Electricity – AS Physics

1. No.6

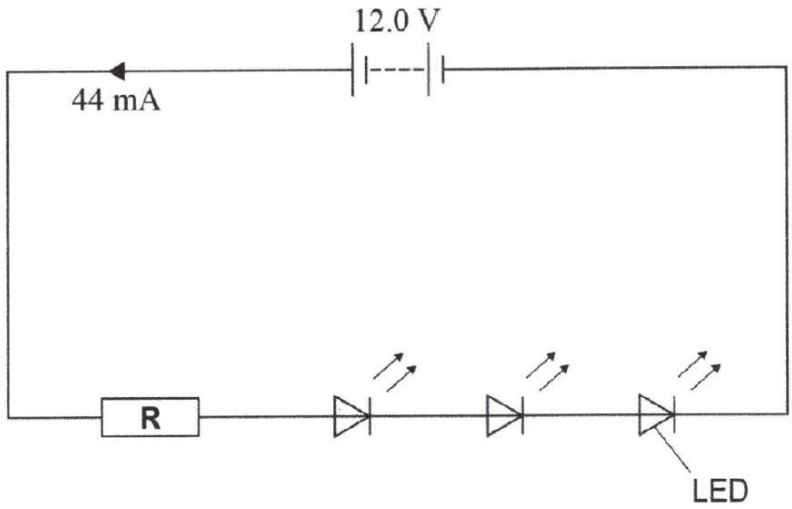
0 6 . 1 State what is meant by the emf (electromotive force) of a battery.

[1 mark]

The amount of chemical energy transfered to electrical energy for 1C of charge through the battery

Figure 10 shows the circuit diagram for a battery-powered torch.
The circuit contains three identical light emitting diodes (LEDs) and a resistor **R**.
The current in the circuit is 44 mA.

Figure 10



0 6 . 2 Calculate the number of electrons that pass a point in the circuit in 37 minutes.

[2 marks]

$Q = It$ and $Q = ne \Rightarrow n = \frac{Q}{e}$

$Q = 0.044 \times 37 \times 60$

$Q = 97.68\,C$

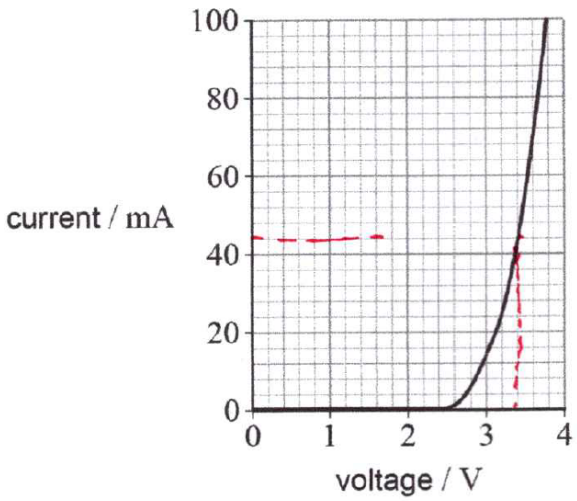
So

$n = \frac{97.68}{1.6 \times 10^{-19}} = 6.1 \times 10^{20}$

number of electrons = 6.1×10^{20}

Figure 11 is the current–voltage characteristic for an LED used in the torch.

Figure 11



0 6 . 3 Determine the power output of one LED when the torch is on.

[3 marks]

When $V = 3.4\,V$, $I = 44\,mA$

$P = VI$

$= 3.4 \times 44 \times 10^{-3}$

$= 0.1496\,W$

power output = 0.15 W

The battery has an emf of 12.0 V and an internal resistance of 1.5 Ω.

0 6 . 4 Determine the resistance of **R** in **Figure 10**.

[4 marks]

