Christ Church
Grammar School

Year 12 Chemistry

Organic Chemistry Test
2020

marking key

Time allowed: **45 minutes**

Name:

Teacher: **MXC** **KLW** **CEM** **NMO**

Mark = **...../~~46~~** 45

SECTION 1 **MULTIPLE CHOICE** **10 marks**

1. Which of the following organic compounds would be the most soluble in water?

C B A
B A C
D C B
A

A. Butane
B. Butan-1-ol
C. Butanoic acid
D. Butyl butanoate

2. Which of the following lists the compounds in order of increasing boiling point?

A. propanamide < propan-1-ol < propanamine < propane
B. propane < propanamine < propan-1-ol < propanamide
C. propane < propan-1-ol < propanamine < propanamide
D. propane < propanamide < propan-1-ol < propanamine

3. The properties of three organic compounds X, Y and Z are described below.

- X and Y react together in the presence of concentrated sulfuric acid to produce a sweet smelling liquid.
- X and Z are isomers of each other.
- When added to acidified potassium permanganate, X produces a colour change but Y and Z do not.

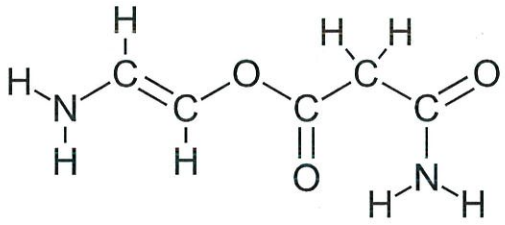
Select the option in the table that correctly identifies X, Y and Z.

	X	Y	Z
A	Butan-1-ol	Butanoic acid	Butan-2-ol
B	Butanoic acid	Ethanol	Methyl propan-2-ol
C	Propan-1-ol	Ethanol	Propan-2-ol
D	Butan-1-ol	Ethanoic acid	Methyl propan-2-ol

4. Which of the following pairs have the same empirical formulae?

A. ethyl ethanoate and ethanal $C_4H_8O_2$ & C_2H_4O
B. propanone and ethanol C_3H_6O & C_2H_6O
C. ethanoic acid and ethanol $C_2H_4O_2$ & C_2H_6O
D. methyl methanoate and propanone $C_2H_4O_2$ & C_3H_6O

5. Which functional groups are present in the following molecule?



A. two primary amines, ester, ketone, alkene

B. amide, ester, alkene, primary amine

C. two primary amines, two ketones, alkene

D. amide, ketone, alkene, primary amine

6. Which two compounds can be distinguished by the addition of acidified potassium dichromate?

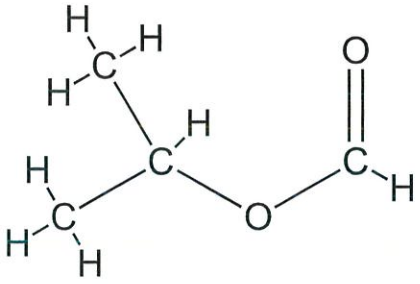
A. ethanoic acid and propan-1-ol

B. butan-2-ol and butan-1-ol

C. propanone and methyl propan-2-ol

D. ethanol and ethanal

7. The following ester is hydrolysed in the presence of sodium hydroxide.



Which of the following correctly lists the two products of this hydrolysis reaction?

A. methanol and sodium propanoate

B. propan-2-ol and methanoic acid

C. propan-2-ol and sodium methanoate

D. propan-1-ol and methanoic acid

8. Which of the following compound(s) could react to form a polyester?

A. $HOOC(CH_2)_5OH$

B. $HO(CH_2)_5CH_3$ and $CH_3(CH_2)_3CH_2COOH$

C. $H_2N(CH_2)_5NH_2$ and $HOOC(CH_2)_3COOH$

D. $CH_3(CH_2)_5COOH$ and $HO(CH_2)_8OH$

9. A polymer is formed from the following two monomers, with molecular weights of 104 and 76 $gmol^{-1}$ respectively. Determine the molecular weight of the polymer if it contains 50 recurring units.

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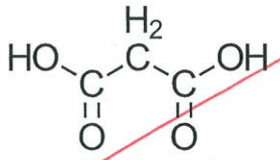
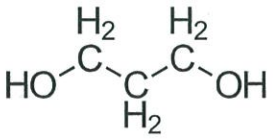




POOR QUESTION SORRY.

