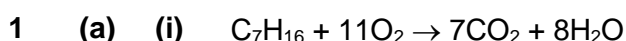


# Yishun Junior College H1 Chemistry Preliminary Examinations 2016

## Paper 1 Answers

1	C	7	C	13	B	19	B	25	C
2	C	8	B	14	D	20	D	26	A
3	B	9	B	15	A	21	C	27	D
4	B	10	D	16	C	22	B	28	D
5	D	11	B	17	D	23	A	29	B
6	C	12	A	18	A	24	D	30	C

## Paper 2 Answers



[1]

(ii)

Bonds broken	kJ mol <sup>-1</sup>	Bonds formed	kJ mol <sup>-1</sup>
6 x C-C	6(+350)	14 x C=O	14(-740)
16 x C-H	16(+410)	16 x O-H	16(-460)
11 x O=O	11(+496)		
<b>Total</b>	<b>+14116 [1]</b>	<b>Total</b>	<b>-17720 [1]</b>

$$\Delta H_c = +14116 - 17720 = -3604 \text{ kJ mol}^{-1}$$

$$= -3600 \text{ kJ mol}^{-1} \text{ [1]}$$

[3]

(b) (i) **D and E**

[1]

(ii) Geometric isomerism arises due to the restricted rotation of the C=C double bond and the presence of 2 different groups attached to each of the carbon atoms in the C=C double bond.

[1]

(c) **F and B** are structural isomers (OR have the same molecular formula). **F** is more branched than **B** and so, it has a smaller surface area of contact. [1]

Hence, less energy is needed to overcome the weaker intermolecular instantaneous dipole-induced dipole interactions for **F**. [1]

[2]

(d) Reagent and conditions:  $\text{KMnO}_4$ ,  $\text{H}_2\text{SO}_4(\text{aq})$ , heat [1]  
Observations: Purple  $\text{KMnO}_4$  is decolourised and the gas formed gives white precipitate with limewater. [1]

[2]

(e)		<b>H</b>	<b>I</b>
conditions		(a) CCl <sub>4</sub> solvent OR room temperature OR (b) UV light	anhydrous FeBr <sub>3</sub> OR Fe catalyst
type of reaction		(a) addition OR (b) substitution	substitution

[2]

any 2 correct – [1]

all 4 correct – [2]

Total: 12

2 (a) (i)  $K_c = \frac{[HI]^2}{[H_2][I_2]}$

[1]

(ii)		H <sub>2</sub>	I <sub>2</sub>	2HI
Initial amt / mol		4.00 × 10 <sup>-3</sup>	8.00 × 10 <sup>-3</sup>	0
Change in amt / mol		-3.4 × 10 <sup>-3</sup>	-3.4 × 10 <sup>-3</sup>	+6.8 × 10 <sup>-3</sup>
Eqm amt / mol		6.0 × 10 <sup>-4</sup>	4.6 × 10 <sup>-3</sup>	6.8 × 10 <sup>-3</sup>
Eqn conc / mol		3.0 × 10 <sup>-4</sup>	2.3 × 10 <sup>-3</sup>	3.4 × 10 <sup>-3</sup>

[1]

[1]

$$K_c = \frac{(3.4 \times 10^{-3})^2}{(3.0 \times 10^{-4})(2.3 \times 10^{-3})} = 16.8$$

[1]

(b) (i) By Le Chatelier's principle, the position of equilibrium shifts to the left, favouring the backward endothermic reaction, so as to absorb the heat added. [1]

Hence, [HI] decreases while [I<sub>2</sub>] and [H<sub>2</sub>] increases, leading to the value of K<sub>c</sub> to decrease. [1]

[2]

(ii) As the amount of gaseous reactants and products are equal, the position of equilibrium will not shift. Hence, the amount of HI will remain the same at the new equilibrium.

