Name ..... Class: .....

Start Time ..... End Time ..... Time Taken .....

Time allowed: 55 minutes

INSTRUCTIONS TO CANDIDATES

- This docu[illegible]s designed to be used as a practice test.
- Comp[illegible] t[illegible] test [illegible]nder exam conditions in one sitting.
- Optional: B[illegible] [illegible]arking it, go through the paper with a set of notes and improve your answers.
- Mark the test [illegible]ng [illegible]ark scheme make corrections on the paper.
- Complete the ta[illegible]e on [illegible] front page.
- Improve your note[illegible] [illegible]at [illegible]ey better reflect your weaknesses.
- Make a note of your [illegible]re[illegible]ins a[illegible] weaknesses for future revision.

Mark Scheme

Success Criteria	Questions in Paper	Mark	Out of	%	Rank Order
Introduction to Transition Metals	[illegible]a, 1d, 2a, [illegible]g, 4[illegible]4b		9		
Variable Oxidation States	1b[illegible] [illegible]4ci, 6, [illegible]		5		
Isomerism in Complexes	[illegible]		3		
Reactions of Aqueous Ions	1f, 2b, [illegible]c, 2e, 2f, 5[illegible] 5f, 5g		11		
Formation of Coloured Compounds	2d, 5a, 5b, 5c		[illegible]		
Redox Titrations	2h		7		
Shapes of Complexes	3, 4cii, 5d		4		
Catalysis	8a, 8b		2		
Redox Equations	8c, 8d		2		
Total			51		

Q1.

(a) (Central) metal atom/ion surrounded by ligands

Allow complex in which number of coordinate bonds exceeds oxidation state of the metal

1

(b) PF_3 is neutral **and** the complex is neutral

*Allow PF_3 has no charge **and** the complex has no charge*

Ignore electronegativity

1

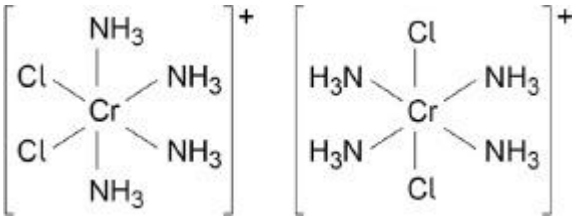
(c) (+)3

1

(d) Covalent (bond)

1

(e)



M1 for the two isomers

M2 for the charge on the complex ion.

Allow 1 mark for one correct isomer with + charge

Cis-trans/geometric/E-Z isomerism

Ignore stereoisomerism

3

(f) $[Cr(H_2O)_5Cl]Cl_2$

Allow $[Cr(H_2O)_5Cl]^{2+}$ + 2 Cl^-

1

[8]

Q2.

(a) $1s^2\ 2s^2\ 2p^6$

Allow $[He]\ 2s^2 2p^6$

1

(b) $Al_2(SO_4)_3 + 12\ H_2O \rightarrow 2\ [Al(H_2O)_6]^{3+} + 3\ SO_4^{2-}$

Allow $[Al(H_2O)_6]_2(SO_4)_3$

1

(c) **M1** Al^{3+} has a high charge **and** small size

OR

Al^{3+} has a high charge density

M2 Al^{3+} weakens the O-H bond (in water ligands and donates H^+ to water or forms H_3O^+ ions with water)

M2 *Al^{3+} attracts electrons from the O-H bond (in the ligand and releases H^+ or H_3O^+ ions)*

OR

Al^{3+} polarises the O-H bond/water molecule

2

(d) Colourless (solution)

Allow no d-d transitions (as there are no d electrons)

