Hilton College; Chemistry Trial Exam PII; 2015

Marks: 200 **Time: 3 hours**

1.1 D✓✓
1.2 A✓✓
1.3 A✓✓
1.4 C✓✓
1.5 C✓✓
1.6 B✓✓
1.7 C✓✓
1.8 B✓✓
1.9 B✓✓
1.10 D✓✓

Question 2:

2.1 The mass (in grams) ✓of 1 mol of a substance✓. (2)

2.2 **Cu** $n = \frac{m}{M} = \frac{19{,}05}{63{,}5 ✓} = 0{,}3\ mol ✓$

HNO_3 $n = c.V = (1{,}4).(0{,}5)✓ = 0{,}7\ mol ✓$ (4)

2.3 $N = n.N_A = (0{,}3).(6{,}02 \times 10^{23} ✓) = 1{,}806 \times 10^{23} ✓$ (2)

2.4 **Carried over from 2.2**

Cu	**:**	**HNO_3**
3 mol	:	8 mol✓
0,3 mol	:	0,8 mol✓

HNO_3 is the limiting reactant as only 0,7 mol.✓ (3)

2.5 **Carried over from 2.4**

HNO_3	**:**	**H_2O**
8 mol	:	4 mol✓
1 mol	:	0,5 mol
0,7 mol	:	0,35 mol✓

$m = n.M = (0{,}35).(18) = \mathbf{6{,}3\ g} ✓$ (3)

2.6 **Carried over from 2.4**

HNO_3	**:**	**NO**
8 mol	:	2 mol
1 mol	:	0,25 mol

0,7 mol : 0,175 mol✓

$V = n.V_m = (0{,}175).(22{,}4) = 3{,}92\ dm^3$ ✓

$\%\ yield = \frac{Actual}{Theoretical} \times 100 = \frac{3}{3{,}92}$ ✓ $\times 100 =$ **76,5 %** ✓ (4)

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<u>Question 3</u>:

3.1.1 A sharing of at least one pair of electrons✓ by two atoms✓. (2)

3.1.2 To melt diamond we need energy to break the strong✓ covalent bonds.
Each carbon atom forms 4✓ covalent bonds. (2)

3.2.1 A measure of the tendency of an atom to attract ✓ a shared pair of electrons✓. (2)

3.2.2 Boron: electronegativity = 2
Nitrogen: electronegativity = 3
Difference in electronegativity = 3 – 2 = 1✓
Polar✓ covalent✓ bond (3)

3.3.1 Strong✓ ionic bond✓ (electrostatic force). (2)

3.3.2 In MgO, the cations and anions have <u>double the charge</u>✓ of the ions in NaCl, leading to stronger✓ electrostatic forces. (2)

3.4.1.1 Dipole – dipole✓ forces (1)

3.4.1.2 Hydrogen bond✓ force. (1)

3.4.2 Within a molecule, a hydrogen atom is bonded to a small atom with a high electronegativity, leading to a strongly polar molecule.✓
This allows the hydrogen atom in one molecule to be attracted✓ to and to get very close✓ to the negative end of a neighbouring molecule. (3)

3.4.3 The H_2Te molecule has the greater electron density✓, leading to stronger✓ dipole – dipole forces. (2)

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4.1 Smaller than ✓ (1)

4.2 Refers to **relationship between dependent and independent variables. ✓✓** (2)
<u>Examples :</u>
Reaction rate (or volume of hydrogen gas produced per unit time) increases with increase in concentration.
OR
Reaction rate (or volume of hydrogen gas produced per unit time) decreases with increase in concentration.
OR
The higher the concentration (of HCl) the faster the rate of the reaction

4.3 Fair test
OR Mg the controlled variable
OR Mg is constant
OR to ensure there is only one variable✓✓

4.4.1 60 cm^3 ✓ (1)

4.4.2 42 cm^3 ✓ (1)