A. 8100 $gmol^{-1}$

B. 9000 $gmol^{-1}$

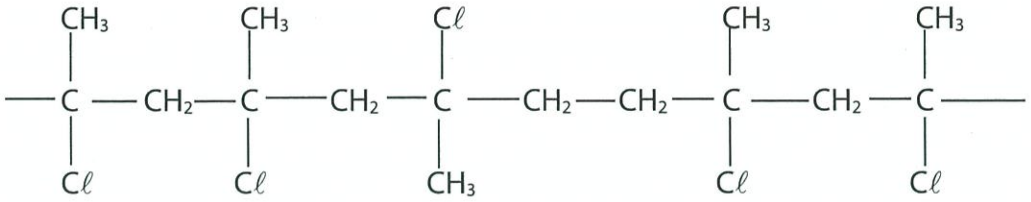
C. 8118 $gmol^{-1}$

D. 8982 $gmol^{-1}$

$50\,(104+76) - 49\,(18)$ (H_2O)

$= 9000 - 882 = 8118$

10. Examine this section of the structure of an addition polymer:



Which one of the following compounds could polymerise to form this chain?

A. *cis* 1-chloropropene

B. 2-chloropropene

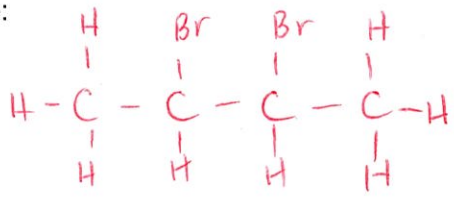
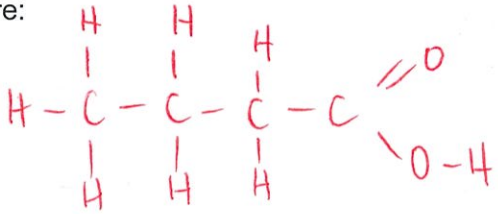
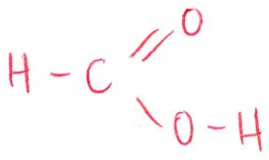
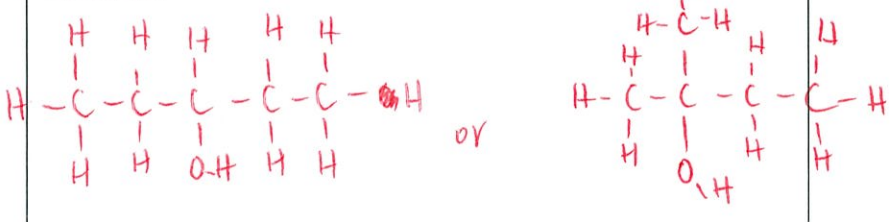
C. 3-chloropropene

D. 2-chlorobut-1-ene

SECTION 2 **SHORT ANSWERS** **36 marks**

Question 11 **8 marks**

Draw the full structural formulae and name the following compounds, showing **ALL** bonds and atoms:

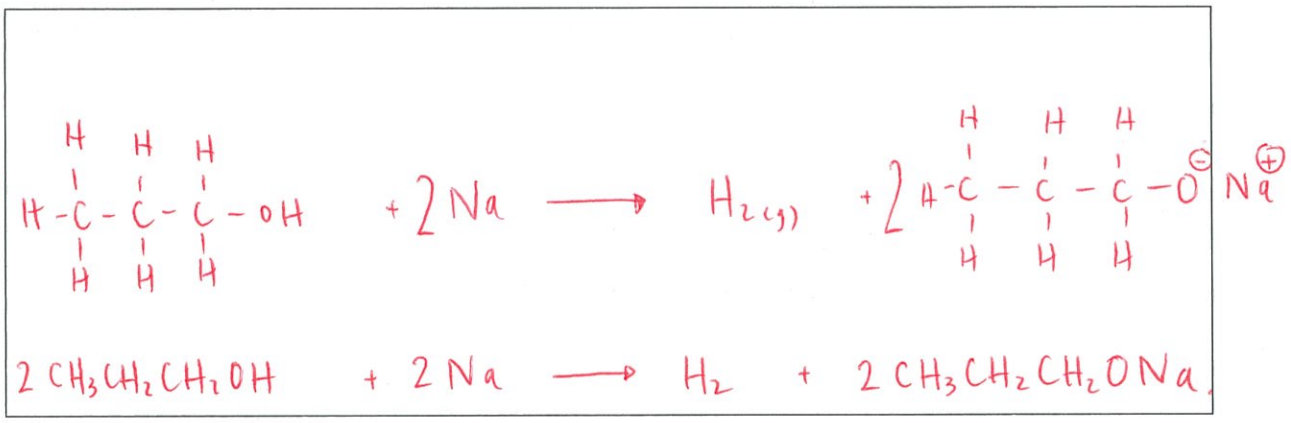
Description	Structure
The product of the reaction between *cis* but-2-ene and bromine water.	Name: 2,3-dibromobutane Structure: 
A compound that has an empirical formula of C_2H_4O and produces a colourless, odourless gas when added to Mg (s).	Name: butanoic acid (or methyl propanoic acid) Structure: 
The main organic product formed from the reaction between methanol and excess acidified potassium permanganate.	Name: methanoic acid Structure: 
An isomer of pentan-2-ol that has a lower boiling point.	Name: pentan-3-ol or 2-methyl butan-2-ol (or other branched alcohol 2°/3° alcohol) Structure: 

-1 overall if not all atoms & all bonds.

