

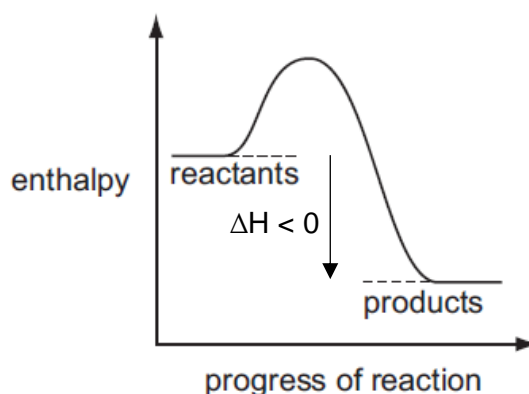
Yishun Junior College H1 Chemistry Preliminary Examinations 2016
Paper 1 Solutions

- 1 Volume of O_2 reacted = 50 cm^3 ; volume of CO_2 = 30 cm^3 C
 $C_xH_y + (x+y/4)O_2 \rightarrow xCO_2 + y/2H_2O$
 $10x = 30$ $3 + y/4 = 5$
 $x = 3$ $y = 8$
- 2 $2Br^- \rightarrow Br_2 + 2e^-$; $Pb^{4+} + 2e^- \rightarrow Pb^{2+}$ C
no. of moles of $PbCl_4$ = no. of moles of Br_2

$$= \frac{6.98}{349} = 0.02 \text{ mol}$$
mass of Br_2 = $0.02 \times 159.8 = 3.196 \text{ g}$
- 3 **A** $Cl_2 + 2OH^- \rightarrow OCl^- + Cl^- + H_2O$ B
Oxidation state of Cl decrease from 0 in Cl_2 to -1 in OCl^- and Cl^-
Change in oxidation state = -1
B $3Cl_2 + 6OH^- \rightarrow ClO_3^- + 5Cl^- + 3H_2O$
Oxidation state of Cl decrease from 0 in Cl_2 to -1 in Cl^- and increase to +5 in ClO_3^-
Change in oxidation state = +5
C $3MnO_4^{2-} + 4H^+ \rightarrow MnO_2 + 2MnO_4^- + 2H_2O$
Oxidation state of Mn decrease from +6 in MnO_4^{2-} to +4 in MnO_2 and increase to +7 in MnO_4^-
Change in oxidation state = -2
D $Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$
Oxidation state of Cr decrease from +6 in $Cr_2O_7^{2-}$ to +3 in Cr^{3+} while oxidation state of Fe increase from +2 in Fe^{2+} to +3 in Fe^{3+} .
Change in oxidation state = -3
- 4 B
- | | <u>compound</u> | <u>no. of unpaired electrons</u> |
|----------|-----------------|-------------------------------------|
| A | CH_3Cl | 3 (around Cl atom) |
| B | $O=C=O$ | 4 (2 around each O atom) |
| C | H_2N-NH_2 | 2 (1 around each N atom) |
| D | NH_4CN | 2 (1 each around C and N atoms) |
- 5 σ bonds are formed from the head-on overlap of 2 s orbitals / 1 s orbital with 1 p orbital / 2 p orbitals. π bonds are formed from the sideways overlap of 2 p orbitals. D
- 6 C
- | Atom | no. of electron pairs | bond angle |
|-------|---------------------------------|-------------|
| C_1 | 4 (bond pairs) | 109° |
| C_2 | 3 (bond pairs) | 120° |
| O_3 | 4 (2 lone pairs & 2 bond pairs) | 105° |

- 7 Standard enthalpy change of formation of CO: $\text{C(s)} + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{CO(g)}$ C
- A $\frac{1}{2} \text{C(s)} + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \frac{1}{2} \text{CO}_2(\text{g})$
- B $\frac{1}{2} \text{C(s)} + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \frac{1}{2} \text{CO}_2(\text{g})$
- C $\text{C(s)} + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$
 $\text{CO}_2(\text{g}) \rightarrow \text{CO(g)} + \frac{1}{2} \text{O}_2(\text{g})$ (inverse of $\text{CO(g)} + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$)
 $\text{C(s)} + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{CO(g)}$
- D $\text{C(s)} + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$
 $\frac{1}{2} \text{CO}_2(\text{g}) \rightarrow \frac{1}{2} \text{C(s)} + \frac{1}{2} \text{O}_2(\text{g})$ (inverse of $\frac{1}{2} \text{C(s)} + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \frac{1}{2} \text{CO}_2(\text{g})$)
 $\frac{1}{2} \text{C(s)} + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \frac{1}{2} \text{CO}_2(\text{g})$

