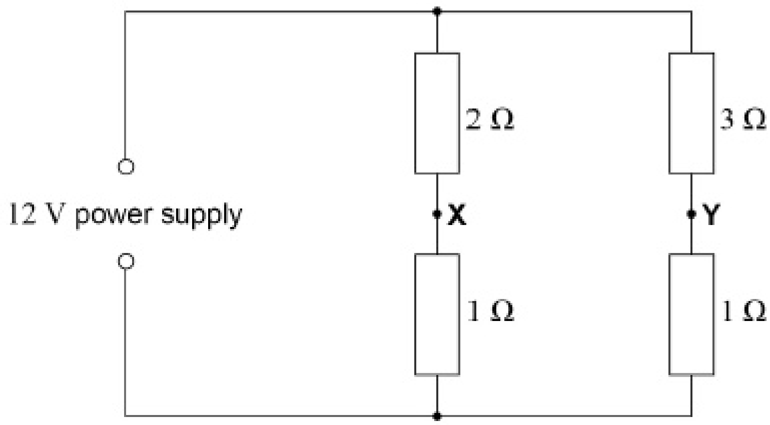
Electricity 001 answers

1 In this resistor network, the emf of the supply is 12 V and it has negligible internal resistance.



What is the reading on a voltmeter connected between points **X** and **Y**?

A	0 V	○
B	1 V	○
C	3 V	○
D	4 V	○

$V_x = \frac{1}{3} \times 12 = 4\,V$

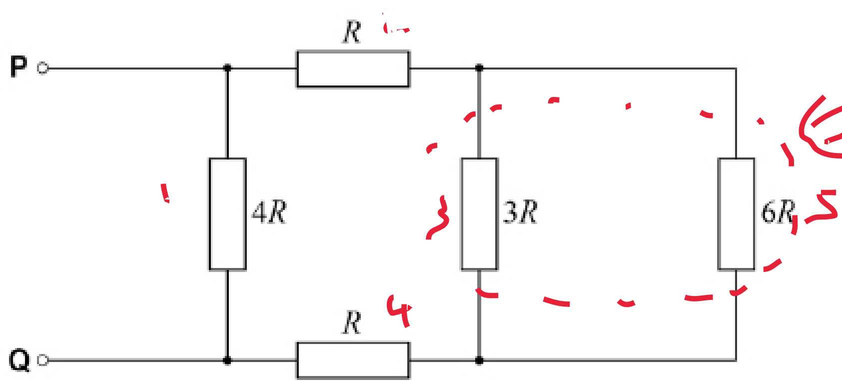
$V_y = \frac{1}{4} \times 12 = 3\,V$

$\therefore pd_{xy} = 1\,V$

(Total 1 mark)

2 The diagram shows a network of resistors connected between the terminals **P** and **Q**.

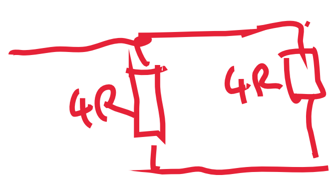
The resistance of each resistor is shown.



1) $R_3 + R_5$ in ∥ : $\frac{1}{R_T} = \frac{1}{3} + \frac{1}{6} \Rightarrow R_T = 2R$

2) $R_2 + R_4 + 2R = 4R$

3) so we have



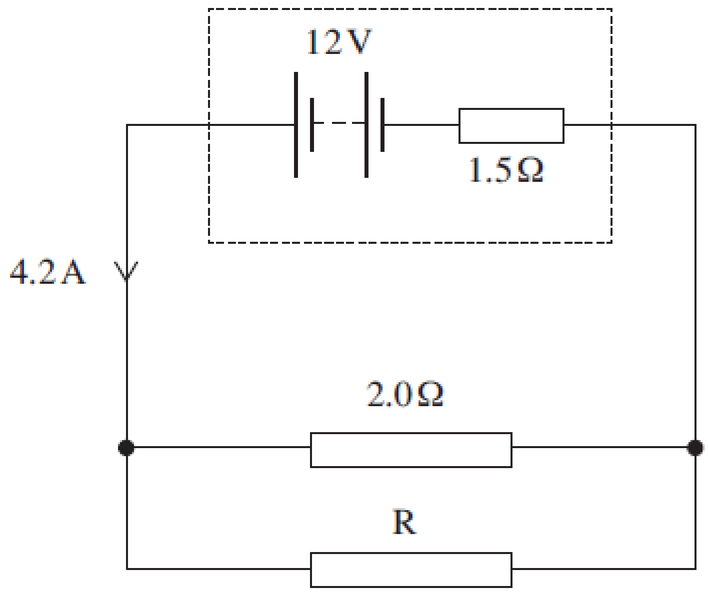
$\equiv 2R$

What is the effective resistance between **P** and **Q**?

