a light-dependent resistor (LDR), as shown in Fig. 6.1.

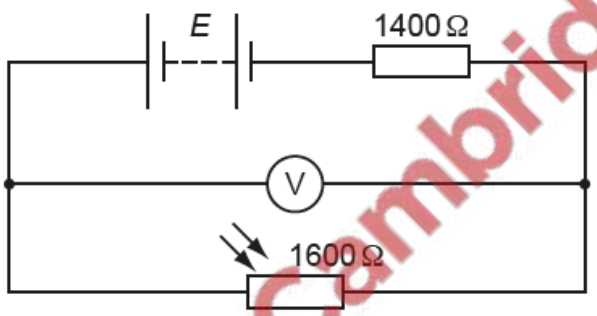


Fig. 6.1

The resistance of the fixed resistor is 1400 Ω. The intensity of the light illuminating the LDR causes it to have a resistance of 1600 Ω. A voltmeter connected across the LDR reads 6.4 V.

(i) Show that the current in the LDR is 4.0×10^{-3} A.

[1]

(ii) Calculate the number of free electrons passing through the LDR in a time of 3.2 minutes.

number of free electrons = ... [2]

(iii) Calculate the e.m.f. E.

E = ... V [2]

(iv) Determine the ratio

$$\frac{\text{power dissipated in LDR}}{\text{power dissipated in fixed resistor}}.$$

ratio = ... [2]

(c) The environmental conditions change causing a decrease in the resistance of the LDR in **(b)**. The temperature of the environment does not change.

State whether there is a decrease, increase or no change to:

(i) the intensity of the light illuminating the LDR

..... [1]

(ii) the current in the battery

..... [1]

(iii) the reading of the voltmeter.

..... [1]

[Total: 12]

27. Nov/2023/Paper_ 9702/23/No.7

(a) State Ohm's law.

.....

.....

..... [2]

(b) A battery of electromotive force (e.m.f.) 6.2 V and negligible internal resistance is connected in a circuit to a uniform resistance wire, a voltmeter, a fixed resistor and a switch, as shown in Fig. 7.1.

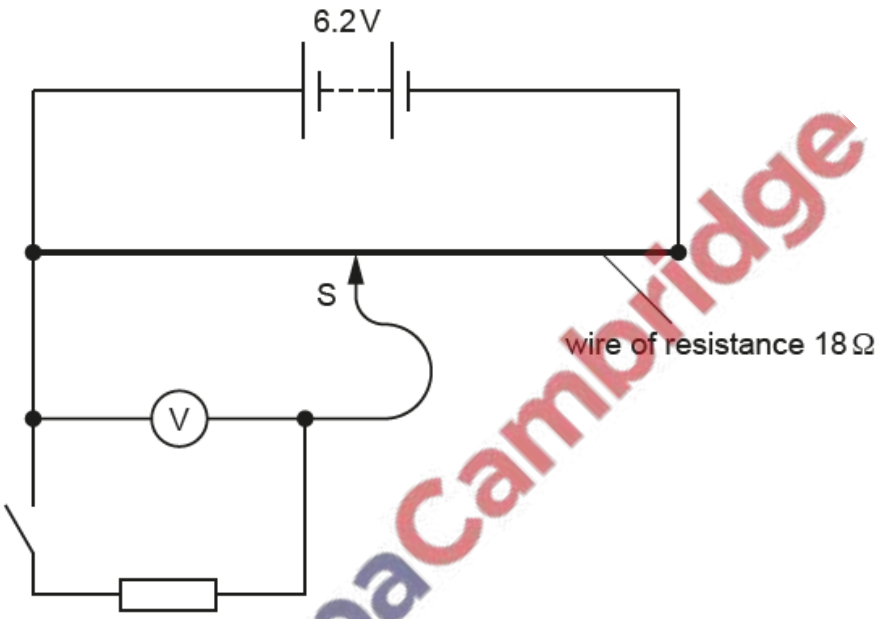


Fig. 7.1

The resistance wire has resistance 18 Ω, length 0.94 m and cross-sectional area 7.2×10^{-8} m^2. The slider S is positioned half-way along the length of the wire.

(i) Calculate the resistivity ρ of the material of the resistance wire.

ρ = ... Ω m [2]

(ii) The switch is open.
State the reading on the voltmeter.

voltmeter reading = ... V [1]

(iii) The switch is now closed.

State whether there is an increase, decrease or no change to:

- the current in the battery

.....

- the voltmeter reading.

.....

[2]

(iv) The switch remains closed. The slider S is moved along the resistance wire so that the voltmeter reading is 3.1 V.

On Fig. 7.1, draw a cross (×) on the resistance wire to show a possible new position of the slider. [1]

(c) The circuit in **(b)** is altered by changing the battery for one of a different e.m.f. The switch is open.

A student records the following data for the resistance wire:

current in the wire	0.93 A
mean drift speed of charge carriers	$1.3 \times 10^{-3}\,\text{m s}^{-1}$
number density of charge carriers	$9.0 \times 10^{28}\,\text{m}^{-3}$.

(i) Determine the charge q of a charge carrier in the wire suggested by this data.

q = ... C [2]

(ii) With reference to the value of q, explain why the data recorded by the student cannot be correct.

.....

..... [1]

[Total: 11]