MEGA LECTURE

TOPIC 15 HW MS

1. (a) $\Delta E = hv$

Allow = hf

1

$v = \Delta E / h = 2.84 \times 10^{-19} / 6.63 \times 10^{-34} = 4.28 \times 10^{14}\ s^{-1}$ / Hz

Allow $4.3 \times 10^{14}\ s^{-1}$ / Hz

Answer must be in the range:

4.28 4.30 × 10^{14}

1

(b) (One colour of) light is absorbed (to excite the electron)

If light emitted, CE = 0

1

The remaining colour / frequency / wavelength / energy is transmitted (through the solution)

Allow light reflected is the colour that we see.

1

(c) Bigger

1

Blue light would be absorbed

OR light that has greater energy than red light would be absorbed

OR higher frequency (of light absorbed / blue light) leads to higher ΔE

Can only score M2 if M1 is correct.

1

(d) Any **three** from:

- (Identity of the) metal
- Charge (on the metal) / oxidation state / charge on complex
- (Identity of the) ligands
- Co-ordination number / number of ligands
- Shape

3 max

[9]

2. (a) Variable oxidation state

1

eg Fe(II) and Fe (III)

Any correctly identified pair

Allow two formulae showing complexes with different oxidation states even if oxidation state not given

1

(Characteristic) colour (of complexes)

1

eg Cu^{2+}(aq) / $[Cu(H_2O)_6]^{2+}$ is blue

Any correct ion with colour scores M3 and M4

Must show (aq) or ligands OR identified coloured compounde.g. $CoCO_3$)

1

(b) Tetrahedral

1

$[CuCl_4]^{2-}$ / $[CoCl_4]^{2-}$

Any correct complex
(Note charges must be correct)

1

Square planar

1

$(NH_3)_2PtCl_2$

Any correct complex

1

Linear

Do not allow linear planar

1

$[Ag(NH_3)_2]^+$

$[AgCl_2]^-$ etc

1

(c) (i) $[Ca(H_2O)_6]^{2+} + EDTA^{4-} \rightarrow [CaEDTA]^{2-} + 6H_2O$

If equation does not show increase in number of moles of particles CE = 0/3 for (c)(ii)
If no equation, mark on

1

(ii) 2 mol of reactants form 7 mol of products

Allow more moles/species of products
Allow consequential to (c)(i)

1

Therefore disorder increases

1

Entropy increases / +ve entropy change / free-energy change is negative

1

(iii) Moles EDTA = 6.25 × 0.0532 / 1000 = (3.325×10^{-4})

1

Moles of Ca^{2+} in 1 dm^3 = $3.325 \times 10^{-4} \times 1000 / 150 = (2.217 \times 10^{-3})$

Mark is for M1 × 1000 / 150 ***OR*** *M1 × 74.1*
If ratio of Ca^{2+} : EDTA is wrong or 1000 / 150 is wrong, CE and can score M1 only
This applies to the alternative

1

Mass of $Ca(OH)_2$ = $2.217 \times 10^{-3} \times 74.1 = 0.164$ g

M1 × 74.1 × 1000 / 150
Answer expressed to 3 sig figs or better
Must give unit to score mark
Allow 0.164 to 0.165

1

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3. (a) W is $CuCl_4^{2-}$

1

Yellow-green/yellow/green

Not necessary to indicate solution
Do not allow precipitate/solid

$[Cu(H_2O)_6]^{2+} + 4Cl^- \rightarrow CuCl_4^{2-} + 6H_2O$ **1**

Allow + *4HCl* → *4H*$^+$ **1**

(b) X is $Cu(H_2O)_4(OH)_2$

Allow $Cu(OH)_2$/copper hydroxide

1

Blue precipitate/solid

Ignore shades

1

$[Cu(H_2O)_6]^{2+} + 2NH_3 \rightarrow Cu(H_2O)_4(OH)_2 + 2NH_4^+$

Allow any balanced equation/equations leading to this hydroxide or $Cu(OH)_2$

But must use ammonia

1

(c) Y is $[Cu(NH_3)_4(H_2O)_2]^{2+}$

1

Deep/dark/royal blue solution

QoL

1

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

Accept equation for formation from $Cu(OH)_2$

1

(d) Z is $CuCO_3$

Allow copper carbonate

1

Green solid/precipitate

Allow blue-green precipitate

1

$[Cu(H_2O)_6]^{2+} + CO_3^{2-} \rightarrow CuCO_3 + 6H_2O$

1

(e) (i) $Cu^{2+}(aq) + Fe(s) \rightarrow Cu(s) + Fe^{2+}(aq)$

Allow hydrated ions

State symbols not essential but penalise if wrong

1

Blue

Do not allow description of solids

1

Green

Allow yellow/(red-)brown/orange

1

(ii) Any two correct points about copper extraction from two of these three categories:

Any relevant mention of lower energy consumption

Do not allow reference to electricity alone or to temperature alone.

