DUNMAN HIGH SCHOOL
2024 YEAR 5 H2 CHEMISTRY TIME PRACTICE 1
Mole Concept, Redox & Atomic Structure

Section A – Multiple Choice Questions

MCQ No.	1	2	3	4	5
Answer	C	C	B	C	B

1 **Answer: C**

$n_{Co_2(SO_4)_3} = \frac{20.3}{406} = 0.0500$ mol

A✓ $n_{Co^{3+}} = 2n_{Co_2(SO_4)_3}$ and $n_{SO_4^{2-}} = 3n_{Co_2(SO_4)_3}$

$n_{ions} = n_{Co^{3+}} + n_{SO_4^{2-}} = 5n_{Co_2(SO_4)_3} = 5 \times 0.0500 = 0.250$ mol

no. of ions $= n_{ions} \times L = 1.50 \times 10^{23}$

B✓ $n_{Co^{3+}} = 2n_{Co_2(SO_4)_3} = 2 \times 0.0500 = 0.100$ mol

C×

mass % of Co = $\frac{2 \times 58.9}{406} \times 100$ % = 29.0 %

D✓ mass % of O = $\frac{4 \times 3 \times 16.0}{406} \times 100$ % = 47.3 %

2 **Answer: C**

Let the oxidation state of X in the product be n.

Reduction: $Fe^{3+} + e^- \rightarrow Fe^{2+}$

Oxidation: $X^{3+} \rightarrow X^{n+} + (n - 3)e^-$

No of moles of Fe^{3+} = $\frac{24}{1000}$ x 0.0300 = 0.000720 mol

= number of moles of electrons

No of moles of X^{3+} = $\frac{20}{1000}$ x 0.0120 = 0.000240 mol

$$\frac{mole\ of\ e^-}{mole\ of\ X^{3+}} = \frac{n-3}{1} = \frac{0.000720}{0.000240}$$

n – 3 = 3

n = 6

Option A: n + (-2) = +1, n = 3

Option B: n + (-2) = +2, n = 4

Option C: n + 2(-2) = +2, n = 6

Option D: 2n + 2(-2) = +2, n = 3

3 **Answer: B**

M shows the largest increase from the 2nd to 3rd IE, so it has 2 valence electrons and it is from group 2.

N shows the largest increase from the 7th to 8th IE, so it has 7 valence electrons and it is from group 17.

$\mathbf{M}^{2+}$ and $\mathbf{N}^{-}$ ions form $\mathbf{MN_2}$.

4 **Answer: C**

angle of deflection $\alpha \dfrac{\text{charge}}{\text{mass}}$

for $^{1}H^{+}$, $\frac{q}{m} = \frac{+1}{1}$

for $^{2}D^{-}$, $\frac{q}{m} = \frac{-1}{2}$

Hence, angle of deflection for $^{2}D^{-}$ = $\underline{-2^{o}}$

5 **Answer: B**

The conversion results in the loss of a proton. So, proton/atomic number decrease by 1. Since the proton is converted into a neutron, mass/nucleon number remains unchanged.

$^{111}_{53}I \rightarrow {}^{111}_{52}Te$

Section B – Structured Questions

6 **(a)** **(i)** Reduction: $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

Oxidation: $Cu \rightarrow Cu^{2+} + 2e^-$

Balanced overall equation: $2Cu + O_2 + 4H^+ \rightarrow 2Cu^{2+} + 2H_2O$

(ii)

amount of copper foil = $\dfrac{5}{63.5}$ = 0.07874 mol

amount of O_2 used in the reaction = $\dfrac{1}{2} \times 0.0787$

= 0.03937 mol

Volume of O_2 used in the reaction at r.t.p. = 0.0394×24

= $\underline{\mathbf{0.945\ dm^3}}$ (3 s.f.)

(b) **(i)** mass of water = $0.163 \times 50 = 8.15$ g

amount of $[(CH_3COO)_2Cu]_2.Cu(OH)_2$ = $\dfrac{50 - 8.15}{460.5}$

= 0.09088 mol

= $\underline{\mathbf{0.0909\ mol}}$ (3 s.f.)

(iii) amount of water present = $\frac{8.15}{18.0}$

= 0.4528 mol

$x = \frac{0.4528}{0.09088}$

= 4.98

= **5** (nearest whole number)

7 $C_xH_y(g) + \left(x + \frac{y}{4}\right)O_2(g) \rightarrow xCO_2(g) + \frac{y}{2}H_2O(l)$

The contraction of 40 cm^3 is due to removal of acidic CO_2 by NaOH.

$C_xH_y \equiv xCO_2$

$\frac{1}{x} = \frac{10}{40}$

$x = 4$

The first contraction of is due to the difference in volume of gaseous reactants and gaseous products. Note that water is a liquid at r.t.p.

$\left(V_{C_xH_y} + V_{\text{initial } O_2}\right) - \left(V_{CO_2 \text{ formed}} + V_{\text{excess } O_2}\right) = 30$

$\left(V_{\text{initial } O_2} - V_{\text{excess } O_2}\right) + 10 - 40 = 30$

$V_{O_2 \text{ used}} = 60 \text{ cm}^3$

$C_xH_y \equiv \left(x + \frac{y}{4}\right)O_2$

$\frac{1}{x + \frac{y}{4}} = \frac{10}{60}$

$y = 8$

The molecular formula of the hydrocarbon is $\mathbf{C_4H_8}$.