[1]

Total: 7

3 (a) (i) 1<sup>st</sup> t<sub>1/2</sub> (when [C<sub>6</sub>H<sub>5</sub>N<sub>2</sub>Cl] falls from 0.2 to 0.1 mol dm<sup>-3</sup>)  
= 63 min  
2<sup>nd</sup> t<sub>1/2</sub> (when [C<sub>6</sub>H<sub>5</sub>N<sub>2</sub>Cl] falls from 0.1 to 0.05 mol dm<sup>-3</sup>)  
= 63 min  
(+ show both t<sub>1/2</sub> on graph) [1]

Since t<sub>1/2</sub> is constant, order of reaction wrt C<sub>6</sub>H<sub>5</sub>N<sub>2</sub>Cl = 1 [1]

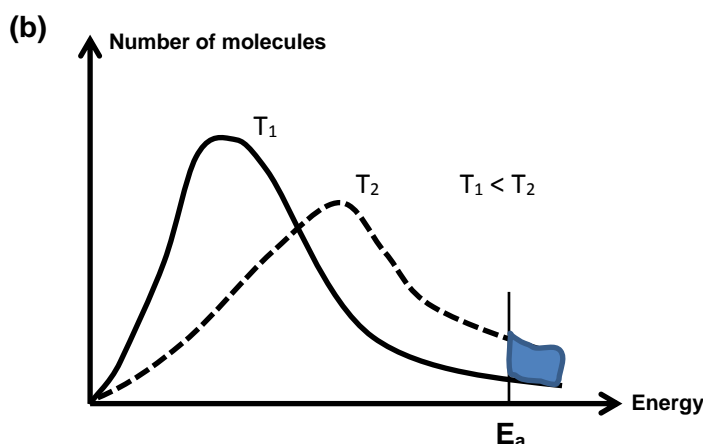
[2]

(ii) rate equation: rate = k[C<sub>6</sub>H<sub>5</sub>N<sub>2</sub>Cl] [1]

units for k: min<sup>-1</sup> or s<sup>-1</sup> [1]

[2]

- (iii) Since excess water was used in the experiment, the concentration of water is almost constant throughout the experiment. Hence, the reaction rate will not be affected by the concentration of water. [1]



At the higher temperature, the average energy of the reacting particles is increased. Hence the proportion of particles with energy equal to or greater than the activation energy increases significantly as seen in the shaded area in the diagram. [1]

In addition, when the temperature of the reactants is increased, their average speeds increase and therefore the frequency of collisions between reacting particles increases. This increases the frequency of effective collisions and consequently the rate constant increases and rate of reaction increases. [1]

[3]  
Total: 8

- 4 (a) (i)  $M_r = 385$  [1]

$$\eta_{cholesterol} = \frac{300 \times 10^{-3}}{385} = 7.79 \times 10^{-4} \text{ mol} \text{ [1]}$$

[2]

- (ii)  $\eta_{H_2} = \frac{1}{2} \times 7.792 \times 10^{-4} = 3.896 \times 10^{-4} \text{ mol} \text{ [1]}$

$$V_{H_2} = 3.896 \times 10^{-4} \times 24 = 0.00935 \text{ dm}^3 = 9.35 \text{ cm}^3 \text{ [1]}$$

[2]

- (b) Due to the large non-polar hydrocarbon chain, the predominant interactions between cholesterol molecules is intermolecular instantaneous dipole-induced dipole (id-id) interactions. [1]

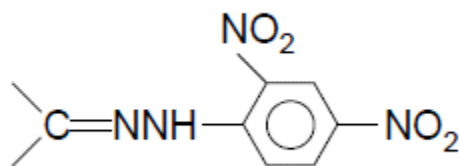
Hence, the hydrogen bonds formed between cholesterol and water molecules do not give off enough energy to overcome the stronger intermolecular id-id interactions in cholesterol and intermolecular hydrogen bonds in water. [1]

[2]

- (c) (i) step I :  $H_2$ , Ni, heat OR  $H_2$ , Pt [1]  
step II :  $KMnO_4$  (OR  $K_2Cr_2O_7$ ),  $H_2SO_4(aq)$ , heat under reflux [1]  
step III:  $HCN$ ,  $NaOH(aq)$  OR  $NaCN(aq)$  10-20 °C [1]

[3]

(ii)

