Past-paper walk-through

Potential difference and power ▪ 9.2

eXercise

Questions in this set

- 9702/11 N25 Q31 ▪ 1 mark
- 9702/12 N25 Q32 ▪ 1 mark
- 9702/11 J25 Q34 ▪ 1 mark
- 9702/14 J25 Q30 ▪ 1 mark
- 9702/22 J25 Q6 ▪ 10 marks

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 31

9702/11 N25 ▪ Q31 ▪ 1 mark

There is a potential difference V across a resistor of resistance R. The current in the resistor is I.

Which equation gives the power P dissipated by the resistor? **[1]**

A $P = V^2 I$

B $P = \frac{V^2}{I}$

C $P = V^2 R$

D $P = \frac{V^2}{R}$

Solution 31

A $P = V^2 I$

B $P = \frac{V^2}{I}$

C $P = V^2 R$

D $P = \frac{V^2}{R}$ ✓

Why

- Power is $P = VI$, and Ohm's law gives $I = V/R$.
- Substituting: $P = V \times V/R = V^2/R$.
- $P = I^2 R$ is the other valid form; A and B mix the two together.

Question 32

9702/12 N25 ▪ Q32 ▪ 1 mark

The current in a resistor of constant resistance is 8.0 mA. The power dissipated by the resistor is P.

The current in the resistor is increased to 12.0 mA.

What is the new power dissipated by the resistor? **[1]**

A $0.44P$

B $0.67P$

C $1.5P$

D $2.3P$

Solution 32

A $0.44P$

B $0.67P$

C $1.5P$

D $2.3P$ ✓

Why

- With the resistance constant, $P = I^2R$, so the power goes as the *square* of the current.
- $(12.0/8.0)^2 = 1.5^2 = 2.25$.
- The new power is $2.3P$; C assumes it scales with I rather than I^2.

Question 34

9702/11 J25 ▪ Q34 ▪ 1 mark

The diagram shows six identical resistors connected in a circuit.

In which branch of the circuit is the most power dissipated? **[1]**

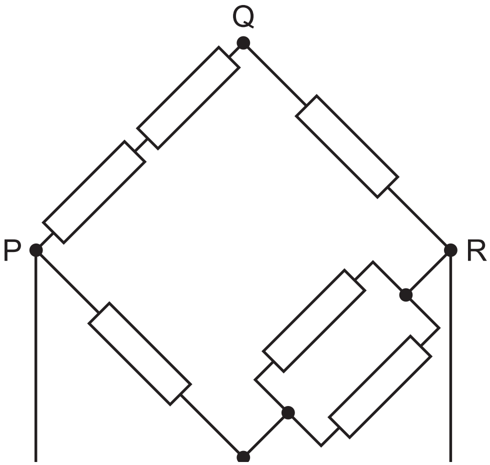
A PQ

B QR

C RS

D SP

Question 34



Solution 34

A PQ

B QR

C RS

D SP ✓

Why

- Read the branches: PQ is two resistors in series ($2R$) and RS is two in parallel ($R/2$).
- So the top path P-Q-R is $3R$ and the bottom path P-S-R is $1.5R$ – the bottom path carries twice the current.
- $P = I^2R$, so SP (a full resistor at the larger current) dissipates $4V^2/9R$, beating PQ and RS at $2V^2/9R$.

Question 30

9702/14 J25 ▪ Q30 ▪ 1 mark

30 What is equivalent to one volt?

A one coulomb per second

B one joule per coulomb

C one joule per second

Question 30

D one joule second per coulomb squared

Solution 30

Answer: **B**

Why

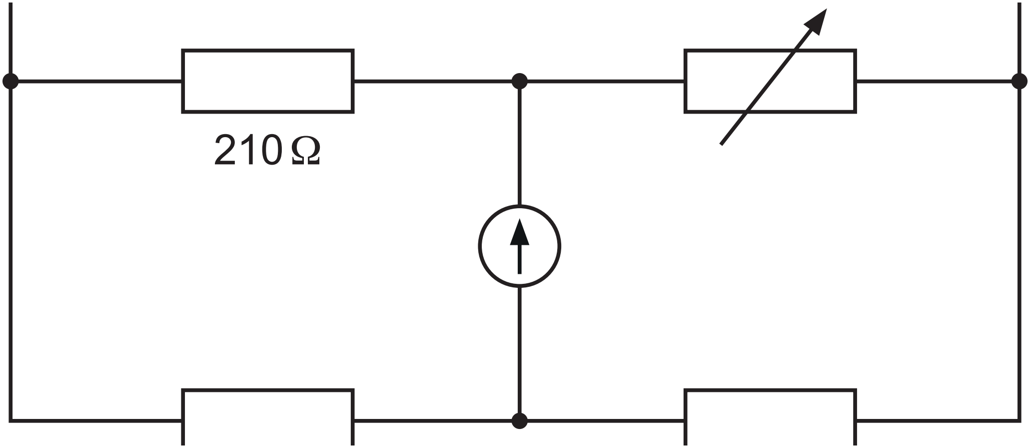
- Potential difference is the energy transferred per unit charge.
- So 1 V $= 1$ J C^{-1}.
- A is the ampere, C is the watt, and D (J s C^{-2}) is the ohm.

