Cambridge Assessment International Education

Interactive

Interactive Example Candidate Responses
Paper 2 (May/June 2016), Question 7
Cambridge International AS & A Level
Physics 9702

Version 1.0

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HIGH MIDDLE LOW

7 **(a)** Electric current is a flow of charge carriers. The charge on the carriers is quantised. Explain what is meant by *quantised*.

It means that charge is divide among the elections [1]

(b) A battery of electromotive force (e.m.f.) 9.0 V and internal resistance 0.25 Ω is connected in series with two identical resistors X and a resistor Y, as shown in Fig. 7.1.

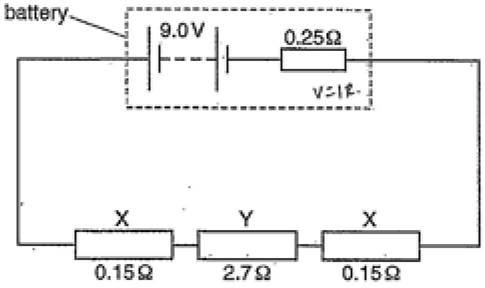

Fig. 7.1

The resistance of each resistor X is 0.15 Ω and the resistance of resistor Y is 2.7 Ω.

(i) Show that the current in the circuit is 2.8 A.

V=IR
I= 9/

$\frac{V_{battery}}{R_{total}} = I$

$I = \frac{9}{(0.25+0.15+0.15+2.7)}$

$= 2.769\ A$

$= 2.8\ A$

[3]

(ii) Calculate the potential difference across the battery.

V= IR
V= 2.8 × 0.25
= 0.69

9 − 0.69
= 8.307
= 8.31

potential difference = 8.31 V [2]

Your Mark

7(a)

7(b)(i)

7(b)(ii)

7(c)(i)

7(c)(ii)

Q7	Mark scheme		
(a)	charge exists only in discrete amounts	B1	[1]
(b)(i)	$E = I(R + r)$ or $V = IR$ (total resistance =) 2.7 + 0.30 + 0.25 (= 3.25 Ω) I = 9.0 / (2.7 + 0.30 + 0.25) **or** 9.0 / 3.25 = 2.8 A	C1 M1 A1	[3]
(b)(ii)	$V = IR_{ext}$ = 2.77 × 3.0 or 2.8 × 3.0 **or** $V = E - Ir$ = 9.0 – 2.77 × 0.25 or 9.0 – 2.8 × 0.25 V = 8.3 (8.31) V **or** 8.4 V A1	C1 (C1)	[2]
(c)(i)	$I = nevA$ v = 2.77 / (8.5 × 10^{29} × 1.6 × 10^{-19} × 2.5 × 10^{-6}) = 8.1 (8.147) × 10^{-6} ms^{-1} or 8.2 × 10–6 ms^{-1}	 M1 A1	[2]
(c)(ii)	A reduces by a factor 4 (1/4 less) **or** resistance <u>of Z</u> goes up by 4× current goes down but by <u>less than</u> a factor of 4 (as total resistance does not go up by a factor of 4) so drift speed goes up	M1 A1	[2] **[Total: 10]**

EXAMINER COMMENTS

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(c) Each resistor X connected in the circuit in (b) is made from a wire with a cross-sectional area of 2.5 mm². The number of free electrons per unit volume in the wire is $8.5 \times 10^{29}\,m^{-3}$.

(i) Calculate the average drift speed of the electrons in X.

$I = nAve$

$2.8 = 8.5 \times 10^{29} \times 2.5 \times 10^{-6} \times v \times 1.6 \times 10^{-19}$

$\frac{2.8}{3.4 \times 10^{17}} = v$

$v = 8.14 \times 10^{-18}$

drift speed = 8.14×10^{-18} ms^{-1} [2]

(ii) The two resistors X are replaced by two resistors Z made of the same material and length but with half the diameter.

Describe and explain the difference between the average drift speed in Z and that in X.

Since the drift speed is inversely proportional to cross-sectional area the drift speed in Z will be increased by 4 times. It will be four times more than X as the area is four times less than X [2]

[Total: 10]

Your Mark

7(a)

7(b)(i)

7(b)(ii)

7(c)(i)

7(c)(ii)