Lost volts $= Ir$

$= 0.044 \times 1.5$

$= 0.066\,V$

P.d $= 12 - 0.066$

$= 11.934\,V$

LED $\Rightarrow R = \frac{3.4}{0.044} = 77\,\Omega$

In series, $R_T = 3 \times 77$

$= 231\,\Omega$

Total R of the circuit

$R_T = \frac{12}{0.044} = 273\,\Omega$

$= 273 - 231 - 1.5$

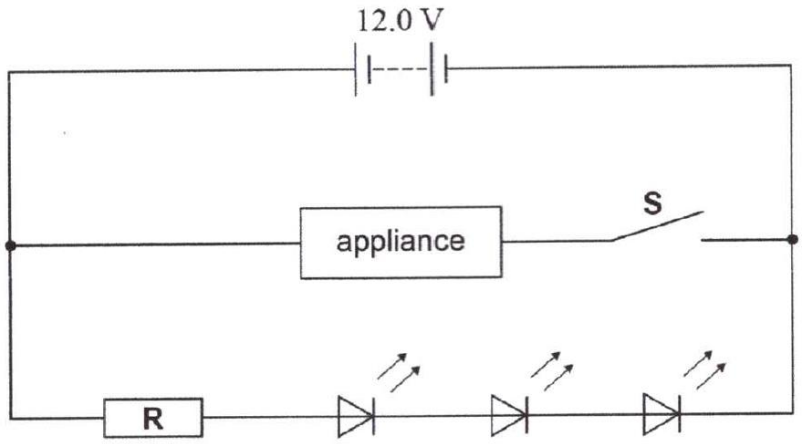
$= 40.5\,\Omega$

resistance = 40.5 Ω

0 6 . 5 Another appliance is connected to the battery as shown in **Figure 12**.

The current in the battery is 3.5 A when switch **S** is closed.

Figure 12



Each LED requires a voltage of at least 2.9 V to light.

Deduce whether the LEDs will light when **S** is closed.

[3 marks]

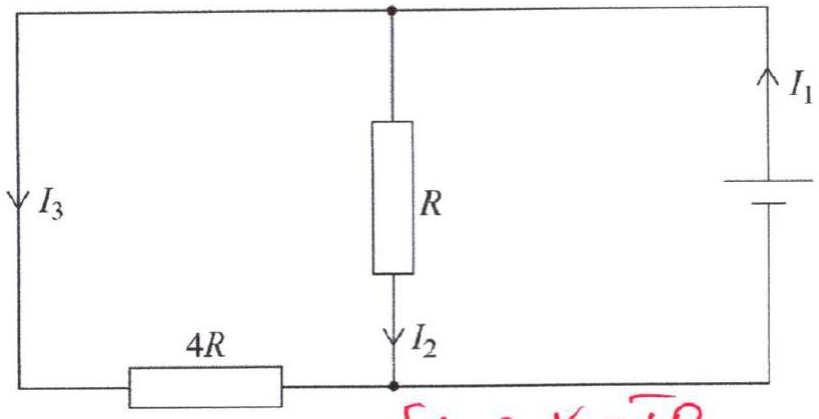
When V = 2.9 V, I = 8 mA so 3 LED, P.d = 3 x 2.9 = 8.7V to light

Terminal Pd = 6.75V, so LED won't light as 8.7V > 6.75V.

2. June/2023/Paper_7407/2/No.11

A cell with negligible internal resistance is connected to two resistors of resistance $4R$ and R.

The currents I_1, I_2 and I_3 in the circuit are shown.



Same $V = IR$

Which equation is correct for this circuit?

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

So

$I \propto \frac{1}{R}$

$\div 4 \quad R \times 4$

[1 mark]

A $I_1 = 4I_2$ ○

B $I_1 = 4I_3$ ○

C $I_2 = 4I_3$ ⊘

D $I_3 = 4I_1$ ○

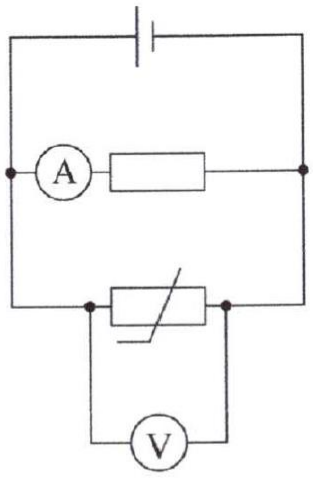
So $I_3 = \frac{I_2}{4}$

or

$4I_3 = I_2$

3. June/2023/Paper_7407/2/No.18

A circuit contains a thermistor and a resistor in parallel. The internal resistance of the cell is negligible.



Temp ↑ so R ↓ and V is unchanged and so I is unchanged for resistor

The temperature of the thermistor is increased.
The temperature of the resistor is kept constant.

What is observed on the voltmeter and the ammeter?

[1 mark]

	Voltmeter reading	Ammeter reading	
A	decreases	increases	○
B	increases	increases	○
C	no change	increases	○
D	no change	no change	✗

4. June/2023/Paper_7407/2/No.19

The table shows the lengths and cross-sectional areas of two wires **X** and **Y** of the same metal.