4.5 Experiment 1 ✓
The gradient / slope (of tangent to graph) is steeper. ✓ OR
Reaction complete quickly (2)

4.6 The number of moles / amount / mass of Mg used in both experiments were the same. ✓ (1)

4.7 Reaction rate increases with increase in concentration. ✓✓
OR
Reaction rate (volume of hydrogen gas formed per unit time) decreases with decrease in concentration. (2)

4.8 a) Remains the same ✓ (1)
b) Increases ✓ (1)

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Question 5

5.1 When the forward reaction continues to proceed at an equal rate✓ to the reverse reaction✓ in a closed system ✓ (3)

5.2 $t_2 - t_3$ ✓ OR $t_4 - t_5$ OR $t_6 - t_7$ (1)

5.3.1 Conc of N_2 was increased / more N_2 added ✓. Forward reaction favoured ✓ to use up N_2 ∴ $[N_2]$ and $[H_2]$ decreases and $[NH_3]$ increases ✓. (3)

5.3.2 Increase in temp ✓. Reverse reaction has been favoured (endothermic) ✓ to remove heat from the system, and $[NH_3]$ ↓, and more N_2 and H_2 are formed ✓. (3)

5.4.1 Increase in pressure ✓✓
(decrease volume)

5.4.2 ↑ P favours the reaction which leads to fewer ✓ moles of gas, i.e. forward reaction ✓ is favoured leading to more NH_3 being formed ✓. (3)

5.5.1 $Kc - \frac{[NH_3}{[N_2][H_2]^3}$ ✓✓ (2)

5.5.2 $C_{H_2} = \frac{n}{v} = \frac{1,28}{2}$

$= 0,64\ mol.dm^{-3}$ ✓

$n_{H_2} = \frac{49,6}{28} = 1,77\ mol$ ✓ $C_{N2} = \frac{n}{v} = \frac{1,77}{2} = 0,89$

$n_{NH_3} = \frac{V}{Vo} = \frac{12,31}{22,4} = 0,55\ mol$ ✓ $C_{NH_3} = \frac{n}{v} = \frac{0,55}{2} = 0,28\ mol.dm^{-3}$ ✓

$K_c = \frac{(0,28)^2}{0,89.(0,64)^3} = 0,34$ (7)

5.5.3 Lies to the left <u>OR</u> low yield <u>OR</u> high concentration of reactants. ✓✓ (2)

5.6.1 stay the same ✓✓

5.6.2 increase ✓✓

5.6.3 stay the same ✓✓ (3)

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6.1	proton donor✓✓	(2)
6.2	oxonium✓ (or hydronium)	(1)
6.3	H_2SO_3 (acid) & HSO_3^-(base)✓ H_3O^+(base) & H_2O (acid)✓	(2)
6.4	acts as either acid or base✓✓	(2)
6.5.1	weak acid ionizes partially✓ in an aqueous solution✓	(2)
6.5.2	weak acid + strong base ✓→ basic salt✓ **/** pH above 7 at equivalence point thus phenolphthalein✓	(3)
6.6.1	one of known concentration✓✓	(2)
6.6.2	n = cV = (0,2)(0,3)✓ = 0,06 mol✓ m = nM = (0,06)(56)✓ = 3,36g✓	(4)
6.6.3	concentration✓ of H_3O^+ ✓ **…** in water at 25C	(2)
6.6.4	$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$ products✓✓ ; balancing✓	(3)
6.6.5	n = CV; = 0,2 x (15/1000); = 0,003 mol✓ Ratio 2:1✓; 0,003 / 2 = 0,0015 mol✓ of H_2SO_4 C = n / V; = 0,0015 / (20/1000)✓; c_a = 0,075mol.dm^{-3} ✓	(5)

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7.1 Electrical to chemical

7.2 NEGATIVE

7.3 $Al^{3+} + 3e^- \rightarrow Al$

7.4 Yes (no mark for this), electricity used is generated by coal, a fossil fuel,✓ which releases extra CO_2 into the atmosphere✓. Carbon anodes react with oxygen✓ to produce CO_2