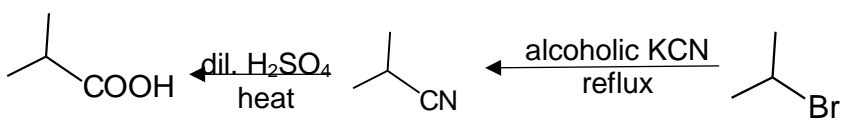
- 8 B



⇒ Reaction is exothermic

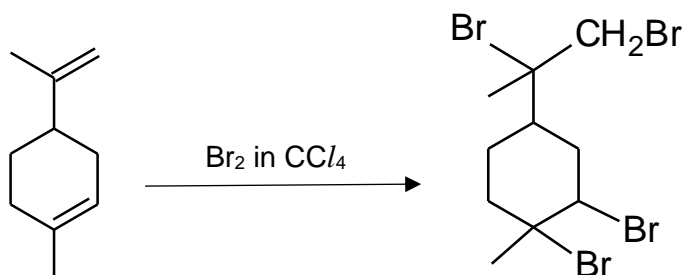
Enthalpy change of formation can be endothermic or exothermic (i.e. not always exothermic). Enthalpy change of combustion, enthalpy change of neutralization and lattice energy are always exothermic.

- 9 $\Delta H_f = \Sigma \Delta H_c(\text{reactants}) - \Sigma \Delta H_c(\text{products})$ B
 $= 4(-394) + 5(-286) - (-2877) = -129 \text{ kJ mol}^{-1}$
- 10 A catalyst provides an alternative route with lower activation energy. D
- 11 Comparing expts 1 & 2, B
 $\frac{6}{h} = \left(\frac{2}{1}\right)^2$
 $h = 1.5$
- Comparing expts 1 & 3,
 $\left(\frac{0.5}{1}\right) \left(\frac{2}{1}\right)^2 = \frac{6}{i}$
 $i = 3$
- Comparing expts 1 & 4,
 $\left(\frac{0.5}{1}\right) \left(\frac{2}{j}\right)^2 = \frac{6}{0.75}$
 $j = 0.5$

- 12 When bromocresol-green is blue, the pH of the solution is greater than 5.5. When phenol-red is yellow, the pH of the solution is less than 6.8. Hence, the pH range is $5.5 < \text{pH} < 6.8$. **A**
- A** $\text{pH} < 7$
B $\text{pH} = 7$
C $\text{pH} > 7$
D $\text{pH} > 7$
- 13 *no. of moles of $\text{H}^+ = 2 \times 0.002 = 0.004 \text{ mol}$ no. of moles of $\text{OH}^- = 0.003 \text{ mol}$* **B**
Hence, OH^- is limiting and there is an excess of 0.001 mol of H^+ .
 $[\text{H}^+] = 0.001 \div 2 = 0.0005 \text{ mol dm}^{-3}$
 $\text{pH} = -\lg 0.0005 = 3.3$
- 14 **A** Aluminum is readily oxidized by oxygen to form aluminum oxide which prevents further attack by oxygen. Aluminum oxide is amphoteric. **D**
B Magnesium oxide burns with a bright white flame to form white solid, MgO which is basic.
C When heated strongly, silicon forms white solid, SiO_2 which is acidic.
D Sulfur burns with a blue flame to form a colourless gas, SO_2 which is acidic.
- 15 Electronic configuration of Cl^- (18 e⁻): $1s^2 2s^2 2p^6 3s^2 3p^6$ **A**
A Electronic configuration of Na^+ (10 e⁻): $1s^2 2s^2 2p^6$
Hence, Cl^- has one more occupied shell than Na^+ and so is larger.
B True statement but does not explain why Cl^- is larger than Na^+
C Incorrect statement. Ionic radius decreases across the period for the cations and anions. Sharp increase in ionic radius when there is a change from cations to anions.
D True statement but does not explain the trend in ionic radius.
- 16 Trend in melting point: $\text{Si} > \text{Al} > \text{Mg} > \text{P}$ **C**
Trend in IE: $\text{Al} < \text{Mg} < \text{Si} < \text{P}$
- 17 **A** Products formed should be non-toxic but toxic CO is formed in this reaction. Also, C_8H_{16} is not octane. **D**
B C_8H_{16} is not octane
C Products formed should be non-toxic but toxic CO is formed in this reaction.
D Correct equation.
- 18 **A** From the equation given, the $\text{C}=\text{C}$ bond is used and the product's side-chain is saturated (i.e. all single bonds) and cyclic. **A**
B The side chain is still unsaturated.
C The side chain is still unsaturated.
D The side chain is not cyclic.
- 19  **B**
- 2-bromopropane

