Gateways School

**Transition metals**

**Revision PPQ**

51 marks

**Q1.**

(a)     (ligand) substitution

*Allow ‘ligand exchange’.*

**1**

(b)     To displace the equilibrium to the right

*To ensure reaction goes to completion.*

**1**

To improve the yield

*Allow ‘to replace all chlorines’.*

**1**

(c)     (i)      K2PtCl4  +  4Kl  →  K2Ptl4  +  4KCl

*Allow correct ionic equations PtCl42−  +  4l−  →  Ptl42−  +  4Cl−*

*Allow multiples and fractions.*

**1**

(ii)     = (780.9) ×100 / (415.3  +  664)

*Working must be clearly shown.*

*Allow one mark for correct relationship even if Mr values are incorrect eg using values from ionic equation.*

**1**

= 72.4

*Allow 72%*

**1**

(d)     (i)      Ag+  +  I−  →  AgI

*Ignore state symbols even if incorrect.*

*This equation only.*

**1**

(ii)     Stops the reverse reaction / equilibrium displaced to the right

**1**

(e)     Number of steps in the process

*Allow ‘equilibrium may lie on the reactant side’ / side reactions / isomer formation.*

**1**

Losses at each stage of the synthesis

*Equilibrium losses or practical losses or yield not 100% for each step.*

**1**

(f)     Minimum amount of hot solvent

*Accept ‘small’ for minimum.*

*Accept water.*

**1**

Cool / crystallise

**1**

Filter

**1**

(g)    (i)      Small amounts are more likely to kill cancer cells rather than the patient

**1**

(ii)     Wear gloves / wash hands after use

*Ignore masks.*

*Apply the list principle if more than one answer.*

**1**

**[15]**

**Q2.**

(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 Ea*

*Ignore references to heterogenous catalysis.*

**1**

(c)     S2O82–  +  2e–    2SO42–

*Allow multiples including fractions.*

*Ignore state symbols.*

**1**

(d)     S2O82–  +  2I–    2SO42–  +  I2

*Allow multiples including fractions.*

*Ignore state symbols.*

*Allow the correct equation involving I3–*

*S2O82–  +  3I–    2SO42–  +  I3–*

**1**

**[4]**

**Q3.**

(a)    In each of **P** and **Q** the oxidation state of Cr is +3 / both contain Cr3+

*If oxidation states are different lose M1 and M2*

**1**

In each of **P** and **Q** the electron configuration is the same / d3 / 3d3

*Do not allow just same number of electrons*

**1**

Ligands are different

**1**

Different energies of (d) electrons / different split of (d) electron energy levels / different energy gap of (d) electrons / different (d) orbital energy

**1**

Different wavelengths / frequencies / energies of light / colours (of light) are absorbed (by the d electrons)

*Reference to emission and / or uv light but not to visible loses M5 and M6*

**1**

Different wavelengths / frequencies / energies of light / colours (of light) are transmitted / reflected

**1**

(b)    [Co(NH3)6]2+ + 3NH2CH2CH2NH2 → [Co(NH2CH2CH2NH2)3]2+ + 6NH3

*Allow NH2C2H4NH2 and CH2NH2CH2NH2*

*Allow partial substitution*

*Do not allow en or other formulae for M1 but can score M2*

**1**

4 particles form 7 particles / increase in number of particles

*Allow molecules, entities, ions, moles instead of particles*

*Do not allow atoms*

*Can score M2 if numbers match candidates incorrect equation provided number of particles increases*

**1**

disorder / entropy increases / *ΔS* positive

*Cannot score M3 if number of particles stated or in equation is the same or decreases*

**1**

*ΔH* is approx. zero / no net change in bond enthalpies

*Allow same number and type of bonds broken and formed*

**1**

*ΔG* is negative / *ΔG*

*Mark M4 and M5 independently*

**1**

(c)    (i)
 

*Correct displayed structure*

*Must show all three N–H bonds on each N*

*Ignore arrows and lone pairs, attempt to show shape*

*Ignore charges on atoms in structure for M1*

**1**

Bond angle 90°

*Allow 87 to 93 degrees*

*Allow this angle for any complex with 4 ligands eg if NH2 or Cl used instead of NH3*

**1**

Charge of zero

*Award this mark if no charge shown on structure but if charges shown on ligands in M1 must state that overall charge = 0*

*Allow M3 only if cisplatin is correct OR if trans form OR if NH3 not displayed OR if NH2 used instead of NH3*

**1**

(ii)     (NH3)2PtCl2 + H2O → [(NH3)2PtCl(H2O)]+ + Cl-

*If formula of cisplatin is incorrect, mark consequentially provided H2O replaces Cl– and charge on complex increases by one*

**1**

(iii)    Use in small amounts / short bursts / target the application / monitor the patients

*Allow: Give patient time between doses*

**1**

(d)    V2O5 + SO2 → V2O4 + SO3 / V2O5 + SO2 → 2VO2 + SO3

*Allow multiples*

**1**

V2O4 +  O2 → V2O5 / 2VO2 +  O2 → V2O5

**1**

Acts as a catalyst / lowers the activation energy

**1**

Speeds up the (overall) reaction (between SO2 and oxygen)

**1**

**[20]**

**Q4.**

(a)    moles of Cr2O72– per titration = 21.3 × 0.0150 / 1000 = 3.195 × 10–4

**1**

(Cr2O72- + 14H+ + 6Fe2+ → 2Cr3+ + 7H2O + 6Fe3+ ) Cr2O72-:Fe2+ = 1:6

*If 1:6 ratio incorrect cannot score M2 or M3*

**1**

moles of Fe2+ = 6 × 3.195 × 10–4 = 1.917 × 10–3

*Process mark for M1 × 6 (also score M2)*

**1**

original moles in 250 cm3 = 1.917 × 10–3 × 10 = 1.917 × 10–2

*Process mark for M3 × 10*

**1**

mass of FeSO4.7H2O = 1.917 × 10–2 × 277.9 = 5.33 (g)

*Mark for answer to M4 × 277.9*

(allow 5.30 to 5.40)

*Answer* ***must*** *be to at least 3 sig figs*

*Note that an answer of 0.888 scores M1, M4 and M5 (ratio 1:1 used)*

**1**

(b)    (Impurity is a) reducing agent / reacts with dichromate / impurity is a version of FeSO4 with fewer than 7 waters (not fully hydrated)

*Allow a reducing agent or compound that that converts Fe3+ into Fe2+*

**1**

Such that for a given mass, the impurity would react with more dichromate than a similar mass of FeSO4.7H2O

OR for equal masses of the impurity and FeSO4.7H2O , the impurity would react with more dichromate.

*Must compare mass of impurity with mass of FeSO4.7H2O*

**1**

**[7]**

**Q5.**

C

**[1]**

**Q6.**

D

**[1]**

**Q7.**

C

**[1]**

**Q8.**

D

**[1]**

**Q9.**

D

**[1]**