Wire	Length / cm	Cross-sectional area / mm^2
X	47	0.10
Y	23	0.40

The resistance of **X** is 6.0 Ω.
The temperature of **Y** is the same as the temperature of **X**.

What is the resistance of **Y**? **[1 mark]**

$R = \rho \frac{L}{A}$ So $R \propto \frac{L}{A}$

A 0.12 Ω ○

B 0.73 Ω ⊘

C 1.2 Ω ○

D 3.1 Ω ○

$\frac{R_X A_X}{L_X} = \frac{R_Y A_Y}{L_Y}$

So

$R_Y = \frac{R_X \times A \times L_Y}{A_Y \times L_X}$

$= 6 \times \frac{1}{4} \times \frac{23}{47}$

$= 0.73$

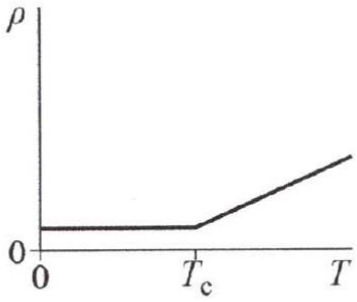
5. June/2023/Paper_7407/2/No.20

A superconducting material has a critical temperature T_c.

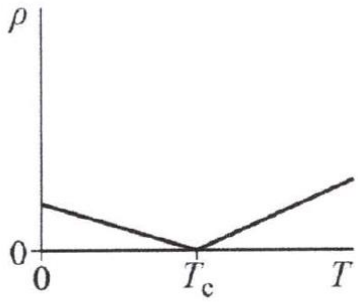
Which graph shows the variation of resistivity ρ with temperature T?

[1 mark]

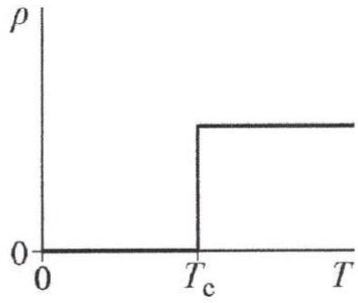
A



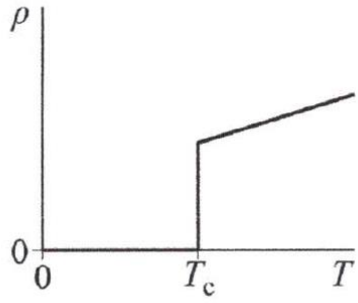
B



C



D

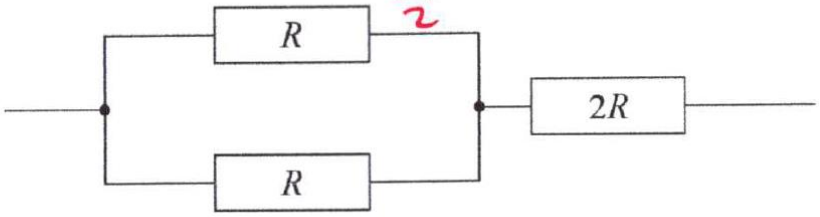


The resistivity decreases as Temperature decreases and as Temperature goes higher, it collapses and increases.

6. June/2023/Paper_7407/2/No.21

X, **Y** and **Z** are three networks of resistors.

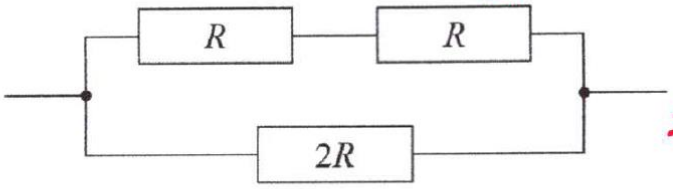
X



$\frac{1}{2} R$

$= 2\frac{1}{2} R$

Y



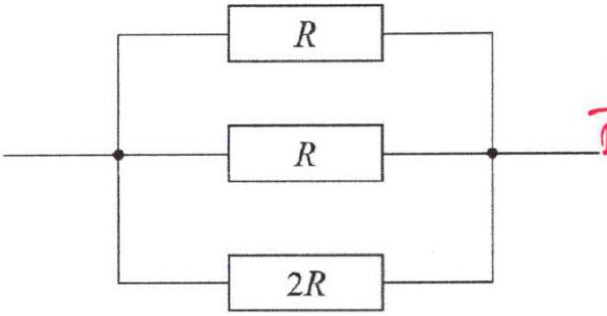
$2R$

$\frac{1}{2R} + \frac{1}{2R} = \frac{1+1}{2R} = \frac{2}{2R}$

$\frac{1}{R} = R$

$\Rightarrow R = R$

Z



$\frac{1}{R} + \frac{1}{R} + \frac{1}{2R} = \frac{2+2+1}{2R}$

$\frac{1}{R_T} = \frac{5}{2R}$

$R_T = \frac{2}{5} R$

Which gives the networks in order of largest total resistance to smallest total resistance?