8 **(a)** The oxidation number of **chromium** increases from **+3** in $Cr(OH)_4^-$ to **+6** in CrO_4^{2-}.

The oxidation number of **oxygen** decreases from **–1** in H_2O_2 to **–2** in H_2O.

H_2O_2 is an **oxidising agent**.

(b) **(i)** volume of $Na_2S_2O_3$ used = $\frac{24.85 + 24.95}{2}$

= **24.90 cm^3**

(ii) $Cr_2O_7^{2-} \equiv 3I_2 \equiv 6S_2O_3^{2-}$

$n(S_2O_3^{2-})$ used $= \frac{24.90}{1000} \times \frac{24.8}{248.2}$

$= 2.49 \times 10^{-3}$ mol

$n(K_2Cr_2O_7)$ in 20.0 cm^3 aliquot $= \frac{1}{6} \times 2.49 \times 10^{-3}$

$= 4.15 \times 10^{-4}$ mol

$n(K_2Cr_2O_7)$ in 250.0 cm^3 $= \frac{250.0}{20.0} \times 4.15 \times 10^{-4}$

$= 5.18 \times 10^{-3}$ mol

mass of $K_2Cr_2O_7 = 5.18 \times 10^{-3} \times 294.2$

$= 1.52$ g

% purity of $K_2Cr_2O_7 = \frac{1.52}{1.65} \times 100$ %

= **92.4 %**

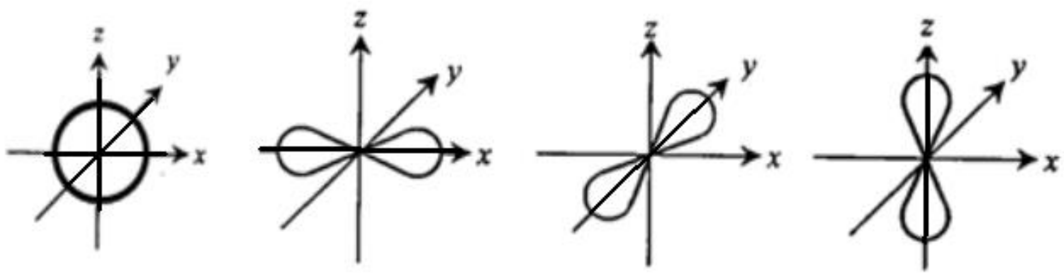
9 **(a)** **(i)** K^+: $1s^2 2s^2 2p^6 3s^2 3p^6$

(ii) **Number of electron shells increase from Na^+ to K^+**, which leads to an increase in **screening effect**.

Hence, outermost electrons are **increasingly further away from the nucleus,** despite the **increase in nuclear charge**

Ionic radius of K^+ is thus **larger than that of Na^+**.

(iii)



3s **$3p_x$** **$3p_y$** **$3p_z$**

(b)

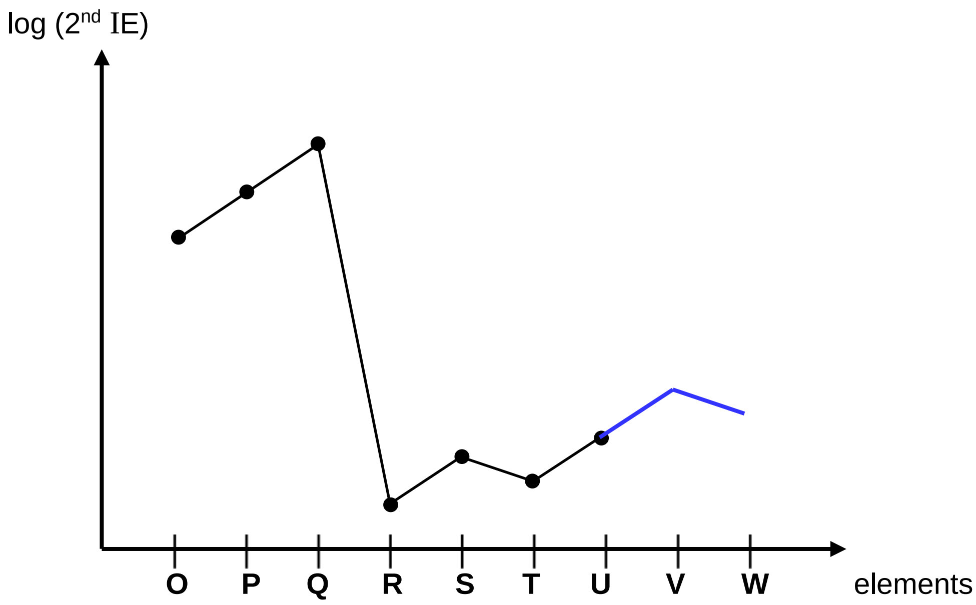


Fig. 9.1

(b) (i) There is a large drop in 2nd IE from **Q** to **R**.

Electron removed from **Q**$^+$ comes from an inner shell which is nearer to the nucleus. Hence, it experiences stronger attraction from the nucleus and requires more energy to remove.

Q has 1 valence electron, i.e. **Q** is in group 1.

(ii) **S**$^+$: ns^2

T$^+$: $ns^2\ np^1$

Smaller amount of energy is required to remove the p electron in **T which** is of **higher energy** than the s electron in **S**.

(iii) (see above)