2021 ASSESSMENT MATERIALS

A- level Chemistry

Inorganic Chemistry

Total number of marks: 47

0 2 The elements sodium to sulfur in Period 3 all react with oxygen to form oxides.

0 2 . 1 Give an equation and **two** observations made for the reaction that occurs when sodium is heated in oxygen.

[2 marks]

Equation $4Na_{(s)} + O_{2(g)} \longrightarrow 2Na_2O_{(g)}$

Observation 1 orange flame

Observation 2 white solid formed

0 2 . 2 Give an equation and **one** observation made for the reaction that occurs when phosphorus is heated in oxygen.

[2 marks]

Equation $P_4 + 5O_2 \longrightarrow P_4O_{10}$

Observation white smoke

0 2 . 3 The melting points of the highest oxides of the elements sodium to sulfur are shown in **Table 2**.

Table 2

	Highest oxide of					
	sodium	magnesium	aluminium	silicon	phosphorus	sulfur
Melting point/K	1548	3125	2345	1883	573	290

Explain the increase in melting point from sodium oxide to magnesium oxide.

[2 marks]

in magnesium oxide there are stronger electrostatic forces of attraction between the Mg^{2+} and O^{2-} ions than between Na^+ and O^{2-} so more energy is required to break the ionic bonds in MgO than Na_2O This is because Mg^{2+} has a higher nuclear charge than Na^+.

0 2 . 4 Explain why the melting point of the oxide of silicon is much higher than that of the highest oxide of phosphorus.

[3 marks]

silicon is a larger molecule (S_8) than phosphorus (P_4) so there are stronger van der Waals forces between the molecules, therefore more energy is required to break these forces

0 3 This question is about Period 3 elements.

0 3 . 3 Explain why the atomic radius decreases across Period 3, from sodium to chlorine.

[2 marks]

atomic radius decreases as the number of protons in the nucleus increases, so the nuclear charge increases and the outer electrons are more strongly attracted to the nucleus so pulled closer in.

0 5 This question is about some Group 7 compounds.

0 5 . 5 Solution **Y** contains **two** different negative ions.

To a sample of solution **Y** in a test tube a student adds

- silver nitrate solution
- then an excess of dilute nitric acid
- finally an excess of concentrated ammonia solution.

The observations after each addition are recorded in **Table 3**.

Table 3

Reagent added to solution Y	**Observation**
silver nitrate solution	cream precipitate containing compound **D** and compound **E**
excess dilute nitric acid	cream precipitate **D** and bubbles of gas **F**
excess concentrated ammonia solution	colourless solution containing complex ion **G**

Give the formulas of **D, E** and **F**.
Give an **ionic** equation to show the formation of **E**.
Give an equation to show the conversion of **D** into **G**.

[6 marks]

Formula of **D** $AgBr$

Formula of **E** Ag_2CO_3

Formula of **F** CO_2

Ionic equation to form **E**

$2Ag^+ + CO_3^{2-} \rightarrow Ag_2CO_3$

Equation to show the conversion of **D** into **G**

$NH_3 + AgBr \longrightarrow [Ag(NH_3)_2]^+ + Br^-$

0 3 . 1 Explain why complexes formed from transition metal ions are coloured.

[3 marks]

electrons in the d orbital of transition metals absorb energy and get excited into a higher energy level. the energy required to cause an electron to jump from a lower to a higher 3d orbital corresponds to a certain wavelength of visible light. This wavelength is absorbed while the other wavelengths are reflected; the complement of the colour absorbed is seen.

The iron content of iron tablets can be determined by colorimetry.

Method:

- Dissolve a tablet in sulfuric acid.
- Oxidise all the iron from the tablet to $Fe^{3+}(aq)$.
- Convert the $Fe^{3+}(aq)$ into a complex that absorbs light of wavelength 490 nm
- Make the solution up to 250 cm^3
- Measure the absorbance of light at 490 nm with a colorimeter.
- Use a calibration graph to find the concentration of the iron(III) complex.