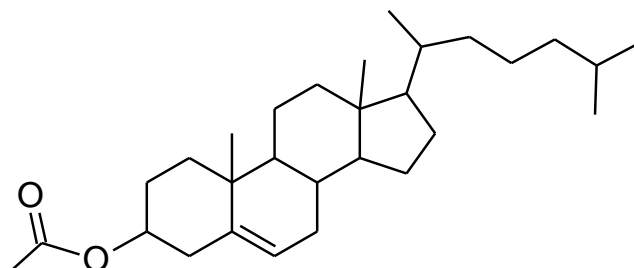


[1]

- (d) (i) conditions: conc  $\text{H}_2\text{SO}_4$ , reflux [1]  
type of reaction: condensation [1]

[2]

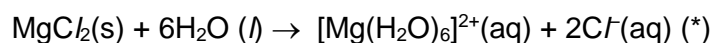
(ii)



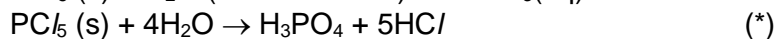
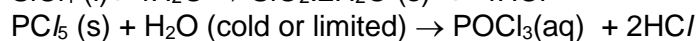
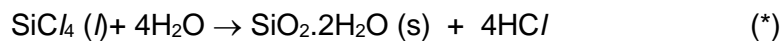
[1]

Total:13

- 5 (a) •  $\text{MgCl}_2$  undergoes partial hydrolysis(\*\*) to give a slightly acidic solution. Approximate pH of resultant solution is 6.5. (\*)



- $\text{SiCl}_4$ ,  $\text{PCl}_3$  &  $\text{PCl}_5$  undergo complete hydrolysis(\*\*)  
Low electron density Si and P provide empty d-orbitals to accommodate lone pair of electrons from  $\text{H}_2\text{O}$ . pH of solution is 1.(\*)



Each \*  $\frac{1}{2}$  mark

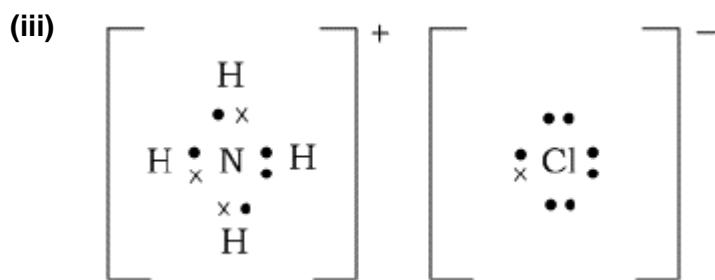
[5]

- (b) (i) Dative / Co-ordinate bond is a covalent bond in which a pair of electrons is shared between 2 atoms but ONLY ONE of them provides both electrons that make up the bond.

[1]

- (ii) Cation :  $\text{NH}_4^+$  Anion :  $\text{Cl}^-$   
Both correct – [1]

[1]



Each ion [1]

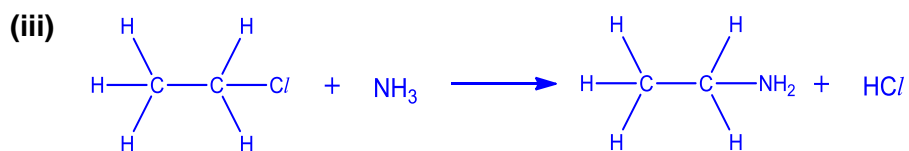
[2]

(c) (i)  $\text{HCl(g)}$  [1] Addition Reaction [1]

[2]

(ii) Cold Concentrated  $\text{H}_2\text{SO}_4$ , followed by  $\text{H}_2\text{O}$ , warm.