Q7	Mark scheme		
(a)	charge exists only in discrete amounts	B1	[1]
(b)(i)	$E = I(R + r)$ or $V = IR$ (total resistance =) 2.7 + 0.30 + 0.25 (= 3.25 Ω) I = 9.0 / (2.7 + 0.30 + 0.25) **or** 9.0 / 3.25 = 2.8 A	C1 M1 A1	[3]
(b)(ii)	$V = IR_{ext}$ = 2.77 × 3.0 or 2.8 × 3.0 **or** $V = E – Ir$ = 9.0 – 2.77 × 0.25 or 9.0 – 2.8 × 0.25 V = 8.3 (8.31) V **or** 8.4 V A1	C1 (C1)	[2]
(c)(i)	$I = nevA$ $v = 2.77 / (8.5 \times 10^{29} \times 1.6 \times 10^{-19} \times 2.5 \times 10^{-6})$ = 8.1 (8.147) × 10^{-6} ms^{-1} or 8.2 × 10–6 ms^{-1}	 M1 A1	[2]
(c)(ii)	A reduces by a factor 4 (1/4 less) **or** resistance of Z goes up by 4× current goes down but by less than a factor of 4 (as total resistance does not go up by a factor of 4) so drift speed goes up	M1 A1	[2] **[Total: 10]**

EXAMINER COMMENTS

MARK SCHEME

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HIGH MIDDLE LOW

7 (a) Electric current is a flow of charge carriers. The charge on the carriers is quantised. Explain what is meant by *quantised*.

'quantised' means expressed as a numerical value. [1]

(b) A battery of electromotive force (e.m.f.) 9.0 V and internal resistance 0.25 Ω is connected in series with two identical resistors X and a resistor Y, as shown in Fig. 7.1.

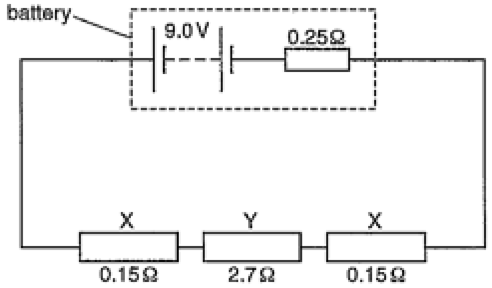

Fig. 7.1

The resistance of each resistor X is 0.15 Ω and the resistance of resistor Y is 2.7 Ω.

(i) Show that the current in the circuit is 2.8 A.

$V = IR$

$9 = I\,(0.25 + 0.15 + 0.15 + 2.7)$

$9 = I\,(3.25)$

$\boxed{\therefore I = 2.8\text{ A}}$ shown.

[3]

(ii) Calculate the potential difference across the battery.

~~p.d.~~

$V = IR$

$= 2.8 \times 0.25$

$= 0.7$ V

potential difference = 0.7 V [2]

Your Mark

7(a)

7(b)(i)

7(b)(ii)

7(c)(i)

7(c)(ii)

Q7	Mark scheme		
(a)	charge exists only in discrete amounts	B1	**[1]**
(b)(i)	$E = I(R + r)$ or $V = IR$ (total resistance =) 2.7 + 0.30 + 0.25 (= 3.25 Ω) I = 9.0 / (2.7 + 0.30 + 0.25) **or** 9.0 / 3.25 = 2.8 A	C1 M1 A1	**[3]**
(b)(ii)	$V = IR_{ext}$ = 2.77 × 3.0 or 2.8 × 3.0 **or** $V = E - Ir$ = 9.0 – 2.77 × 0.25 or 9.0 – 2.8 × 0.25 V = 8.3 (8.31) V **or** 8.4 V A1	C1 (C1)	**[2]**
(c)(i)	$I = nevA$ v = 2.77 / (8.5 × 10^{29} × 1.6 × 10^{-19} × 2.5 × 10^{-6}) = 8.1 (8.147) × 10^{-6} ms^{-1} or 8.2 × 10–6 ms^{-1}	 M1 A1	**[2]**
(c)(ii)	A reduces by a factor 4 (1/4 less) **or** resistance <u>of Z</u> goes up by 4× current goes down but by <u>less than</u> a factor of 4 (as total resistance does not go up by a factor of 4) so drift speed goes up	M1 A1	**[2]** **[Total: 10]**

EXAMINER COMMENTS

MARK SCHEME

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(c) Each resistor X connected in the circuit in **(b)** is made from a wire with a cross-sectional area of 2.5 mm^2. The number of free electrons per unit volume in the wire is 8.5 × 10^{29} m^{-3}.

(i) Calculate the average drift speed of the electrons in X.

$I = nAVq$

$2.8 = (8.5 \times 10^{29}) \cdot (2.5 \times 10^{-3}) (V) \cdot (1.6 \times 10^{-19})$

$\therefore V = 8.2 \times 10^{-9}$ ms^{-1}

drift speed = 8.2×10^{-19} ms^{-1} [2]

(ii) The two resistors X are replaced by two resistors Z made of the same material and length but with half the diameter.

Describe and explain the difference between the average drift speed in Z and that in X.