Any relevant mention of benefits of less mining (of copper ore)

Allow avoids depletion of (copper ore) resources

Less release of CO_2 (or CO) into the atmosphere

Not just greenhouse gases. Must mention CO_2 or CO

Max 2

[17]

4. (a) (i) Correctly plots all points (± one square) and draws straight line of best fit

Lose this mark if the candidate's line is doubled or kinked.
Lose this mark if the line does not pass within one square of the origin, extending the line if necessary.

1

Plotted points cover over half of grid

1

(ii) 0.046 ± 0.002 (mol dm^{-3})

1

0.088 to 0.096 (mol dm^{-3})

Allow M1 × 2
Allow two marks for correct answer.
Answer must be to at least two significant figures.

1

(iii) Total volume = (100 × 0.1) / 0.04 = 250 (cm^3)

Allow any correct alternative method of working.

1

Therefore add 150 cm^3

Correct answer without working scores M2 only.

1

(b) Iron needed for haemoglobin / for red blood cells / to carry oxygen around the body

Accept well-water may contain eg Ca^{2+} ions / dissolved minerals that are good for bones / teeth etc.

1

[7]

5. (a) Same phase/state

1

(b) Because can exist in one oxidation state

Allow do not have variable oxidation states

1

(c) $2I^- + S_2O_8^{2-} \rightarrow I_2 + 2SO_4^{2-}$

Ignore state symbols
Allow multiples

1

(d) Both (ions)have a negative charge

Or both have the same charge
Or (ions) repel each other
Do not allow both molecules have the same charge (contradiction)

1

(e) $2Fe^{2+} + S_2O_8^{2-} \rightarrow 2Fe^{3+} + 2SO_4^{2-}$

1

$2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$

1

Equations can be in any order

Positive and negative (ions)/oppositely charged (ions)

Mark independently

1

(f) Equations 1 and 2 can occur in any order

Allow idea of Fe^{3+} converted to Fe^{2+} then Fe^{2+} converted back to Fe^{3+}

1

[8]

6. (a) $2MnO_4^- + 16H^+ + 5C_2O_4^{2-} \rightarrow 2Mn^{2+} + 8H_2O + 10CO_2$

1

Mn^{2+} OR Mn^{3+}

If catalyst incorrect can only score M1 and M3

1

(Possible because) Mn can exist in variable oxidation states

1

E_a lowered because oppositely charged ions attract

These marks can be gained in any order

1

Mn^{3+} (reduced) to Mn^{2+} by $C_2O_4^{2-}$ / equation

M5 may appear before M2

1

Mn^{2+} (oxidised (back)) to Mn^{3+} by MnO_4^- / equation

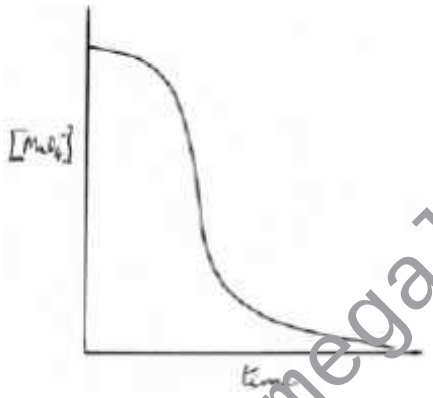
M5 and M6 can be scored in unbalanced equations or in words showing:

$Mn^{3+} + C_2O_4^{2-} \rightarrow Mn^{2+}$

$Mn^{2+} + MnO_4^- \rightarrow Mn^{3+}$

1

(b) **Graph marks**



S-shaped curve must not rise significantly and must not fall rapidly initially.

Starts on concentration axis **and** is levelling out (can level out on time axis or above but parallel to time axis)

Cannot score graph marks (M1 and M2) if no axes and / or no labels

1

1

Explanation marks

Slope / rate increases as catalyst (concentration) forms

1

Slope / rate decreases as (concentration) of MnO_4^- ions / reactant(s) decreases (OR reactants are being used up)

Explanation marks can be awarded independent of graph.

→

1

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7. (a) $Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$

1

(b) $MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$

1

(c) Moles MnO_4^- in 19.6 cm^3
= $19.6 \times 0.022 \times 10^{-3} = 4.312 \times 10^{-4}$

1

Moles Fe^{2+} in 25 cm^3
= $5 \times 4.312 \times 10^{-4} = 2.156 \times 10^{-3}$

1

Moles Fe^{2+} in 250 cm^3
= $10 \times 2.156 \times 10^{-3} = 2.156 \times 10^{-2}$

1

Mass Fe^{2+} = moles × A_r
$A_r = 2.156 \times 10^{-2} \times 55.8 = 1.203$ g

1

Percentage by mass of carbon
= (1.270 – 1.203) × 100/1.270
= 5.28%

1

(d) Repeat the titration and take an average of the concordant results

1

(e) Analyse several samples from different parts of the molten iron

1

[9]

8. B

[1]

9. A

[1]

10. D

[1]