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

Name : _____ Date: _____

Class : _____ Duration: 50 minutes

| Qn | MCQ | Q6 | Q7 | Q8 | Q9 | Total | % | Grade |
|---|---|---|---|---|---|---|---|---|
| Marks | /5 | /6 | /3 | /6 | /10 | /30 | | |

**Section A – Multiple Choice Questions**
**Answer all questions. Write your answers in the boxes below.**

| MCQ No. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Your Answer | | | | | |

**1** *Use of Data Booklet is relevant to this question.*

Which statement about a 20.3 g sample of $Co_2(SO_4)_3$ ($M_r$ = 406) is **incorrect**?

**A** It contains $1.5 \times 10^{23}$ ions.

**B** It contains 0.1 mol of $Co^{3+}$ ions.

**C** It contains 14.5% of cobalt by mass.

**D** It contains 47.3% of oxygen by mass.

**2** In an experiment, $Fe^{3+}$ oxidises $X^{3+}(aq)$ in acidic medium, while itself is reduced to $Fe^{2+}$.

20.0 $cm^3$ of 0.0120 mol $dm^{-3}$ $X^{3+}(aq)$ was found to require 24.00 $cm^3$ of 0.0300 mol $dm^{-3}$ $Fe^{3+}$ for complete oxidation.

What is the formula of the X-containing species formed?

**A** $XO^+$ **B** $XO^{2+}$

**C** $XO_2^{2+}$ **D** $X_2O_2^{2+}$

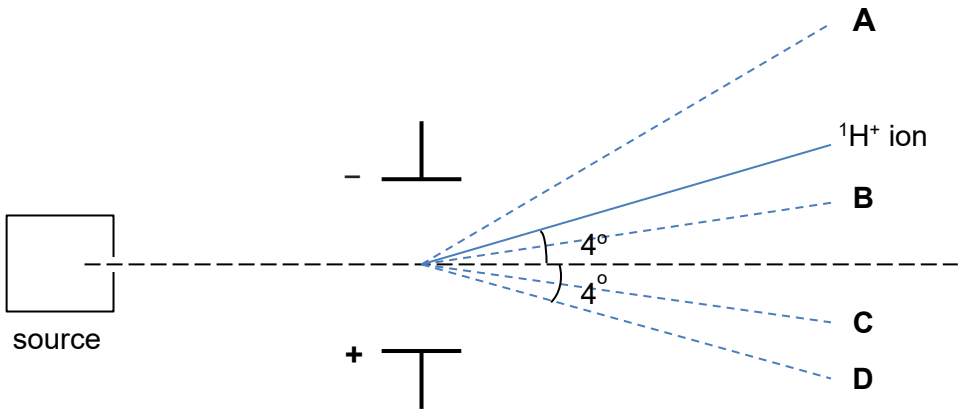
**3** The successive ionisation energies (IE) of two elements, **M** and **N**, are given below.

| IE / kJ mol$^{-1}$ | 1$^{st}$ | 2$^{nd}$ | 3$^{rd}$ | 4$^{th}$ | 5$^{th}$ | 6$^{th}$ | 7$^{th}$ | 8$^{th}$ |
|---|---|---|---|---|---|---|---|---|
| **M** | 550 | 1065 | 4138 | 5500 | 6910 | 8760 | 10230 | 11800 |
| **N** | 1140 | 2103 | 3470 | 4560 | 5760 | 8550 | 9940 | 18600 |

What is the most likely formula of the compound that is formed between **M** and **N**?

**A** **MN** **B** **$MN_2$** **C** **$M_2N$** **D** **$M_3N_2$**

**4** When passed through an electric field, the $^1H^+$ ion is deflected as shown below.




Which of the above beams represents the deflection for the ion $^2D^-$?
(D = $^2_1H$)

**5** *Use of Data Booklet is relevant to this question.*

Some isotopes are unstable and undergo nuclear (radioactive) reactions. In one type of reaction, an unstable nucleus assimilates an electron from an inner orbital of its electron cloud. The net effect is the conversion of a proton and an electron into a neutron.

$$^1_1p + {}^0_{-1}e \rightarrow {}^1_0n$$

Which of the following is an example of this type of reaction?

