CAPE PHYSICS

Unit 2

R2S NEXUS ™

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Please find both the answer key and the detailed solutions for the numerical and reasoning questions of your MCQ assignment on Electric Charge.

SECTION A: MCQ Answer key

1.	A	6.	B	11.	D
2.	D	7.	D	12.	C
3.	C	8.	B	13.	A
4.	A	9.	A	14.	n/a
5.	C	10.	C	15.	n/a

Please Turn Over

SECTION B: Expanatory Solutions

Q.01 The famous Oil Drop Experiment was developed by Robert Millikan to achieve the scientific accomplishments that helped to solidify the electron as an elementary particle - quantized and negatively charged!

Q.02 Recall the mathematical definition of average current:

$$I = \frac{\Delta Q}{\Delta t}$$

$$\Leftrightarrow \Delta Q = I \Delta t$$

More simplistic, $Q = It$.

Hence, the unit of charge is such that $1\ C = 1\ A \cdot s$

Q.03 Net charge is

$Q = Nq$ $\quad q$ = charge on 1 particle, N = # of charges

$= (n N_A) e$

$= 1\ \text{mol.} \times 6.02 \times 10^{23} \frac{\text{electrons}}{\text{mol}} \times 1.60 \times 10^{-19} \frac{C}{\text{electron}}$

$= 9.63 \times 10^{-4}\ C$

NB. Using more precise values (at 4 sig. fig.),

$$e = 1.602 \times 10^{-19}\ C$$

$$N_A = 6.023 \times 10^{23}\ mol^{-1}$$

would result in $Q = 9.659 \times 10^{-4}\ C$.

Q. 04 A single Helium atom contains 2 electrons. So, the cummulative charge required is

$$Q = Nq \quad \text{where } q = \text{total charge on all the electrons}$$

$$= nN_A \times (2e)$$

$$= 2N_Ae \quad \text{since } n = 1 \text{ mole}$$

$$= 2\,\text{mol.} \times 6.02 \times 10^{23}\ \text{mol}^{-1} \times (-1.60 \times 10^{-19}\ C)$$

$$\approx -1.9 \times 10^{5}\ C$$

Q. 05 Electric Current, $i(t)$ is the rate of flow of electric charges, $q(t)$

$$\therefore \quad i(t) = \frac{dq}{dt} \quad \text{(instantaneous value)}$$

or

$$I(t) = \frac{\Delta Q}{\Delta t} \quad \text{(average value)}$$

Q. 06 Based on the definition in Q.05, the unit of electric current is that of 'charge per unit time'.

Q.07 Recall: $\Delta Q = I \Delta t$

(This equation ONLY works when the current is CONSTANT!)

$$\therefore \quad \Delta Q = 2A \times 2s$$

$$= 4 \ A.s$$

$$= 4 \ (C.s^{-1}).s$$

$$= 4C$$

↑ Not necessary to show! ↓

Q.08 Recall: $\Delta Q = I \Delta t$

$$\Leftrightarrow \quad Nq = I \Delta t$$

$$\therefore \quad N = \frac{I \Delta t}{q}$$

$$= \frac{2A \times 2s}{1.60 \times 10^{-19} \ C \text{ per electron}}$$

Note!

$$\approx 2.5 \times 10^{19} \text{ electrons.}$$

Pay close attention to the UNITS!

Q. 09 Simply put,

conversions to S.I. units!

$$Q = It$$

$$= 500 \times 10^{-3}\ A \times 2.0\ hr \times \frac{3600\ s}{1\ hr}$$

$$= 3600\ C$$

NB: The "120 W" was a distractor! (typical in MCQs)

Q. 10 By definition, average current is

$$I = \frac{\Delta Q}{\Delta t}$$

$$= \frac{24 \times 10^{3}\ C}{12\ min \times 60\ \frac{s}{min}}$$

$$= 33\ A$$

Q. 11 In a closed loop, $\sum$ p.d.'s $= 0V$. But potential difference is 'work done per unit charge'.

$$\therefore \sum \frac{\Delta W}{q} = 0 \text{ volts}$$

$$\Leftrightarrow \sum \Delta W = 0 \text{ joules}$$

This is an example of the conservation of energy.

Q. 12 An insulating material or substance would not be suitable to test Ohm's Law. Nitrogen is the worst conductor presented.

Q. 13. Materials with 'loosely held' electrons to their nucleus makes good electrial conductors. Typically these are valence electrons in an atom or molecule.

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