1 Propanoic acid is a carboxylic acid. Its formula is $CH_3–CH_2–COOH$.

(a) Propanoic acid is the third member of the homologous series of carboxylic acids.

(i) Give the name and structural formula of the fourth member of this series.

name .....

formula ..... [2]

(ii) Members of a homologous series have very similar chemical properties.
State **three** other characteristics of a homologous series.

.....

.....

.....

..... [3]

(b) Carboxylic acids can be made by the oxidation of alcohols.

(i) Draw the structural formula of the alcohol which can be oxidised to propanoic acid.
Show all atoms and bonds.

[1]

(ii) Name a reagent, other than oxygen, which can oxidise alcohols to carboxylic acids.

..... [2]

(c) Complete the following equations for some of the reactions of propanoic acid.
The salts of this acid are called propanoates.

(i) zinc + propanoic acid → .... + hydrogen [1]

(ii) calcium oxide + propanoic acid → .... + ... [1]

(iii) $LiOH + CH_3CH_2COOH \rightarrow$ ..... + ... [1]

(d) A piece of magnesium was added to 100 cm^3 of an aqueous acid. The time taken for the metal to react completely was measured. This experiment was repeated using different aqueous acids. The same volume of acid was used in each experiment and the pieces of magnesium used were identical. In one experiment the reaction was carried out at a different temperature.

experiment	acid	concentration in mol / dm^3	temperature / °C	time / minutes
A	propanoic	1.0	20	5
B	propanoic	1.0	30	3
C	propanoic	0.5	20	8
D	hydrochloric	1.0	20	1

Explain the following in terms of collision rate between reacting particles.

(i) Why is the rate in experiment **C** slower than the rate in experiment **A**?

.....

.....

..... [2]

(ii) Why is the rate in experiment **B** faster than the rate in experiment **A**?

.....

.....

..... [2]

(iii) Why is the rate in experiment **D** faster than the rate in experiment **A**?

.....

.....

..... [3]

[Total: 18]

2 Explain each of the following in terms of the kinetic particle theory.

(a) The rate of most reactions increases at higher temperatures.

.....

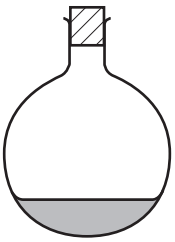
.....

.....

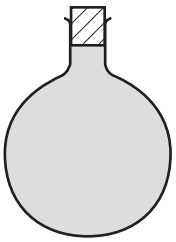
..... [3]

(b) A liquid has a fixed volume but takes up the shape of the container. A gas takes up the shape of the container but it does not have a fixed volume.

liquid



gas



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..... [3]

[Total: 6]

3 The alcohols form an homologous series.

(a) Give **three** characteristics of an homologous series.

.....

.....

.....

..... [3]

(b) The following two alcohols are members of the series and they are isomers.

$CH_3—CH_2—CH_2—CH_2—OH$ and $(CH_3)_2CH—CH_2OH$

(i) Explain why they are isomers.

.....

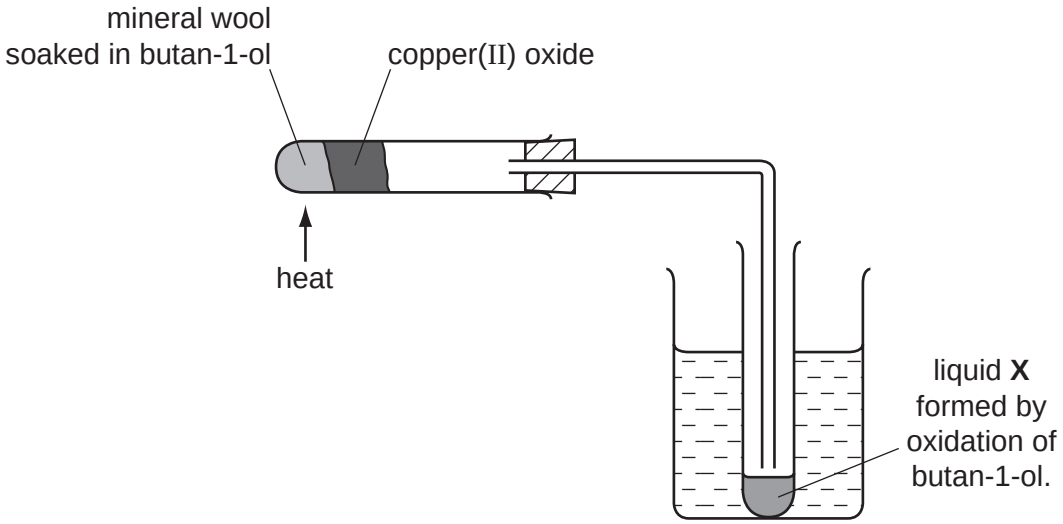
.....

..... [2]

(ii) Give the structural formula of another alcohol which is also an isomer of these alcohols.

[1]

(c) Copper(II) oxide can oxidise butan-1-ol to liquid **X** whose pH is 4.



(i) Name another reagent which can oxidise butan-1-ol.

..... [1]

(ii) What type of compound is liquid **X** and what is its formula?

type of compound ..... [1]

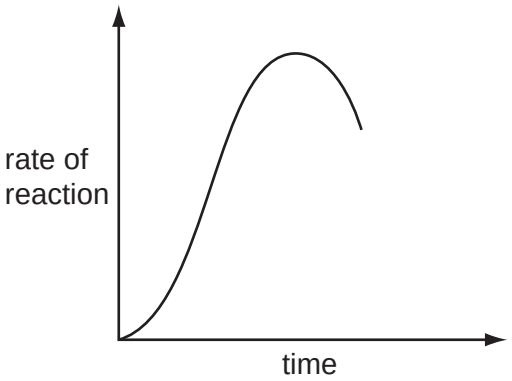
formula of liquid **X**

[1]

(d) The alcohol ethanol can be made by fermentation. Yeast is added to aqueous glucose.

$$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

Carbon dioxide is given off and the mixture becomes warm as the reaction is exothermic. The graph shows how the rate of reaction varies over several days.



(i) Suggest a method of measuring the rate of this reaction.

.....

..... [2]

(ii) Why does the rate increase initially?

.....

..... [1]

(iii) Suggest **two** reasons why the rate eventually decreases.

.....

..... [2]

(iv) Why is fermentation carried out in the absence of air?

.....

..... [1]

[Total: 15]

4 Vanadium is a transition element.

(a) An atom of the most common isotope of vanadium can be represented as $^{51}_{23}V$.

Complete the following table to show the number of protons, electrons and neutrons in each particle.

particle	number of protons	number of electrons	number of neutrons
$^{51}_{23}V$			
$^{51}_{23}V^{3+}$			
$^{50}_{23}V$			

[3]

(b) The major use of vanadium is to make vanadium steel alloys.

(i) Explain the phrase *steel alloys*.

.....

..... [2]

(ii) State the name and use of another steel alloy.

name .....

use ..... [2]

(c) Two of the oxidation states of vanadium are +3 and +4.

(i) Write the formula of vanadium(III) oxide and of vanadium(IV) oxide.

vanadium(III) oxide .....

vanadium(IV) oxide ..... [2]

(ii) Vanadium(III) oxide is basic and vandium(IV) oxide is amphoteric.
Describe how you would obtain a sample of vanadium(III) oxide from a mixture of these two oxides.

.....

.....

..... [3]

[Total: 12]