[1]



$\text{NH}_3$  in ethanol/alcohol and heat in sealed tube. [1]

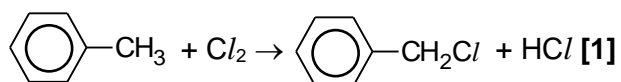
[2]

- (iv) • C-Cl is a stronger bond with bond energy of  $340 \text{ kJ mol}^{-1}$  and while C-Br is weaker with bond energy of C-Br  $280 \text{ kJ mol}^{-1}$ , hence easier to break. [2]
- Hence the rate of reaction for  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$  will be slower than that of  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$ . [1]

[3]

(d) Conditions: UV light [1]

Type of reaction: Substitution [1]



[3]

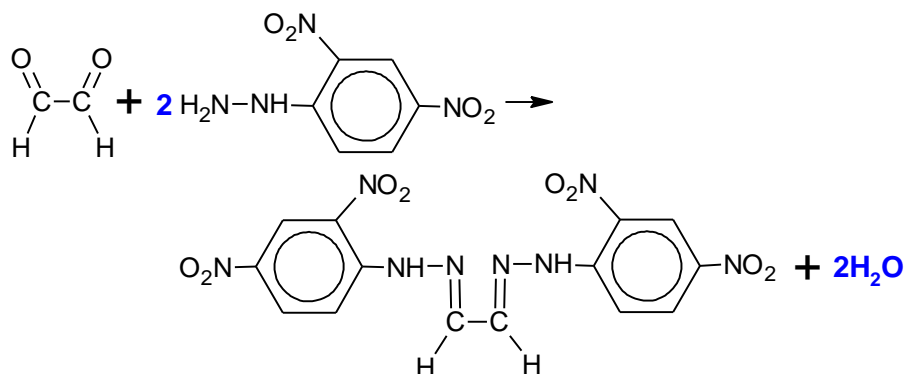
Total: 20

6 (a) Primary alcohol and carboxylic acid

[1]

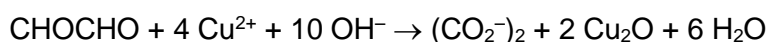
(b) Test: Add 2,4-DNPH to each compound separately.

Observation: For ethanedial, orange ppt of hydrazone is observed. For glycolic acid, no orange ppt is observed.



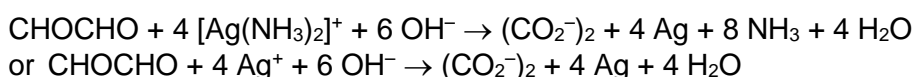
Test: Add Fehling's solution to each compound separately and warm.

Observation: For ethanedial, brick-red ppt of  $\text{Cu}_2\text{O}$  is observed. For glycolic acid, no brick red ppt is observed.



Test: Add Tollens' reagent to each compound separately and warm.

Observation: For ethanedial, silver mirror is observed. For glycolic acid, no silver mirror is observed.



For each test, correct reagent **[1]**; correct observations **[1]**; and correct equation **[1]**

[3m x 2 sets = 6m]

[6]

(c) (i) A weak Bronsted acid is one which dissociates partially in solution to donate protons,  $\text{H}^+$ .

[1]

(ii)

$$K_a = \frac{[\text{HOCH}_2\text{CO}_2^-][\text{H}^+]}{[\text{HOCH}_2\text{CO}_2\text{H}]}$$

[1]

(iii) Since  $[\text{CH}_2(\text{OH})\text{COO}^-] = [\text{H}^+]$ ,

$$K_a = \frac{[\text{H}^+]^2}{[\text{HOCH}_2\text{CO}_2\text{H}]}$$

$$1.48 \times 10^{-4} = \frac{[\text{H}^+]^2}{0.20}$$

$$[\text{H}^+] = 5.44 \times 10^{-3} \text{ mol dm}^{-3} \text{ [1]}$$

$$\text{pH} = -\lg(5.44 \times 10^{-3}) = 2.26 \text{ [1]}$$

[2]

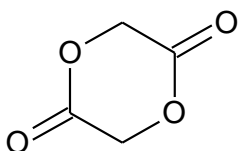
- (iv) A buffer solution is one which is capable of maintaining a fairly constant pH (by resisting pH change) when small amounts of acid or base is added to it. [1]

When small amount of  $H^+$  is added,  
 $CH_2(OH)COO^- + H^+ \rightarrow CH_2(OH)COOH$  [1m]

When small amount of  $OH^-$  is added,  
 $CH_2(OH)COOH + OH^- \rightarrow CH_2(OH)COO^- + H_2O$  [1m]