8.1 cathode

8.2 silver

8.3 $Ag^+ + e \rightarrow Ag$

8.4 Q = Ixt = 0,5 x 3600 = 1800 C✓
$N_{electrons} = Q_{TOT}/Q_e = 1800/1,6\text{x}10^{-19}$ ✓= $1,125\text{x}10^{22}$ ✓
1 e^- reduces 1x Ag^+ (1:1 ratio. Look at equation in 8.3)
Thus $1,125\text{x}10^{22}$ Ag atoms✓
$n = N/N_A = 1,125\text{x}10^{22}/6,02\text{x}10^{23}$ = **0,019 mol✓✓**

NB: For a question like this we could also start with moles and you can work out time, for example. Using the mole ratio between electrons and solid is important.

1 mol of Ag: 1 mol electrons
Calculate number of electrons: $N_e = n \times 6,02 \times 10^{23}$
Total charge = $N_e \times 1,6 \times 10^{-19}$
Therefore time = total charge/current

8.5 Silver anode is oxidised and keeps supplying Ag^+ to electrolyte.

8.6 Plastic does not conduct electricity✓ whereas graphite does✓.

8.7 Platinum is more expensive than silver.

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9.1 Concentration of electrolyte must be $1 mol/dm^3$. Temperature must be 25^0C.

9.2 a substance that donates electrons✓✓

9.3 Mg is a better reducing agent than silver; therefore oxidation will take place at the Mg electrode

9.4 Mg/Mg^{2+}✓ ($1\ mol.dm^{-3}$, 298K) //Ag^+/Ag✓ ($1\ mol.dm^{-3}$, 298K) … conditions✓

9.5 $Mg + 2Ag^+ \rightarrow Mg^{2+} + 2Ag$✓✓ balancing✓

9.6 $E^0_{CELL} = E^0_{CATH} - E^0_{ANOD}$ ✓ = 0,8-(-2,37)✓=3,17V✓

9.7 INCREASE✓, according to Le Chateliers the forward reaction will be favoured✓ to remove excess Ag^+ thus ↑V.✓

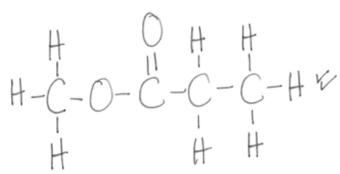
10.1.1 4,5-dimethyl✓-2-hexyne✓ (2)
10.1.2 carbon dioxide✓: water✓ (2)

10.2.1 2-chloro✓-1-fluoro✓-3-methyl✓pentane✓ (3)
10.2.2 haloalkane✓ (1)

10.3.1 1-butene (2)
10.3.2 addition / hydrohalogenation✓ (1)
10.3.3 $CH_3CH_2CHClCH_3$ ✓ 2-chlorobutane✓ (2)
Or $CH_3CH_2CH_2CH_2Cl$✓ 1-chlorobutane✓

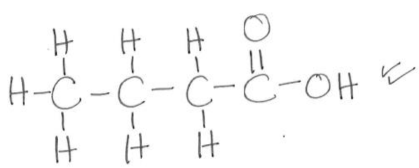
10.4.1 carboxyl group✓ or drawn (1)
10.4.2 1-propanol✓✓(or propanal) (2)
10.4.3 oxidation✓ (1)

10.5.1 esterification / condensation✓ (1)
10.5.2 B: methanol✓; C: propanoic acid✓ (2)
10.5.3 it catalyses the reaction✓ (1)
10.5.4 Bumping stones in test tube prevent violent splashing while boiling✓
Heat using water bath not open flame because reagents are flammable✓ (2)
10.5.5 methyl ✓propanoate✓ (2)



(2)

10.5.6



(2)

10.5.7 The isomer (butanoic acid) will have higher bp ✓– it has strong hydrogen bonding✓ between molecules as opposed to weak van der Waals IMF's between ester molecules✓. (3)

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