**A** $^{11}C \rightarrow {}^{12}C$

**B** $^{111}I \rightarrow {}^{111}Te$

**C** $^{76}Br \rightarrow {}^{75}Br$

**D** $^{76}Kr \rightarrow {}^{75}Br$

## Section B – Structured Questions

**Answer all questions in the space provided. Marks will be allocated for relevant working.**

**6** Verdigris was the most vibrant green pigment available and was frequently used in painting until the 19$^{th}$ century. Verdigris is resistant to fading when it is exposed to light, as numerous examples of the paintings show. This pigment was made by hanging copper foil over boiling vinegar.

**(a)** During the preparation of verdigris, copper atoms are oxidised to copper(II) ions, $Cu^{2+}$. Oxygen is reduced to water in acidic medium.

**(i)** Write half–equations for both the reduction and oxidation reactions. Hence write the balanced equation for the reaction between Cu and $O_2$.

Reduction: ……...……

Oxidation: ……...

Overall: ..……[2]

**(ii)** Given that 5 g of copper foil was boiled in vinegar to produce verdigris, calculate the volume of oxygen used in the reaction at room temperature and pressure.

[2]

**(b)** **(i)** A sample of verdigris has the formula $[(CH_3COO)_2Cu]_2.Cu(OH)_2.xH_2O$. 50 g of the sample contains 16.3% of water by mass.

Calculate the number of moles of $[(CH_3COO)_2Cu]_2.Cu(OH)_2$ present in 50 g of the verdigris sample.

[$M_r$ of $[(CH_3COO)_2Cu]_2.Cu(OH)_2$ = 460.5]

[1]

**(ii)** Hence or otherwise, calculate the value of $x$ in the formula.

[1]

[Total: 6]

**7** 10 $cm^3$ of a gaseous hydrocarbon, $C_xH_y$, was exploded with an excess of oxygen. There was a contraction of 30 $cm^3$. When the resulting gaseous mixture was treated with aqueous sodium hydroxide, there was a further contraction of 40 $cm^3$. Given that all gas volumes were measured at r.t.p., determine the molecular formula of the hydrocarbon. Show your working clearly.

[3]

[Total: 3]

**8** **(a)** $[Cr(OH)_4]^-$ reacts with hydrogen peroxide, $H_2O_2$, under alkaline conditions as shown in the below equation:

$$2[Cr(OH)_4]^- + 3H_2O_2 + 2OH^- \rightarrow 2CrO_4^{2-} + 8H_2O$$

State the changes in oxidation numbers that occur during this reaction. Hence identify the role of hydrogen peroxide when it reacts with $[Cr(OH)_4]^-$.

……

……

……

……[2]

**(b)** The percentage purity of a sample of potassium dichromate, $K_2Cr_2O_7$, was determined by volumetric analysis.

1.65 g of $K_2Cr_2O_7$ ($M_r$ = 294.2) was added to excess aqueous potassium iodide, KI, in acidic medium. The solution was made up to 250.0 $cm^3$ with distilled water.

$$Cr_2O_7^{2-} + 6I^- + 14H^+ \rightarrow 3I_2 + 2Cr^{3+} + 7H_2O$$

A 20.0 $cm^3$ aliquot was withdrawn and titrated against 24.8 g $dm^{-3}$ aqueous sodium thiosulfate pentahydrate, $Na_2S_2O_3.5H_2O$ ($M_r$ = 248.2).

$$2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$$

The following results were obtained.

| Titration | 1 | 2 | 3 |
|---|---|---|---|
| Initial burette reading / $cm^3$ | 0.40 | 0.10 | 0.10 |
| Final burette reading / $cm^3$ | 25.55 | 24.95 | 25.05 |
| Volume of $Na_2S_2O_3.5H_2O$ used / $cm^3$ | 25.15 | 24.85 | 24.95 |

**(i)** From the titration results above, obtain a suitable volume of $Na_2S_2O_3.5H_2O$ which reacted with the iodine in the 20.0 $cm^3$ aliquot. Show clearly how you obtained this volume.

