Bukit Batok Secondary School
Sec 4 Express Chemistry (6092)
Prelim Exam 2024 Answers

1a	The molecules lose energy to the surroundings and slow down in their movement hence coming closer together making the air more dense / denser. *(More collisions between air molecules on the bottom of aeroplane caused more lift)*	1m 1m
1bi	Flooding of low-lying areas leading to loss of crops/destruction of animal habitats.	1m
1bii	Increase in usage of carbon containing fuels Higher usage or presence of cars Deforestation	either 1m
1biii	CS is expensive as it takes a lot of equipment to capture, purify, liquefy, transport and bury CO_2. Safety concerns because it is uncertain what the consequences will be if there is leakage of large amounts of CO_2. One might imagine that large amounts of CO_2 could escape and incapacitating humans and animals. CO_2 is a gas that occurs in nature, but can be dangerous in large, concentrated quantities. *accept answers relevant to context of question*	either 1m
2a	Titanium, carbon, magnesium	1m
2b	The magnesium chloride produced in reactor 2 is collected and electrolysed to produce magnesium metal which is then used to react with titanium chloride again. Chlorine produced by electrolysis is used to react with rutile to produce titanium chloride in reactor 1.	either 1m
2c	Argon is used to provide an unreactive/ inert atmosphere to prevent the oxidation of / reaction of oxygen with magnesium / titanium / titanium chloride.	1m
2d	Wash the mixture with water to dissolve the soluble magnesium chloride. Filter the mixture to obtain titanium as the residue.	1m 1m

3a

		true	false
	An iron catalyst is used.	√	
	The reaction is reversible and so the conditions must be chosen carefully to give the best yield.	√	
	A good yield of ammonia is obtainable even without the use of high pressure.		√
	Nitrogen from the air is converted into a substance from which nitrogenous fertilisers can be easily produced.	√	

4√ - 2m
2-3√ - 1m
1√ - 0m

3b (i) sodium hydroxide is added to A and warm 1m

(ii) (dilute) nitric acid and barium nitrate is added to A 1m

(iii) blue precipitate formed is insoluble in excess sodium hydroxide 1m

(iv) sodium hydroxide and aluminium foil are added to A and warm 1m

(v) ammonium iodide 1m

4a R_f value of yellow dye is 0 in pure water.
Thus yellow dye does not dissolve in pure water and be separated. 1m

R_f value of red dye is 0 in pure ethanol.
Thus red dye is insoluble in pure ethanol and unable to be separated. 1m

4b All 3 dyes have same R_f value of 0.4 when solvent has 80% ethanol. 1m

4c Total volume = 80 + 120 = 200 cm^3
%ethanol = (80/200) x 100 = 40% 1m

R_f value of blue dye ***<u>0.6</u>***
R_f value of red dye ***<u>0.6</u>***
R_f value of yellow dye ***<u>0.04</u>*** 1m

4d No. When solvent has 40% ethanol, blue and red dyes have the same R_f value thus will not be separated. 1m

5ai $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$ 1m

5aii No of moles of NaOH = 10/1000 x 0.1 = 0.00200 mol (3sf) 1m

1mol of acid reacts with 1mol of NaOH
0.00200 mol acid reacts with 0.00200 mol NaOH

Concentration of ethanoic acid = 0.002/ (10/1000) = 0.200 mol/dm^3 1m

5aiii pH > 2

Ethanoic acid is a weak acid that dissociates partially in water to produce low concentration of H^+ ions in water. — partial dissociate 1m

Thus, in 0.200 mol/dm^3 acid, concentration of H ions is lesser than 0.200 mol/dm^3. *pH = – lg [<0.2] = >2* — conc 1m

5bi
1) Initial pH for (1) is lower than (2)
2) At the start of (1), pH stays constant until $20cm^3$,but in (2) pH increases gradually.
3) Extent of pH change at endpoint is greater for (1), from 2 to 12, but is lesser for (2), from 7 to 11.

either 2 each 1m total 2m

5bii The salt formed from a strong acid-strong alkali reaction is neutral (pH7). The salt formed from a weak acid-strong alkali reaction is alkaline/basic (pH= 8.5). — both 1m

6a
A : ethanoic acid
B : ethyl ethanoate
C : ethene
D : carbon dioxide
E : dibromoethane
F : ethane
L : ethanol

7√ - 4m
5-6√ - 3m
3-4√ - 2m
1-2√ - 1m

6b $C_2H_5OH + CH_3COOH \rightarrow CH_3COOC_2H_5 + H_2O$ — 1m

7a ***2.8.18***.8.2 — 1m

7b Student A.

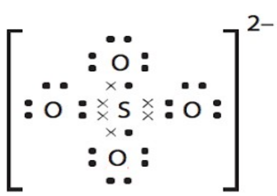
As atomic radius of Group 2 elements increases, the distance between negatively charge valence electrons and positively charge nucleus increases. — 1m

Electrons are more readily lost as they are less strongly attracted to nucleus. — 1m

7ci Hg_2O and HgO — both 1m

7cii basic — 1m

7d



shared e- 1m
valence e- & charge 1m

8a Oxidising agent : $S_2O_8^{2-}$
Reducing agent : Fe^{2+} both 1m

8b $S_2O_8^{2-}(aq) + 2I^-(aq) \rightarrow 2SO_4^{2-}(aq) + I_2(aq)$ 1m

8c A catalyst speeds up a reaction by providing an alternative pathway with lower activation energy. 1m

More particles have required activation energy to react.
Frequency of effective collisions increases and reaction is faster. 1m