Question 12 **4 marks**

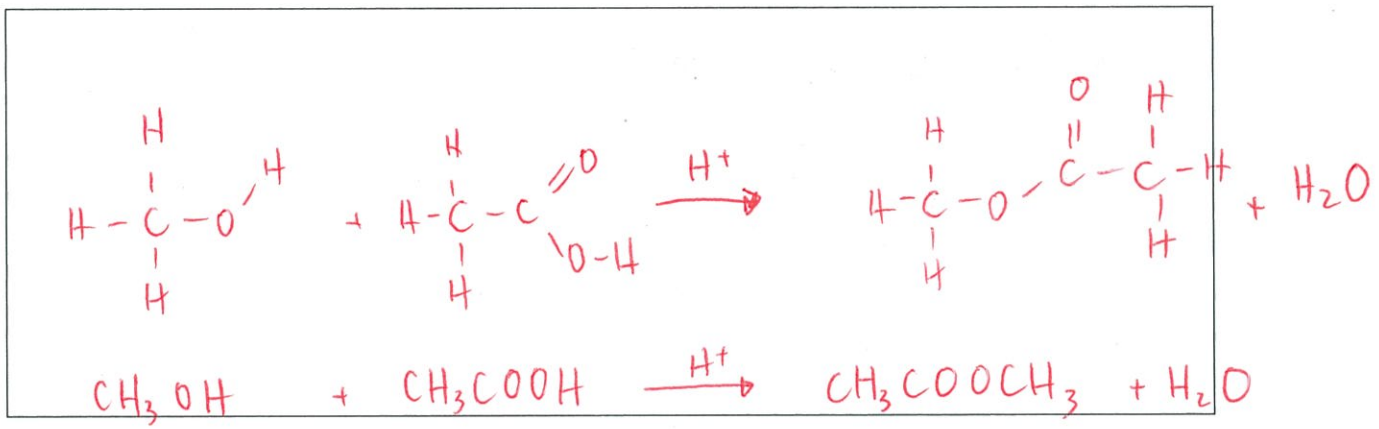
Write a chemical equation/s to show how the following products can be made.
Include relevant catalysts.

(a) sodium propoxide ($CH_3CH_2CH_2ONa$) 2 marks



or

(b) methyl ethanoate 2 marks



or

Question 13 **7 marks**

Ethanol, pentan-1-ol and ethyl pentanoate all have differing boiling points and solubilities in water.

a) Molecules of ethanol and pentan-1-ol can both form hydrogen bonds, dipole-dipole interactions and dispersion forces with each other. However, pentan-1-ol (280°C) has a higher boiling point than ethanol (78°C). Explain why. 3 marks

- pentan-1-ol has more electrons than ethanol (1)
- therefore, dispersion forces are stronger (1) [as there is a higher chance of temporary dipoles forming and molecules are more polarisable]
- pentan-1-ol has a higher sum of all intermolecular forces and it requires more energy to convert from liquid → gas (1)

b) Ethanol and pentan-1-ol are both soluble in water, however ethyl pentanoate is not. Explain why ethyl pentanoate is insoluble in water.

4 marks

- Ethyl pentanoate is polar. Molecules exhibit dipole-dipole & dispersion forces between them (1)
- Water is polar and molecules exhibit hydrogen bonding, dipole-dipole and dispersion forces between them. (1)

When ethyl pentanoate and water mix, there is ability to form hydrogen bonds, dipole-dipole & dispersion forces between them. (1)

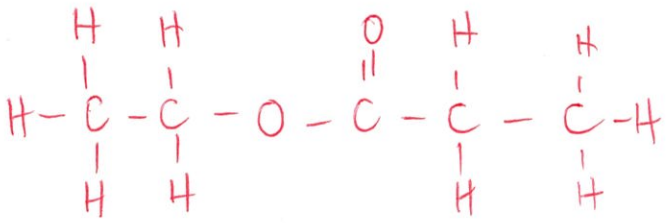
However, energy released when these ethyl pentanoate-water bonds form is insufficient to provide the energy required to break the intermolecular forces holding each substance together. (1)

[this is because the dispersion forces between ester molecules are significant, and many hydrogen bonds between H_2O molecules need to be broken to accomodate the ester]