Question 6

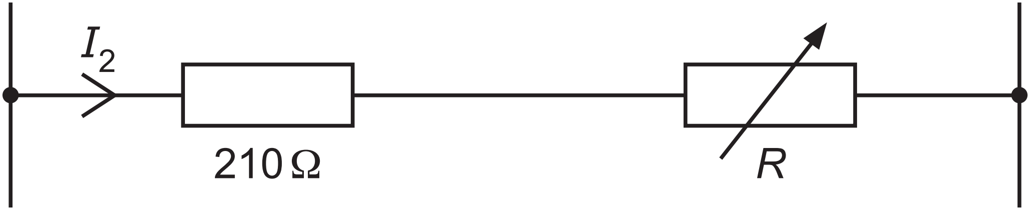
9702/22 J25 ▪ Q6 ▪ 10 marks

(a) Define electric potential difference across a component. **[1]**
(b)(i) Determine the charge passing through the battery in a time of 4.0 minutes. **[2]**
(b)(ii) Calculate I_1. **[2]**
(b)(iii) Calculate I_2. **[1]**
(b)(iv) Determine *R*. **[2]**
(c) The variable resistor in (b) is fitted with a scale so that its resistance can be accurately determined. The resistor of resistance $240\ \Omega$ is now replaced by a new resistor X of unknown resistance. A galvanometer is connected as shown in Fig. 6.2.
Fig. 6.2
With reference to ratios of resistances, explain how this circuit can be used to determine the resistance of X. **[2]**

Question 6



Question 6



Solution 6

(a)

Mark scheme

- energy transferred (to the component) per (unit) charge **B1**

Solution 6

(b)(i)

Worked steps

- $Q = It$, with the time in **seconds**: 4.0 minutes $= 240$ s.
- $Q = 0.030 \times 240$
- $Q = 7.2$ C

Mark scheme

- Q = It
- $=$ 0.030 $\times$ 4.0 $\times$ 60 **C1**
- $=$ 7.2 C **A1**

Solution 6

(b)(ii) Worked steps

Both branches sit across the full 8.0 V, so treat each on its own.

- The two resistors in this branch are in series: $430 + 240 = 670\ \Omega$.
- $I_1 = \dfrac{V}{R} = \dfrac{8.0}{670}$
- $I_1 = 0.012$ A

Solution 6

Mark scheme

- $I = V / R$
- $I1 = 8.0 / (430+240)$ **C1**
- $= 0.012$ A **A1**

Solution 6

(b)(iii)

Worked steps

Kirchhoff's first law at the junction: the branch currents add up to the battery current.

- $I_2 = 0.030 - I_1 = 0.030 - 0.012$
- $I_2 = 0.018$ A

Mark scheme

- I2 = 0.030 – I1
- = 0.030 – 0.012
- = 0.018 A **A1**

Solution 6

(b)(iv) Worked steps

The second branch also has 8.0 V across it, shared between the $210\ \Omega$ resistor and R.

- P.d. across the $210\ \Omega$ resistor $= 0.018 \times 210 = 3.8$ V.
- P.d. across R $= 8.0 - 3.8 = 4.2$ V.
- $R = \dfrac{4.2}{0.018}$
- $R = 230\ \Omega$

Mark scheme

- R = V / I2

Solution 6

- $= (8.0 - (0.018 \times 210)) / 0.018$ **C1**
- $= 230\ \Omega$ **A1**
- OR resistance of top branch $= 8.0 / 0.018$
- $R = 8.0 / 0.018 - 210$
- (C1)
- $= 230\ \Omega$
- (A1)
- OR total circuit resistance $= 8.0 / 0.030 = 267$
- $1 / 267 = 1 / (210 + R) + 1 / (430 + 240)$
- $1 / 267 - 1 / 670 = 1 / (210 + R)$

Solution 6

- $210 + R = 443$
- (C1)
- $R = 230\ \Omega$
- (A1)

Solution 6

(c) Worked steps

This is a Wheatstone bridge, and the whole method rests on one condition.

- Adjust the variable resistor until the **galvanometer reads zero**. No current then flows across the bridge, so the two junctions are at the same potential.
- That happens when the two branches divide their 8.0 V in the same ratio, i.e. when the ratio of the resistances in one branch equals the ratio in the other.
- Three of the four resistances are known (the two fixed ones and the variable one read off its scale), so X follows from that ratio.

Solution 6

Mark scheme

- (When) the galvanometer reads 0 (A) **M1**
- The ratio of the resistances in the top branch will equal the ratio of the resistances in the bottom branch (so the resistance of X can be determined) **A1**
- OR
- The ratio of the left pair of resistances will equal the ratio of the right pair of resistances
- (A1)