[1 mark]

A **X, Y, Z** ☒

B **Y, X, Z** ○

C **Z, X, Y** ○

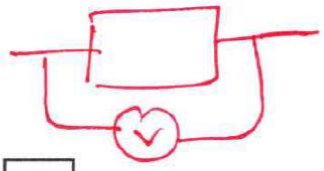
D **Z, Y, X** ○

7. June/2023/Paper_7407/2/No.28

Which row shows the resistance of an ideal ammeter and of an ideal voltmeter?

[1 mark]

	Resistance of ammeter	Resistance of voltmeter
A	zero	zero
B	zero	infinite
C	infinite	zero
D	infinite	infinite



A ○ We need no current through it

B ☒ So no resistance in ammeter and infinite resistance in voltmeter

C ○

D ○

The current in a resistor is 15 mA.

How many electrons pass through the resistor in 3 minutes?

8. June/2023/Paper_7407/2/No.29

The current in a resistor is 15 mA.

How many electrons pass through the resistor in 3 minutes?

resistance in voltmeter

[1 mark]

A 2.8×10^{17} ○

B 1.7×10^{19} ☒

C 2.8×10^{20} ○

D 1.7×10^{22} ○

$n = \frac{Q}{e}$

$I = 0.075$

$Q = It$

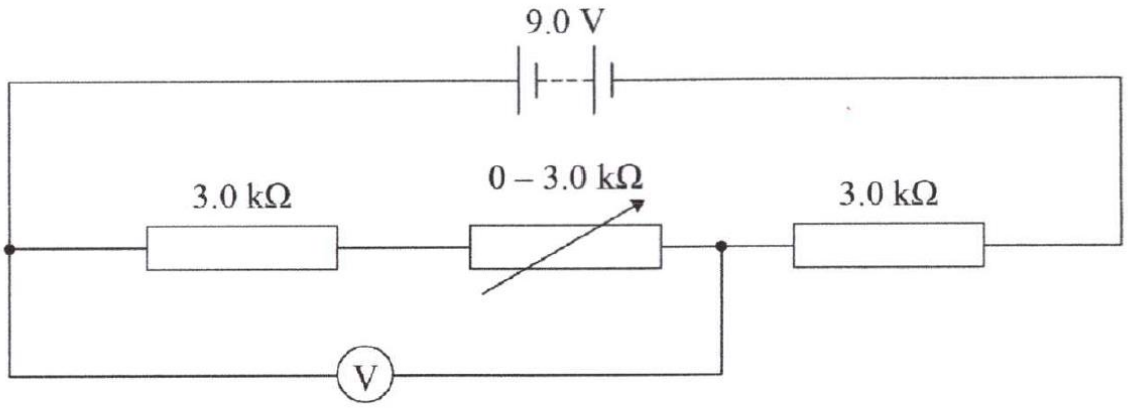
$= 0.075 \times 3 \times 60$

1.6×10^{-19}

$= 1.7 \times 10^{19}$ electrons

9. June/2023/Paper_7407/2/No.30

Three resistors are connected in series with a 9.0 V battery of negligible internal resistance.



The resistance of the variable resistor is varied from 0 to 3.0 kΩ.

The range of potential difference observed on the voltmeter is

[1 mark]

when 0, V = 4.5 V
when 3 kΩ, V = 6 V

A 0 to 6.0 V ⬭

B 3.0 V to 6.0 V ⬭

C 4.5 V to 6.0 V ⬭ (crossed out)

D 4.5 V to 9.0 V ⬭

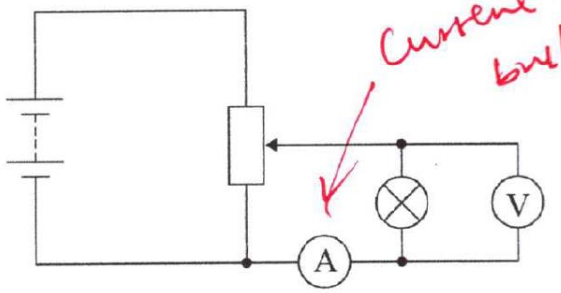
10. June/2023/Paper_7407/2/No.31

The current–voltage characteristic between 0 and 6.0 V is required for a filament lamp. The lamp is connected in a circuit with a battery of emf 6.0 V and negligible internal resistance.