OR

Doesn't absorb visible light

1

(e) $[Al(H_2O)_6]^{3+} + 3\ NH_3 \rightarrow Al(H_2O)_3(OH)_3 + 3\ NH_4^+$

White ppt or white solid

*Do **not** accept effervescence*

*Do **not** accept white ppt dissolves in excess NH_3*

Ignore state symbols

2

(f) $[Al(H_2O)_6]^{3+}$

1

(g) A circle around one or more N

A circle around one or more O^-

2

(h) M1 n ($EDTA^{4-}$) added = $\underline{5 \times 10^{-4}}$ mol

alternative methods will be allowed

M2 n (Zn^{2+}) = $\underline{1.89 \times 10^{-4}}$ mol

M3 n ($EDTA^{4-}$) reacted with the 25 cm^3 sample of Al^{3+} = $5 \times 10^{-4} - 1.89 \times 10^{-4} = 3.11 \times 10^{-4}$ mol

M3 = M1 − M2

M4 n $EDTA^{4-}$ reacted with the 250 cm^3 sample of Al^{3+} = 3.11×10^{-4} **x 10** = 3.11×10^{-3} mol

$$M4 = \frac{M3 \times 250}{25}$$

M5 n $Al_2(SO_4)_3\ xH_2O = 3.11 \times 10^{-3}$ **÷ 2** = 1.555×10^{-3} mol

M5 = M4 ÷ 2

M6 M_r $Al_2(SO_4)_3\ xH_2O = 1.036 \div 1.555 \times 10^{-3} = 666.2$

M6 = 1.036 ÷ M5

M7 $342.3 + 18x = 666(.2)$ so $x = 18$

$M7 = \frac{M6 - 342.3}{18}$ *and answer as integer*

7

[17]

Q3.

A

$[CoCl_4]^{2-}$ is square planar.

[1]

Q4.

(a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$

allow [He] $2s^2$. or [Ne] $3s^2$.or [Ar]$3d^{10}$

1

d sub-shell / shell / orbitals / sub-level full (or not partially full)

can only score M2 if d^{10} in M1 correct

allow 'full d orbital' if d^{10} in M1

do not allow d block

1

(b) H_2 / hydrogen

do not allow H

1

no lone / spare / non-bonded pair of electrons

only score M2 if M1 correct or give 'H' in M1

1

(c) (i) +2 or 2+ or Pd^{2+} or II or +II or II+ or two or two plus

1

(ii) tetrahedral

these shapes can be in any order

1

square planar

allow phonetic spelling e.g. tetrahydral

1

[9]

Q5.

(a) (visible/white) light <u>absorbed</u> (and (d) electrons excited)

*do **not** accept absorbs yellow light*

1

only yellow light transmitted/reflected

*do **not** accept emitted*

1

reference to light required in M1 or M2

(b) $(\Delta)E = h\nu$ **or** $\frac{hc}{\lambda}$

*allow with **or** without numbers*

1

$6(.00) \times 10^{14}$ (s^{-1})

1

(c) (change in) oxidation state (of metal)

1

(change of) ligand

allow (change the) number of ligands

1

(change in) co-ordination number

1

(d) tetrahedral

allow tetrahedron

1

(e) $[CuCl_4]^{2-} + 6H_2O \rightarrow [Cu(H_2O)_6]^{2+} + 4Cl^-$

1

(f) deep blue

allow dark blue

1

$[CuCl_4]^{2-} + 4NH_3 + 2H_2O \rightarrow [Cu(NH_3)_4(H_2O)_2]^{2+} + 4Cl^-$

1

(g) $[Cu(EDTA)]^{2-}$

ignore absence of brackets

1

[12]

Q6.

C

$FeSO_4$

[1]

Q7.

A

[1]

Q8.

(a) Negative ions repel one another

1

(b) Positive ions attract negative ions in catalysed process

Allow activation energy decreases.

Allow alternative route with lower E_a
Ignore references to heterogenous catalysis.

1

(c) $S_2O_8^{2-} + 2e^- \longrightarrow 2SO_4^{2-}$

Allow multiples including fractions.
Ignore state symbols.

1

(d) $S_2O_8^{2-} + 2I^- \longrightarrow 2SO_4^{2-} + I_2$

Allow multiples including fractions.
Ignore state symbols.
Allow the correct equation involving I_3^-
$S_2O_8^{2-} + 3I^- \longrightarrow 2SO_4^{2-} + I_3^-$

1

[4]