0 3 . 2 Calculate the energy, in J, gained by each excited electron in the absorption at 490 nm

Speed of light, $c = 3.00 \times 10^8$ m s^{-1}
Planck constant, $h = 6.63 \times 10^{-34}$ J s

[3 marks]

$$\Delta E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{4.9 \times 10^{-9}}$$

$490nm = 4.9 \times 10^{-9}$ $\Delta E = 4.06 \times 10^{-17}$ J

Energy gained by each electron 4.06×10^{-17} J

0 3 . 3 Describe how a calibration graph is produced and used to find the concentration of the iron(III) complex.

[3 marks]

produce a calibration graph by measuring the absorbance of five known concentrations and plot concentration (on x axis) and absorbance (on y axis). Draw a line of best fit and then measure the absorbance of the iron(III) complex Draw a line across from absorbance and down to concentration.

0 1 This question is about emissions of oxides of nitrogen from petrol and diesel engines.

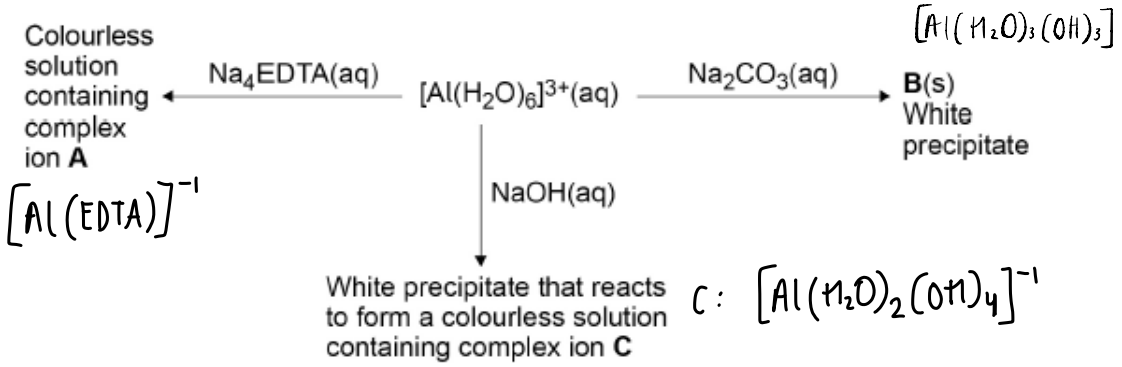
0 1 . 4 Petrol vehicles have a catalytic converter which decreases emissions of oxides of nitrogen.
Platinum in the catalytic converter acts as a heterogeneous catalyst.

State the meaning of the term heterogeneous catalyst.

[2 marks]

a catalyst that is in a different state to the reactants

0 5 Some reactions of the $[Al(H_2O)_6]^{3+}(aq)$ ion are shown.



$[Al(EDTA)]^{-1}$

C: $[Al(H_2O)_2(OH)_4]^{-1}$

0 5 . 1 Give the formula of the white precipitate **B**.

State **one** other observation when $Na_2CO_3(aq)$ is added to a solution containing $[Al(H_2O)_6]^{3+}(aq)$ ions.

Give an equation for this reaction.

[3 marks]

Formula of **B** $[Al(H_2O)_3(OH)_3]$

Observation effervescence

Equation

$$2[Al(H_2O)_6]^{3+} + 3CO_3^{2-} \longrightarrow 2[Al(H_2O)_3(OH)_3] + 3CO_2 + 3H_2O$$

0 5 . 2 Give the formula of the complex ion **C**.

State **one** condition needed for the formation of **C** from $[Al(H_2O)_6]^{3+}(aq)$ and $NaOH(aq)$.

Give an equation for this reaction.

[3 marks]

Formula of **C** $[Al(H_2O)_2(OH)_4]^{-1}$

Condition NaOH in excess

Equation

$$[Al(H_2O)_6]^{3+} + 4OH^- \longrightarrow [Al(H_2O)_2(OH)_4]^{1-} + 4H_2O$$

0 5 . 3 Deduce the formula of the complex ion **A**.