Which circuit should be used?

[1 mark]

A

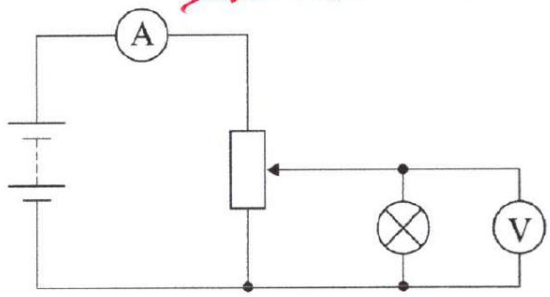


Current of bulb

☒

we can't have anything in series, so no C and D.

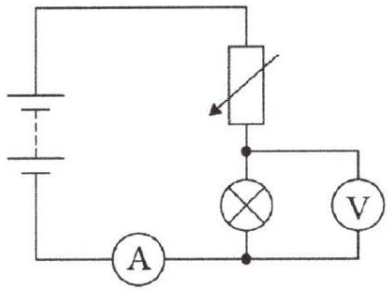
B



whole circuit

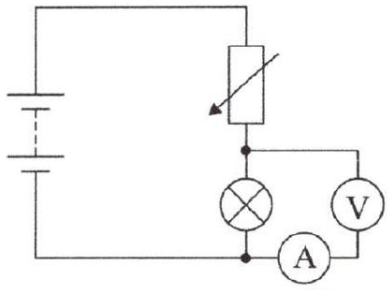
☐

C



☐

D

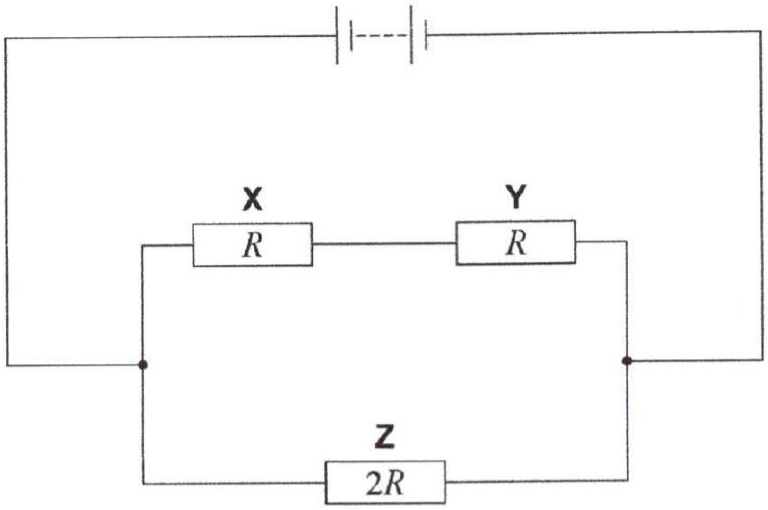


☐

↑ can't be in parallel

11. June/2023/Paper_7407/2/No.32

The diagram shows a circuit containing three resistors **X**, **Y** and **Z**.



X and **Y** each have resistance R.
Z has resistance $2R$.

What is $\frac{\text{power in X}}{\text{power in Z}}$?

[1 mark]

A $\frac{1}{4}$ ⬭

B $\frac{1}{2}$ ⬭

C 2 ⬭

D 4 ⬭

$P = \frac{V^2}{R} = I^2R = IV$

$\frac{P_X}{P_Y} = \frac{\frac{V_X^2}{R}}{\frac{V_Y^2}{2R}} = \frac{V_X^2}{V_Y^2} \times \frac{2R}{R}$

$\frac{P_X}{P_X} = 2 \times \left(\frac{V_X^2}{V_Y^2}\right)$

$\frac{P_X}{P_Y} = \left(\frac{1}{2}\right)^2 \times 2 = \frac{1}{2}$