A	R	☐
B	$2R$	☐
C	$3R$	☐
D	$4R$	☐

(Total 1 mark)

3 The circuit diagram below shows a battery of electromotive force (emf) 12 V and internal resistance 1.5 Ω connected to a 2.0 Ω resistor in parallel with an unknown resistor, R. The battery supplies a current of 4.2 A.



(a) (i) Show that the potential difference (pd) across the internal resistance is 6.3 V.

V = IR => V = 4.2 × 1.5 = 6.3 V

(1)

(ii) Calculate the pd across the 2.0 Ω resistor.

12 − 6.3 = 5.7 V

pd ____________________ V

(1)

(iii) Calculate the current in the 2.0 Ω resistor.

$V/R = I$ $\quad 5.7/2 = 2.85$

current 2.9 A

(1)

(iv) Determine the current in R.

$4.2 - 2.85 = 1.35$

current 1.4 A

(1)

(v) Calculate the resistance of R.

$V/I = R \Rightarrow 5.7/1.35$

R 4.2 Ω

(1)

(vi) Calculate the total resistance of the circuit.

$\frac{1}{R_T} = \frac{1}{4.2} + \frac{1}{2} = 1.35$ $\quad$ add in r $\quad 1.35 + 1.5$

circuit resistance 2.85 Ω

(2)

(b) The battery converts chemical energy into electrical energy that is then dissipated in the internal resistance and the two external resistors.

(i) Using appropriate data values that you have calculated, complete the following table by calculating the rate of energy dissipation in each resistor.

$P = I^2R$

resistor	rate of energy dissipation / W
internal resistance	$4.2^2 \times 1.5 = 26.5$
2.0 Ω	$2.85^2 \times 2 = 16.2$
R	$1.35^2 \times 4.2 = 7.7$

= 50.4 W

(3)

(ii) Hence show that energy is conserved in the circuit.

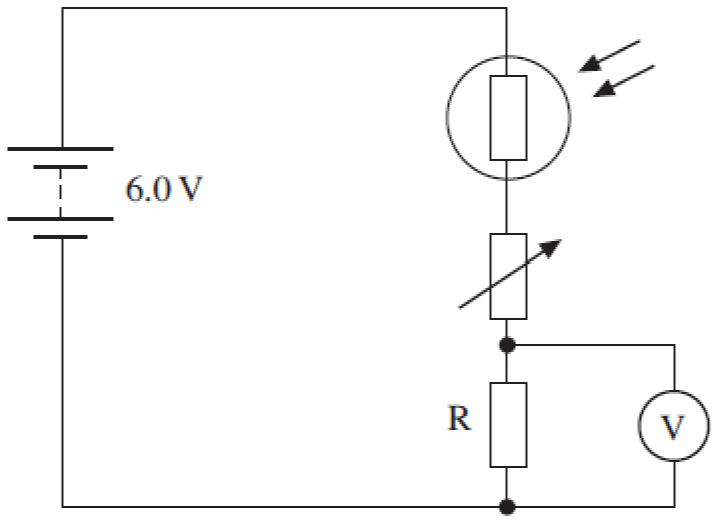
Battery supplies 12V at 4.2A = 50.4

Total = 50.4

(2)

(Total 12 marks)

4 The circuit diagram below shows a 6.0 V battery of negligible internal resistance connected in series to a light dependent resistor (LDR), a variable resistor and a fixed resistor, R.



(a) For a particular light intensity the resistance of the LDR is 50 kΩ. The resistance of R is 5.0 kΩ and the variable resistor is set to a value of 35 kΩ.

(i) Calculate the current in the circuit.

$R_T = 50K + 5K + 35K = 90 \times 10^3\ \Omega$

$\frac{V}{R} = I \Rightarrow I = \frac{6}{90 \times 10^3}$

current 6.7×10^{-5} A

(2)

(ii) Calculate the reading on the voltmeter.

$V = IR \Rightarrow 6.7 \times 10^{-5} \times 5000$

voltmeter reading 0.3 V

(2)

(b) State and explain what happens to the reading on the voltmeter if the intensity of the light incident on the LDR increases.