[1]

**(ii)** Using your answer to **(b)(i)**, calculate the percentage purity of the sample of potassium dichromate.

[3]

[Total: 6]

**9** **(a)** While glutamic acid is often used as a flavour enhancer in the form of its sodium salt, monosodium glutamate (MSG), other cations such as $K^+$ have also been used to form glutamate salts.

**(i)** Write the full electronic configuration of $K^+$.

……..[1]

**(ii)** State and explain how the ionic radius of $K^+$ compares to that of $Na^+$.

……...

……...

……...

……...

……...

…….. [2]

**(iii)** Sketch, on separate diagrams, all the **occupied** orbitals in the **outermost** electron shell of $K^+$. Label the orbitals clearly.

[2]

**(b)** Fig. 9.1 shows a sketch of the second ionisation energy ($2^{nd}$ IE) of seven consecutive elements from **O** to **U**.

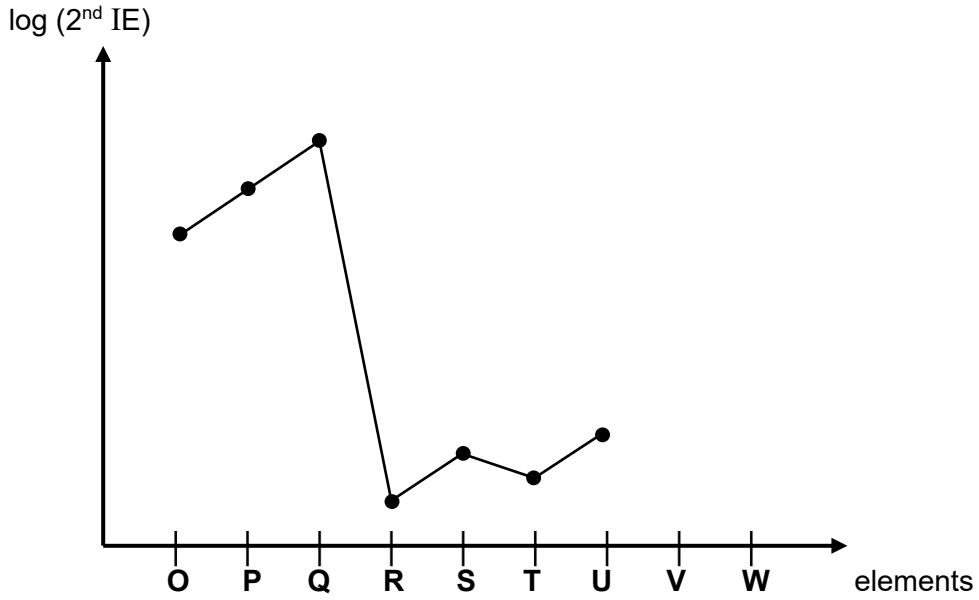



**Fig. 9.1**

**(i)** By comparing the $2^{nd}$ IE of **Q** and **R**, deduce which Group in the Periodic Table element **Q** is from.

……...

……...

……...

……...

……..[2]

**(ii)** By considering the outermost shell electronic configurations of $\mathbf{S}^+$ and $\mathbf{T}^+$, explain why there is a drop in $2^{nd}$ IE from **S** to **T**.

$\mathbf{S}^+$: ……. $\mathbf{T}^+$: ……

……...

……...

……..[2]

**(iii)** On Fig. 9.1, complete the sketch to indicate the $2^{nd}$ IE of the next two consecutive elements, **V** and **W**. [1]

[Total:10]

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