If the diameter is halved, the area is decreased by four times. According to $I = nAVq$, if the area decreases by four times, the ~~veloci~~ average drift speed which increase by four times. [2]

[Total: 10]

$\frac{I}{nAq} = V$

Your Mark

7(a)

7(b)(i)

7(b)(ii)

7(c)(i)

7(c)(ii)

Q7	Mark scheme		
(a)	charge exists only in discrete amounts	B1	**[1]**
(b)(i)	$E = I(R + r)$ or $V = IR$ (total resistance =) 2.7 + 0.30 + 0.25 (= 3.25 Ω) I = 9.0 / (2.7 + 0.30 + 0.25) **or** 9.0 / 3.25 = 2.8 A	C1 M1 A1	**[3]**
(b)(ii)	$V = IR_{ext}$ = 2.77 × 3.0 or 2.8 × 3.0 **or** $V = E - Ir$ = 9.0 – 2.77 × 0.25 or 9.0 – 2.8 × 0.25 V = 8.3 (8.31) V **or** 8.4 V A1	C1 (C1)	**[2]**
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(c)(ii)	A reduces by a factor 4 (1/4 less) **or** resistance of Z goes up by 4× current goes down but by less than a factor of 4 (as total resistance does not go up by a factor of 4) so drift speed goes up	M1 A1	**[2]**
			[Total: 10]

EXAMINER COMMENTS

MARK SCHEME

7 (a) Electric current is a flow of charge carriers. The charge on the carriers is quantised. Explain what is meant by *quantised*.

measured how many charge flows per unit time [1]

(b) A battery of electromotive force (e.m.f.) 9.0V and internal resistance 0.25Ω is connected in series with two identical resistors X and a resistor Y, as shown in Fig. 7.1.

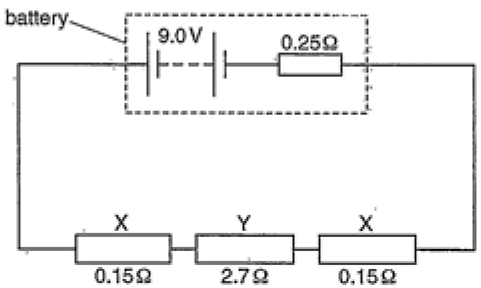

Fig. 7.1

The resistance of each resistor X is 0.15Ω and the resistance of resistor Y is 2.7Ω.

(i) Show that the current in the circuit is 2.8A.

$E = I(R+r+r+r)$

$9.0V = I(0.25+0.15+2.7+0.15)$

$9.0 = I(3.25)$

$I = \frac{9.0}{3.25}$

$= 2.769$

$\simeq 2.8A$

shown.

[3]

(ii) Calculate the potential difference across the battery.

$V = IR$

$\cancel{V = 2.769 \times 0.25}$ $V = 2.769 \times 0.25$

$\cancel{V = 0.692V}$ $V = 0.69V$

potential difference = 0.69 V [2]

Your Mark

7(a)

7(b)(i)

7(b)(ii)

7(c)(i)

7(c)(ii)

Q7	Mark scheme		
(a)	charge exists only in discrete amounts	B1	[1]
(b)(i)	$E = I(R + r)$ or $V = IR$ (total resistance =) 2.7 + 0.30 + 0.25 (= 3.25 Ω) I = 9.0 / (2.7 + 0.30 + 0.25) **or** 9.0 / 3.25 = 2.8 A	C1 M1 A1	[3]
(b)(ii)	$V = IR_{ext}$ = 2.77 × 3.0 or 2.8 × 3.0 **or** $V = E - Ir$ = 9.0 – 2.77 × 0.25 or 9.0 – 2.8 × 0.25 V = 8.3 (8.31) V **or** 8.4 V A1	C1 (C1)	[2]
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(c) Each resistor X connected in the circuit in (b) is made from a wire with a cross-sectic
of $2.5\,mm^2$. The number of free electrons per unit volume in the wire is $8.5 \times 10^{29}\,m^{-}$

$2.5 \times 10^{-3}\,m^2$

(i) Calculate the average drift speed of the electrons in X.

$I = nAve$

$2.8 = 8.5 \times 10^{29} \times 2.5 \times 10^{-3} \times v \times 1.60 \times 10^{-19}$

$2.8 = 3.4 \times 10^{8}\,v$

$v = \frac{2.8}{3.4 \times 10^{8}}$

$v = 8.24 \times 10^{-9}$ drift speed = 8.24×10^{-9}

two resistors X are replaced by two resistors Z made of the same mat
th but with half the diameter.

cribe and explain the difference between the average drift speed in Z and tl

sistance is doubled therefore the current de

the average drift speed in Z is less than in

may be halved.

[

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HIGH MIDDLE LOW

Your Mark

7(a)

7(b)(i)

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			[Total: 10]

EXAMINER COMMENTS

MARK SCHEME

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