8d Uncatalysed reaction is slow as it involves collisions of (three) negatively charged ions which will repel one another. 1m

8e Fe^{3+} ion used up in Step 1 of is regenerated in Step 2. 1m

8f Iron forms compounds with variable oxidation states (+2 and +3) but magnesium only has one oxidation state (+2). 1m
Reject : magnesium does not / does not have variable oxidation state

9ai When the distance between the two hydrogen atoms increases, the bond energy decreases 1m

to a minimum energy of – 432 kJ/mol at 74pm 1m

When the distance is greater than 74pm, the H-H bond energy increases to almost 0 kJ/mol. 1m
Answers that only mention positive/negative energy will be awarded max. 2 marks

9aii At 74pm, there is the greatest attraction of the negatively charged electrons 1m
in one atom to the positively-charged protons in the other atom. 1m
If no mention of negative/positive charges of electrons/protons, or the "greatest" attraction, max. 1 mark

9b Do not agree. H-H is a single bond / 1 bond, but the bond length is the lowest at 74pm compared to N≡N, where there is a triple bond but the bond length is longer at 110pm.

OR

Agree. O=O has a double bond / 2 bonds and a longer bond length of 121pm compared to N≡N at 110pm.

compare no of bond 1m
bond length 1m

Any combination is fine, best is to compare between same type of atoms

9c	There is <u>more</u> energy taken <u>in</u> to <u>break</u> (*N≡N and O=O*) bonds than energy given <u>out</u> to <u>form</u> the (*N-O/N=O*) bonds.	more 1m break/form 1m
9di	Silicon tetrahydride has a simple molecular structure / is a simple molecule.	1m
	Weak intermolecular force between molecules requires little amount of energy to overcome.	
	Thus boiling point is low.	1m
9dii	Hydrogen bonds are stronger than weak intermolecular force between molecules. More energy required to break the bonds.	1m
10a	A : hydrogen (gas) B : oxygen (gas)	both 1m
10b	Insert a glowing splint, it will relight.	1m
10c	Cathode : $4H^+_{(aq)} + 4e^- \rightarrow 2H_{2\,(g)}$	
	Anode : $4OH^-_{(aq)} \rightarrow 2H_2O_{(l)} + O_{2\,(g)} + 4e^-$	eqn 1m
	With same no. of moles of electrons flow in circuit, 2 moles of hydrogen is produced at cathode and 1 mole of oxygen produced at anode. *OR* Overall equation : $2H_2O_{(l)} \rightarrow 2H_{2\,(g)} + O_{2\,(g)}$ Mole ratio of hydrogen to oxygen produced is 2:1. Volumes of gases produced is also in ratio of 2:1.	explain 1m
10di	Aluminium anode reacts with oxygen produced, forming a layer of aluminium oxide, causing mass to increase.	1m
10dii	Solid aluminium oxide does not conduct electricity. When the anode is fully coated, electrolysis stops as circuit is broken.	1m
10diii	Mass increase is due to oxygen Mass of O_2 = 27.8 – 15.0 = 12.8 g	
	No of moles of O_2= 12.8 ÷ 2(16) = 0.400 mol	mass & mol 1m
	1mol of O_2 is produced with 2mol of H_2 0.400 mol of O_2 is produced with 0.800 mol of H_2	
	Volume of H_2 = 0.800 x 24 = <u>***19.2 dm³***</u>	ratio & vol 1m

11ai 37 °C, airtight/ anaerobic/absence of oxygen 1m

11aii (*filter away solids*) then fractional distillation 1m

11bi $CH_2{=}CHCH_2CH$ 1m
$CH_3CH{=}CHCH_3$ 1m
full structures

11bii C_4H_{10} or $C_4H_8Br_2$ (*any halogen*) 1m

11c Step 1 :
Hydration - react with steam at 300 °C and 60 atm with phosphoric (V) acid as catalyst 1m

$HO-CH_2-CH_2-CH_2-OH$ obtained (*diol*) 1m

Step 2 :
Oxidation – add acidified potassium manganate (VII) 1m

$HO-\overset{\overset{\displaystyle O}{\|}}{C}-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-OH$ obtained (*dicarboxylic acid*) 1m

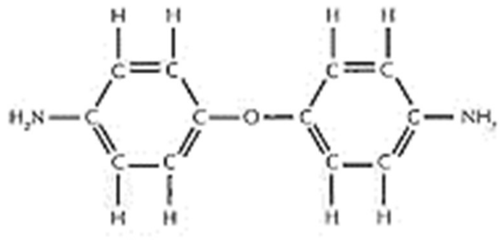
Step 3 :
Condensation polymerisation of diol and dicarboxylic acid 1m
Polymer obtained

12ai Polymer C
It has the highest thermal resistance at low temperatures. 1m
It has highest RSI value among the polymers. 1m

At 0 °C, it has RSI value of *4.2* m^2K/W, which is *1.5* m^2K/W higher than Polymer B and *1.7* m^2K/W more than Polymer A. infer data +1m
(*values read from graph : accept range of values appropriate to graph*)

12aii None
The RSI values of Polymers A, B and C decrease at temperature below 0 °C and above 36 °C. 1m
They will not provide good thermal resistance for the astronauts at extreme temperatures. 1m

12bi diamine



1m

12bii Water 1m

12biii
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  O       O
  ||      ||
– C – N – C –
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1m

12biii Chemical method : Cracking
Break down long chain of Polymer X into smaller molecules to produce new plastics

Physical method : mechanical recycling
Polymer X pulled into long strands and cut into pellets to make into new products.

methods 1m
describe each 1m
total 3m