[1 mark]

$[Al(EDTA)]^{1-}$

0 5 . 4 Explain, with the use of an equation, why a solution containing $[Al(H_2O)_6]^{3+}$ has a pH <7

[3 marks]

Equation

$[Al(H_2O)_6]^{3+} \rightarrow [Al(H_2O)_5(OH)]^{2+} + H^+$

Explanation Al^{3+} acts as an acid and dissociates to form H^+ ions in solution

1 5 In the test for a halide ion in aqueous solution, dilute nitric acid is added before the addition of silver nitrate solution.

Why is nitric acid added?

[1 mark]

A It increases the concentration of nitrate ions. ○

B It prevents the precipitation of silver compounds other than halides. ●

C It prevents the silver nitrate being precipitated. ○

D It provides the acidic solution required for precipitation. ○

1 7 Which shows the electron configuration of an atom of a transition metal?

[1 mark]

A [Ar] $4s^2 3d^0$ ○

B [Ar] $4s^2 3d^8$ ●

C [Ar] $4s^2 3d^{10}$ ○

D [Ar] $4s^2 3d^{10} 4p^1$ ○

1 8 Which will **not** act as a ligand in the formation of a complex ion?

[1 mark]

A CH_4 ●

B CO: ○

C H_2O: ○

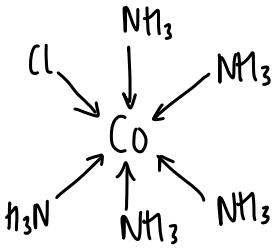
D :NH_3 ○

1 9 Which shows the correct oxidation state and co-ordination number of cobalt in $[Co(NH_3)_5Cl]Cl_2$?

$x + 0 + -1 + -2 = 0 \Rightarrow x = +3$

[1 mark]

	oxidation state	co-ordination number	
A	+2	5	○
B	+2	6	○
C	+3	5	○
D	+3	6	●



2 1 Which compound decolourises acidified potassium manganate(VII) solution?

MnO_4^-

[1 mark]

A $Al_2(SO_4)_3$ ○

B $CuSO_4$ ○

C $FeSO_4$ $Fe^{2+} \rightarrow Fe^{3+}$ and $Mn^{+7} \rightarrow Mn^{+2}$ ●

D $Fe_2(SO_4)_3$ ○

3 1 What is the minimum volume, in cm^3, of 0.02 mol dm^{-3} $KMnO_4$ solution needed to oxidise 0.01 mol of VO^{2+}?

$$5VO^{2+} + MnO_4^- + H_2O \rightarrow 5VO_2^+ + Mn^{2+} + 2H^+$$

$0.01 \longrightarrow 0.002$

[1 mark]

A 10 ○

B 50 ○

C 100 ●

D 200 ○

$V = \frac{n}{C} = \frac{0.002}{0.02} = 0.1\ dm^3 = 100cm^3$

soluble, no ppt

$Ba + H_2O \rightarrow Ba(OH)_2 + H_2$

1 5 What is the correct observation when barium metal is added to an excess of water?

[1 mark]

A Forms a colourless solution only ○

B Forms a colourless solution and effervesces ●

C Forms a white precipitate only ○

D Forms a white precipitate and effervesces ○

1 6 An aqueous solution of a salt gives a white precipitate when mixed with aqueous silver nitrate and when mixed with dilute sulfuric acid.

$AgNO_3$

Which could be the formula of the salt?

[1 mark]

A $BaCl_2$ ●

B $(NH_4)_2SO_4$ ○

C KCl ○

D $Sr(NO_3)_2$ ○

HCl

1 8 What is observed when concentrated hydrochloric acid is added to an aqueous solution of $CuSO_4$ until no further change occurs?

[1 mark]

A A colourless gas is evolved and a precipitate forms. ○

B A colourless gas is evolved and no precipitate forms. ○

C A precipitate forms that dissolves in an excess of concentrated hydrochloric acid. ○

D The solution changes colour and no precipitate forms. ●