20 Alkene groups in limonene undergo addition reaction with Br₂.

D

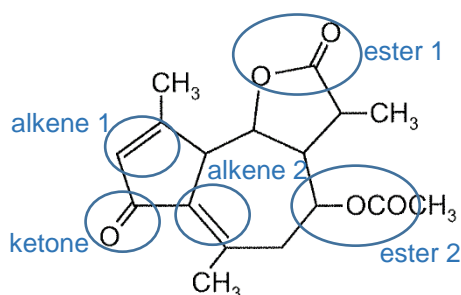


- 21 **A** $\text{CH}_3(\text{CH}_2)_3\text{CH}_2\text{OH} \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{CH}_2$ (1 alkene formed) **C**
B $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}_2\text{OH} \rightarrow$ cannot undergo elimination
C $\text{CH}_3(\text{CH}_2)_2\text{CH}(\text{OH})\text{CH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{CH}_2 + \text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$ (exists as a pair of cis-trans isomers) (Hence, 3 alkenes formed)
D $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$ (exists as a pair of cis-trans isomers)

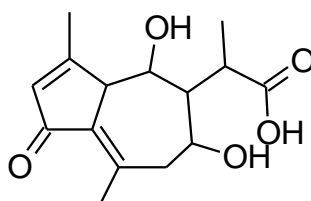
- 22 Reduce Tollens' reagent to form a silver mirror \rightarrow aldehyde group present **B**
 $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO} + \text{CH}_3\text{CH}(\text{CH}_3)\text{CHO}$
Hence, there are 2 structural isomers.

- 23 $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{CHCHO}$ contains alkene and aldehyde groups. **A**
 $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{COCH}_2\text{CH}_3$ contains a ketone group.
A Aldehyde group is the product from the oxidation of a primary alcohol while ketone group is the product from the oxidation of a secondary alcohol.
B Only the alkene group can decolourise bromine.
C The ketone group cannot decolourise KMnO₄.
D Only the aldehyde group gives a positive test with Fehling's reagent.

- 24 **D**



- A** The ester groups undergo hydrolysis with hot dilute sulfuric acid. The structure of the main product formed is



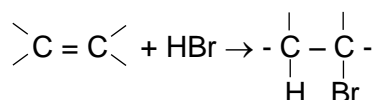
Hence, the product has only 1 carboxylic acid group. (The other product formed is ethanoic acid.)

- B** The alkene groups undergo oxidative cleavage. Alkene 1 forms 1 carboxylic acid group while alkene 2 does not form any carboxylic acid groups.

The ester groups undergo hydrolysis (due to the hot acidified conditions). (Refer to option **A** for the products of hydrolysis of the esters). Ester 1 produces a carboxylic acid group and an alcohol group. Ester 2 produces an alcohol group and ethanoic acid. Both alcohols formed from the hydrolysis of the esters are secondary alcohols so they will be oxidized to ketones.

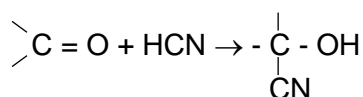
Hence, the product has 2 carboxylic acid groups (from the oxidative cleavage of alkene 1 and hydrolysis of ester 1).

- C** HBr is added to the C=C double bonds, i.e.



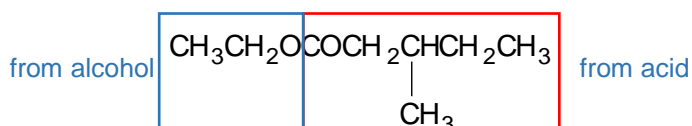
Hence, only 1 Br atom is added to each C=C double bond. Since there are 2 C=C double bonds, 2 Br atoms are added.

- D** Only the ketone group will undergo addition with HCN and NaCN to form a hydroxynitrile, i.e.



Since there is only 1 ketone group, the product will contain only 1 N atom (from the –CN group).