Question 14 **8 marks**

8.00 g of ethanol (M = 46.068 $gmol^{-1}$) and 8.00 g of propanoic acid (M = 74.058 $gmol^{-1}$) were mixed together. 1.00 mL of concentrated H_2SO_4 was added and the mixture warmed for 15 minutes. The reaction was stopped by the addition of water.

a) Draw the major organic product formed. 1 mark



b) 8.25 g of the product was collected. Determine the yield of the reaction. 5 marks

$n(\text{ethanol}) = \frac{m}{M} = \frac{8}{46.068} = 0.1737$ (1)

$n(\text{prop. acid}) = \frac{m}{M} = \frac{8}{74.058} = 0.1080$ (1)

limiting reagent = propanoic acid as react in 1:1 ratio

n (ester) if 100% = 0.1080 moles (1)

m (ester) = n × M = 0.1080 × (46.068 + 74.058 − 18.016) (1)

= 0.1080 × 102.11

= 11.03 g (1)

$\% = \frac{8.25}{11.03} \times 100$

= 74.8 %

c) Give one reason why the yield is not closer to 100%. Explain. 2 marks

• ethyl propanoate is slightly soluble in water (especially if warm). (1) This means that some product may be lost in the water, reducing the yield (1)

Many possible answers. Explanation required

ie. reaction may have reached equilibrium when heated. K value not large, so some reactants remain at equilibrium.

Question 16 **9 marks**

An unknown hydrocarbon, Compound X, contains 32.00 % by mass carbon, 6.71 % by mass hydrogen, as well as oxygen and nitrogen.

A 2.07 g sample of the hydrocarbon was treated to convert all the nitrogen to ammonia, producing a 250 mL solution. 20.00 mL aliquots of this ammonia solution were then titrated against 0.120 $molL^{-1}$ hydrochloric acid, and an average titre volume of 18.42 mL recorded.

a) Use the information provided above to determine the empirical formula of Compound X. 6 marks

$n(HCl) = C \times V$

$= 0.12 \times 0.01842$

$= 0.0022104$ moles (1)

$n(NH_3)$ in 20mL = 0.0022104 moles

$n(NH_3)$ in 250mL $= 0.0022104 \times \frac{250}{20}$ (1)

$= 0.02763$ moles

n(N) in 2.07g sample = 0.02763 mol

m(N) in 2.07g sample = $n \times 14.01$

$= 0.3871$ g (1)

$\%N = \frac{0.3871}{2.07} \times 100 = 18.7\%$ (1)

$\%O = 100 - 32 - 6.71 - 18.7 = 42.59\%$ (1)

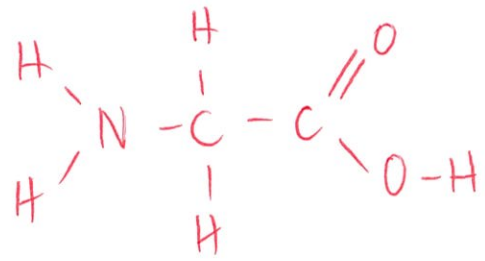
	C	H	N	O
%	32.00	6.71	18.70	42.59
n	2.664	6.657	1.335	2.662
ratio	2	5	1	2

$\therefore C_2H_5NO_2$ (1)

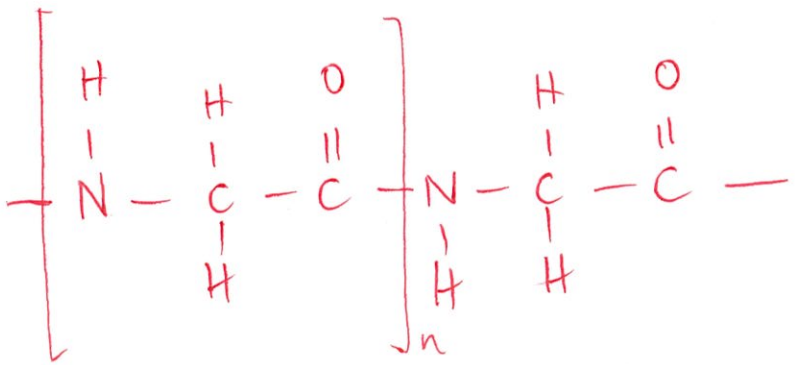
b) Given that compound X is capable of reacting with itself to form a condensation polymer, draw a possible structure for X. 1 mark

Note that if you were not able to determine an empirical formula in part a, you may use $C_3H_7NO_2$ as Compound X to answer parts b) and c).

Compound X



c) Draw the polymer that can be formed from compound X. Include at least two repeating units. 2 marks



① correct amide link

① correct structure & 2 repeating units

END OF TEST