I ↑ ⇒ LRR ↓ ∴ V ↑ ∵

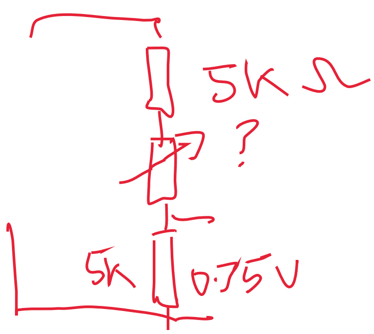
gets a higher proportion

(2)

(c) For a certain application at a particular light intensity the pd across R needs to be 0.75 V. The resistance of the LDR at this intensity is 5.0 kΩ.

Calculate the required resistance of the variable resistor in this situation.

$I = V/R = 0.75/5000 = 1.5 \times 10^{-4}$ A



resistance ______________________ Ω

(3)

(Total 9 marks)

Voltage over top also 0.75 V

∴ V across variable $= 6 - (2 \times 0.75)$

$= 4.5$ V

$V/I = R \Rightarrow \frac{4.5}{1.5 \times 10^{-4}} = 30$ kΩ

Mark schemes

1 **B**

[1]

2 B

[1]

3 (a) (i) *(use of V=Ir)*
V= 4.2 × 1.5 ✓ = 6.3 (V)

1

(ii) pd = 12 − 6.3 = 5.7 V✓
NO CE from (i)

1

(iii) (*use of I = V / R*)
I = 5.7 / 2.0 = 2.8(5) A✓
CE from (ii)
(a(ii)/2.0)
accept 2.8 or 2.9

1

(iv) *I* = 4.2 – 2.85 = 1.3(5) A ✓
CE from (iii)
(4.2 −(a)(iii))
accept 1.3 or 1.4

1

(v) *R*= 5.7 / 1.35 =4.2 Ω ✓
CE from (iv)
(a(ii) / (a)(iv))
Accept range 4.4 to 4.1

1

(vi) $\frac{1}{R_{Parallel}} = \frac{1}{4.2} + \frac{1}{2.0} = 0.737$ ✓
CE from (a)(v)
$R_{parallel}$ = 1.35 **Ω**
second mark for adding internal resistance

R_{total} = 1.35 <u>+ 1.5</u>✓ = 2.85 Ω
OR
R = 12/4.2 ✓
R= 2.85 Ω ✓

2

(b) (i)

resistor	Rate of energy dissipation (W)
1.5 Ω internal resistance	$4.2^2 \times 1.5 = 26.5$ ✓
2.0 Ω	$2.85^2 \times 2.0 = 16.2$ (15.68 − 16.82) ✓
R	$1.35^2 \times 4.2 = 7.7$ (7.1 − 8.2) ✓

CE from answers in (a) but not for first value

2.0: a(iii)^2×2

R: a(iv)^2×a(v)

3

(ii) energy provided by cell per second = 12 × 4.2 = <u>50.4</u> (W) ✓
energy dissipated in resistors per second = 26.5 + 16.2 + 7.7 = 50.4 ✓
(hence energy input per second equals energy output)

if not equal can score second mark if an appropriate comment

2

[12]

4 (a) (i) *(use of I = V / R)*

first mark for adding resistance values 90 k Ω

I = 6.0 / (50 000 + 35 000 + 5000) ✓ = 6.7×10^{-5}A ✓

accept 7×10^{-5} or dotted 6×10^{-5}

but not 7.0×10^{-5} and not 6.6×10^{-5}

2

(ii) V = $6.7 \times 10^{-5} \times 5000$ ✓= 0.33 (0.33 − 0.35) V ✓
OR
V = 5 / 90 × 6 ✓ = 0.33(V) ✓

CE from (i)
BALD answer full credit
0.3 OK and dotted 0.3

2

(b) resistance of LDR decreases ✓

need first mark before can qualify for second

reading increase because greater <u>proportion / share</u> of the voltage across R OR higher current ✓

2

(c) I = 0.75 / 5000 = 1.5×10^{-4} (A) ✓

(pd across LDR = 0.75 (V))

pd across variable resistor = 6.0 − 0.75 − 0.75 = 4.5 (V) ✓

$R = 4.5 / 1.5 \times 10^{-4} = 30\,000\ \Omega$ ✓

or

I = 0.75 / 5000 = 1.5×10^{-4} (A) ✓

R_{total}I = 6.0 / 1.5×10^{-4} = 40 000 Ω ✓

$R = 40\,000 - 5000 - 5000 = 30\,000\ \Omega$ ✓

3

[9]