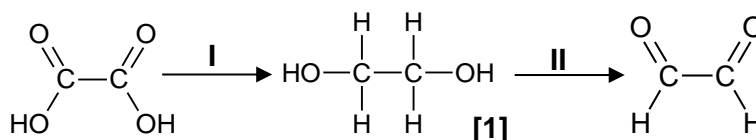
[3]

(d)



[1]

(e) (i)



[1]

Step I:  $LiAlH_4$  in dry ether, r.t.p. [1]

Step II:  $K_2Cr_2O_7(aq)$ ,  $H_2SO_4(aq)$ , heat under distillation [1]

[3]

- (ii) The intermolecular forces of attraction between ethanedioic acid molecules is stronger hydrogen bond [1] while permanent dipole-permanent dipole interaction exists between ethanedial molecules. [1] Hence more energy is needed to overcome the stronger hydrogen bonds between ethanedioic molecules.

[2]

Total:20

- 7 (a) (i) Amount of  $H_2SO_4 = 60/1000 \times 1.2 = 0.0720$  mol  
 Amount of  $Al_2O_3 = 3/102 = 0.0294$  mol  
 $H_2SO_4$  is the limiting reagent. [1]

Amount of  $H_2O = 0.0720$  mol

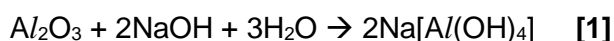
$$Q' = mc\Delta T = 60 \times 4.2 \times 11.5 \\ = 2898 \text{ J}$$

$$Q = 100/75 \times 2898 = 3864 \text{ J} [1]$$

$$\Delta H_n^\theta = -\frac{Q}{n_{H_2O}} \\ = -3864 / 0.07200 \\ = -53666 \text{ J mol}^{-1} \\ = -53.7 \text{ kJ mol}^{-1} [1]$$

[3]

- (ii) Agreed, NaOH may be used as  $Al_2O_3$  is an amphoteric oxide. [1]



[2]

- (iii) Since ethanoic acid is a weak acid, some energy is absorbed to dissociate the acid. [1]

The enthalpy change of neutralisation would be less negative than that in (ii) / less exothermic. [1]

[2]

- (b) (i) Shape: trigonal planar [1]  
Bond angle: 120° [1]

[2]

- (ii)  $AlCl_4^-$  is electron deficient [1].

The lone pair of electrons from  $Cl^-$  is donated into the empty p orbital of  $Al$ , forming a dative bond. [1]

[2]

- (c) (i) The relative atomic mass of a certain element is defined as the average mass of one atom compared to 1/12 the mass of a  $^{12}C$  atom, and is given by:

$$A_r = \frac{\text{average mass of an atom}}{\frac{1}{12} \times \text{mass of an atom of } ^{12}C}$$

[1]

- (ii) Relative atomic mass of aluminium sample  
=  $27(99.9) + 26(0.1) / 100$   
= 26.999  
= 27.0

[1]

- (iii) For the  $^{27}Al$  atom

protons	neutrons	electrons
13 [1]	14 [1]	13 [1]

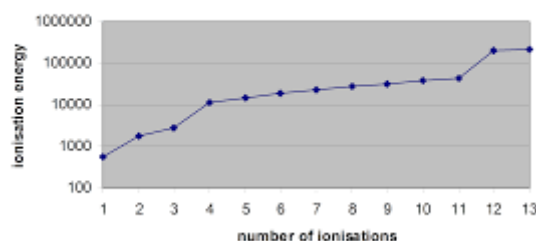
For its most stable ion,  $^{27}Al^{3+}$

protons	neutrons	electrons
13	14	10 [1]

[4]

- (iv)  $Al : 1s^2 2s^2 2p^6 3s^2 3p^1$

Variation of ionisation energy with number of ionisations for aluminium



- Labelled axes [1]
- No. of ionisation = 13 and generally increasing IE [1]
- 2 "big jump" : between ionisation number 2 and 3 and ionisation number 11 and 12 [1]

[3]

Total:20