AS Level Physics

Chapter 3 – Electric Circuits

3.2.2 Circuit Symbols, e.m.f and p.d.

Worked Examples

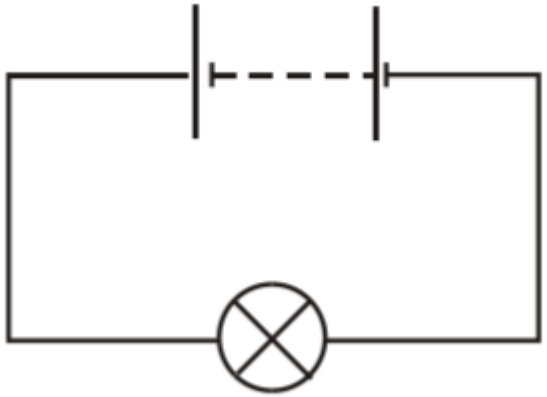
Potential Difference (p.d.) or Voltage

Exam Style Question 1

a) State the word equation that is used to define charge.

b) Define potential difference.

A $9.0\ V$ battery of negligible internal resistance is connected to a light bulb.



c) Calculate the energy transferred in the light bulb when $20\ C$ of charge flows through it.

Potential Difference (p.d.) or Voltage

Exam Style Question 1

a)State the word equation that is used to define charge.

$$Q = It$$

$$charge = current \times time$$

b) Define potential difference.

Work done per unit charge flowing.

OR

The POTENTIAL DIFFERENCE (p.d.) or VOLTAGE, between any two points in a circuit is defined as the amount of electrical energy transferred to other energy forms PER COULOMB of charge flowing between the points.

c) Calculate the energy transferred in the light bulb when $20\ C$ of charge flows through it.

Use: $W = VQ$

$$W = 9\ V \times 20\ C$$

$$W = 180\ J$$

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Potential Difference (p.d.) or Voltage

Exam Style Question 2

a) A steady current of $0.25\ A$ passes through a torch bulb for $6\ minutes$. Calculate the charge which flows through the bulb in this time.

b) The torch bulb is now connected to a battery of negligible internal resistance. The battery supplies a steady current of $0.25\ A$ for $20\ hours$. In this time the energy transferred in the bulb is $9.0 \times 10^4\ J$.

i) Calculate the potential difference across the bulb,

ii) The power of the bulb.

Potential Difference (p.d.) or Voltage

Exam Style Question 2

a) Calculate the charge which flows through the bulb in this time.

Use: $Q = It$

For t convert 6 minutes into seconds that would give us:

$$6\ mins \times 60\ secs = 360\ secs$$

Now substitute $t = 360\ sec$ into $Q = It$

$$Q = 0.25\ A \times 360\ s = 90\ C$$

Therefore the charge which flows through the bulb in this time is $90\ C$.

bi) Calculate the potential difference across the bulb.

Use: $V = \frac{W}{Q}$

But remember charge is $Q = It$ where the time changed from $6\ mins$ to $20\ hours$. So convert 20 hours into seconds:

$$t = 20\ hours \times 60\ mins \times 60\ seconds = 72000\ seconds$$

$$V = \frac{9.0 \times 10^4\ J}{0.25\ A \times 72000\ seconds} = 5.0\ V$$

Therefore the p.d. across the bulb is $5.0\ V$.

bii) Calculate the power of the bulb.

Use: $P = \frac{W}{t}$

Remember t is still 20 hours so convert it from hours to seconds as we did below:

$$P = \frac{9.0 \times 10^4\ J}{20\ hours \times 60\ mins \times 60\ seconds} = 1.25\ W$$

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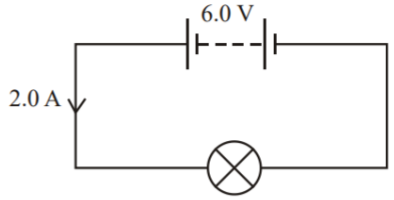
Potential Difference (p.d.) or Voltage

Exam Style Question 3

ai) Write the word equation that defines potential difference.

aii) The unit of potential difference is the volt. Express the volt in terms of base units only.

A $6.0\ V$ battery of negligible internal resistance is connected to a filament lamp. The current in the lamp is $2.0\ A$.



b) Calculate how much energy is transferred in the filament when the battery is connected for $2.0\ minutes$.

Potential Difference (p.d.) or Voltage

Exam Style Question 3

ai) Write the word equation that defines potential difference.

$$V = \frac{W}{Q}$$

$$potential\ difference = \frac{work\ done}{charge}$$

aii) The unit of potential difference is the volt. Express the volt in terms of base units only.

