STEM SMART Phase One, 2022

Physics Week 1 – Charge Flow

https://isaacphysics.org/gameboards#smart_p_1_1

Essential GCSE Physics 22.1

GCSE - Challenge (C1)
A Level - Practice (P1)

Assume the electron has a charge of $-1.60 \times 10^{-19}\ \mathrm{C}$.

A $3.00\ \mathrm{A}$ appliance has $360\ \mathrm{C}$ of charge flow through it.

Part A Operating duration

How long was the appliance operating?

Part B Number of electrons

How many electrons passed through the appliance in this time?

Essential GCSE Physics 22.2

GCSE - Challenge (C1)
A Level - Practice (P1)

$-1.00\,\text{coulomb}$ is the charge of how many electrons? Give your answer to 3 SF.

Essential GCSE Physics 22.3

GCSE - Challenge (C1)
A Level - Practice (P1)

If two electrons are removed from an atom, what is the charge of the resulting cation (positively charged ion)?

Essential Pre-Uni Physics C2.1

A Level - Practice (P1)

Data:

- Magnitude of the charge on the electron = $1.60 \times 10^{-19}\,\mathrm{C}$

How many electrons are needed to carry a charge of $-6.00\,\mathrm{C}$?

Essential Pre-Uni Physics C2.2

A Level - Practice (P1)

Data:

- Magnitude of the charge on the electron = $1.60 \times 10^{-19}\,\mathrm{C}$

How many electrons flow past a point each second in a $5.0\,\mathrm{mA}$ electron beam?

Essential Pre-Uni Physics C2.3

A Level - Practice (P1)

Data:

- Magnitude of the charge on the electron = $1.60 \times 10^{-19}\ \mathrm{C}$

Alpha particles have twice the charge of an electron. What is the current caused by a radioactive source which emits 3000 alpha particles per second, to 3 significant figures?

Essential Pre-Uni Physics C2.4

A Level - Practice (P1)

Data:

- Magnitude of the charge on the electron = $1.60 \times 10^{-19}\ \mathrm{C}$

An electron gun emits 3.0×10^{21} electrons in two minutes. What is the beam current? Give your answer to 2 significant figures.

Essential Pre-Uni Physics C3.5

A Level - Practice (P1)

Data: Magnitude of the charge on the electron = $1.60 \times 10^{-19}\ \mathrm{C}$

How long does it take for a current of $6.0\ \mathrm{A}$ to deliver $1.5 \times 10^{17}\ \mathrm{Cu}^{2+}$ ions in a solution? Assume these ions are the only charged particles moving.

Conveying Current

A Level - Challenge (C2)

A conveyor belt of width $w = 10\,\text{cm}$ has a surface containing a layer of electrons with an area number density of $10\,000\ \text{mm}^{-2}$. The conveyor belt is moving at a speed $v = 5.0\,\text{m}\,\text{s}^{-1}$. At a certain point there is a wire brush that collects all of the electrons on the belt and transports them away as electric current.

Part A Magnitude of current

What is the magnitude of the electric current through the wire brush?

Part B Protons "swept up"

There is a spillage in the conveyor belt factory which doesn't affect the conveyor belt in any way except that now there is an extra proton density of $3000\,\text{mm}^{-2}$.

Assuming the protons and electrons don't interact as they are stuck on an insulating belt, but that the protons are "swept up" by the brush, what now is the magnitude of the current though the wire brush?

Adapted with permission from UCLES, A level Additional Physics, June 1989, Paper 1, Question 18

Cool Coulometers

A coulometer is a device for measuring the amount of charge which has passed through a circuit. These are based on measuring the mass of the metal which has been deposited on the cathode. In the circuit shown below, C is a silver coulometer, and A and B are copper coulometers.

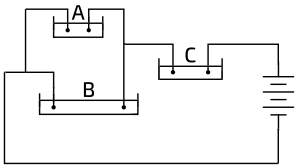

Figure 1: A circuit consisting of three coulometers. A and B are different copper coulometers, whereas C is a silver coulometer.

After current has passed for a time, the mass of silver deposited is $1.08\,\mathrm{g}$, and the mass of copper deposited on B is $0.118\,\mathrm{g}$. Calculate the mass of copper deposited in A?

Silver has a relative atomic mass of $108\,\mathrm{g\,mol^{-1}}$ and $1+$ ions.

Copper has a relative atomic mass of $63.6\,\mathrm{g\,mol^{-1}}$ and $2+$ ions.

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