25



C

Hence, the alcohol is CH₃CH₂OH and the carboxylic acid is CH₃CH₂CH(CH₃)CH₂COOH.

26

| | Uuq | Uuh |
|-----------------|-----|-----|
| proton number | 114 | 116 |
| nucleon number | 289 | 292 |
| no. of neutrons | 175 | 176 |

A

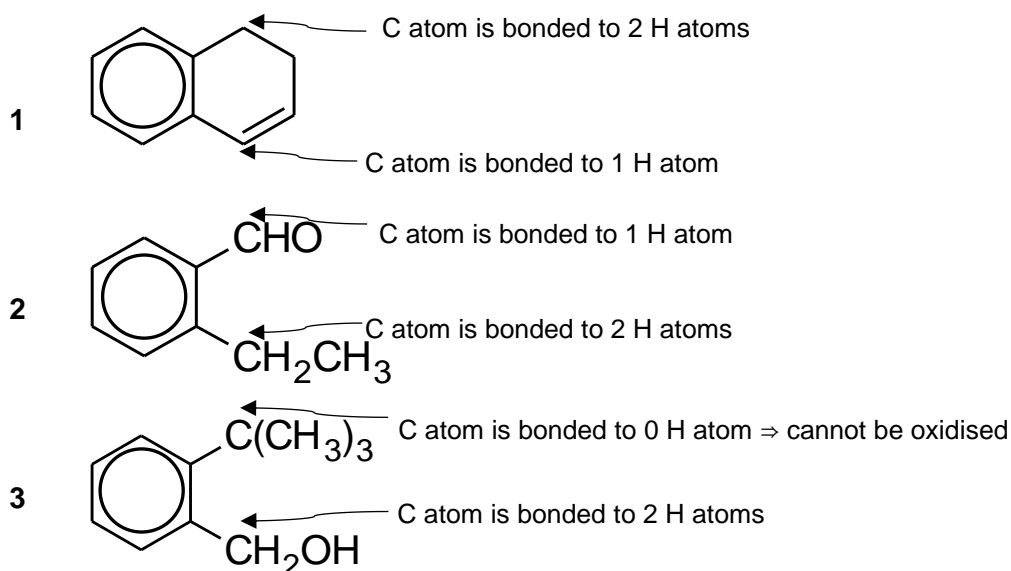
- Refer to the above table. (No. of neutrons = nucleon no – proton no)
- No. of electrons in 1 Uuq²⁻ ion = 114 + 2 = 116 (same as the no. of electrons in 1 Uuh atom)
- No. of electrons in 1 Uuh⁺ ion = 116 – 1 = 115
No. of electrons in 1 Uuq⁻ ion = 114 + 1 = 115

- 27 1 Position of equilibrium will shift to the right, favouring the forward reaction that produces lesser amount of gases so as to reduce the increased pressure. Hence, the yield of SO_3 increases. **D**
 2 Increasing the temperature will increase the rate of the forward and backward reactions.
 3 No. of moles of SO_3 = no. of moles of SO_2 = $64 \div 64 = 1$
 Yield of SO_3 = $1 \times 80 = 80 \text{ g}$

- 28 no. of moles of **X** = $20 \times 10^{-3} \times 0.10 = 0.002$ **D**
 no. of moles of **Y** = $10 \times 10^{-3} \times 0.10 = 0.001$
 \Rightarrow 1 mole of **Y** requires 2 moles of **X** for neutralisation and so, **Y** is a dibasic acid.

The pH at the equivalence point is 7 which indicates that this is a strong acid and strong base titration. Hence, **Y** is a strong acid.

- 1 Sulfuric acid is a strong dibasic acid.
 2 Hydrochloric acid is strong monobasic acid.
 3 Ethane-1,2-dioic acid is a weak dibasic acid.
- 29 To form benzene-1,2-dicarboxylic acid, the C atoms bonded to the benzene ring must have at least 1 H atom directly bonded to it. **B**



- 30 1 Both Cl atoms are bonded to the benzene ring and so, are unable to undergo substitution to form Cl^- ions. Hence, no precipitate is formed. **C**
 2 Has 1 Cl atom bonded to the side chain which can undergo substitution to form Cl^- which will form a precipitate with silver nitrate.
 3 Has 2 Cl atoms bonded to the side chain which can undergo substitution to form Cl^- which will with silver nitrate.