Remember the base units for:

Work done: $J = kg\ m^2 s^{-2}$

Charge: $C = A\ s$

Therefore the base units for the volt is:

$$V = \frac{kg\ m^2\ s^{-2}}{A\ s} = kg\ m^2\ A^{-1}\ s^{-3}$$

Therefore the base units for the volt is $kg\ m^2\ A^{-1}\ s^{-3}$.

b) Calculate how much energy is transferred in the filament when the battery is connected for $2.0\ minutes$.

Use: $W = QV = ItV$

Convert 2 minutes to seconds:

$$2\ minutes \times 60\ seconds = 120\ seconds$$

And substitute it into t:

$$W = (2.0\ A)(120\ s)(6.0\ V)$$

$$W = 1440\ J$$

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Potential Difference (p.d.) or Voltage

Exam Style Question 4

a) Define the term electromotive force (e.m.f.)

b) Use energy considerations to distinguish between potential difference (p.d.) and electromotive force (e.m.f.).

c) Here is a list of possible units for e.m.f. or p.d.

$$J\,s^{-1} \quad J\,A^{-1} \quad J\,C^{-1}$$

State which one is a correct unit.

Potential Difference (p.d.) or Voltage

Exam Style Question 4

a) Define the term electromotive force (e.m.f.)

Energy conversion or work done per unit charge.

b) Use energy considerations to distinguish between potential difference (p.d.) and electromotive force (e.m.f.).

p.d.: energy transferred per unit charge from electrical form into other forms e.g. light/heat.
e.m.f.: energy transferred per unit charge into electrical form from other forms, e.g. chemical/mechanical.

c) State the correct unit:

$$J\,C^{-1}$$

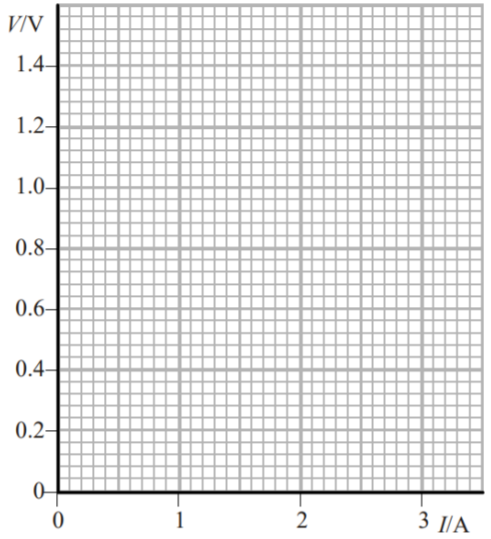
Potential Difference (p.d.) or Voltage

Exam Style Question 5

Using the following results:

Current in the cell I/A	Terminal potential difference across the cell V/V
0.5	1.2
0.9	1.0
1.5	0.8
1.9	0.6
2.5	0.4
2.9	0.2

a) Plot the results on the grid below and draw the line of best fit through your points.

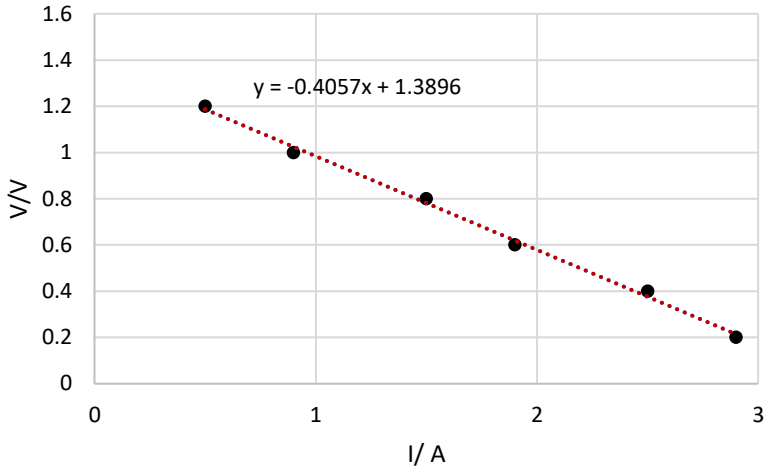


b) Use your graph to determine the e.m.f. of the cell.

Potential Difference (p.d.) or Voltage

Exam Style Question 5

a) Plot the results on the grid below and draw the line of best fit through your points.



b) Use your graph to determine the e.m.f. of the cell.

To determine the e.m.f. of the cell just extend the line of best fit until it cross the y-axis. This will give you the y-intercept and in turn the e.m.f. The range is between $[1.36\ -1.44\ V]$.

But because I used excel, excel calculated the y-intercept to be 1.3896 therefore the e.m.f. is $1.3896\ V$.

Please see ‘3.2.1 Circuit symbols, e.m.f. and p.d. notes’ pack for revision notes.

For more revision notes, tutorials and worked examples please visit www.tutorpacks.co.uk.

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