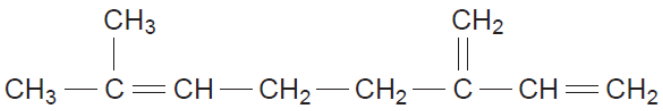
GCE AS LEVEL CHEMISTRY

S21- B410

Assessment Resource F

Energy, Rate and Carbon Compounds

1. Myrcene is a significant component of the essential oils of many plants. It has the structure shown below.



(a) State the **empirical** formula of myrcene. [1]

.....

(b) Draw the **skeletal** formula of myrcene. [1]

(c) Describe a test to show that myrcene contains C=C double bonds. [2]

.....

.....

2. The polymer PMMA which is used in aeroplane windows and skylights is formed from the monomer methyl methacrylate.

$CH_2=C(CH_3)CO_2CH_3$

Draw the repeat unit of this polymer. [1]

3. Collagen has the formula $C_{57}H_{91}N_{19}O_{16}$. Analysis of a sample showed that it contained 0.0204 mol of carbon.

Calculate the simplest ratio of carbon atoms to nitrogen atoms in the formula and use this to calculate the mass of nitrogen present in the sample. [2]

Mass of nitrogen = ... g

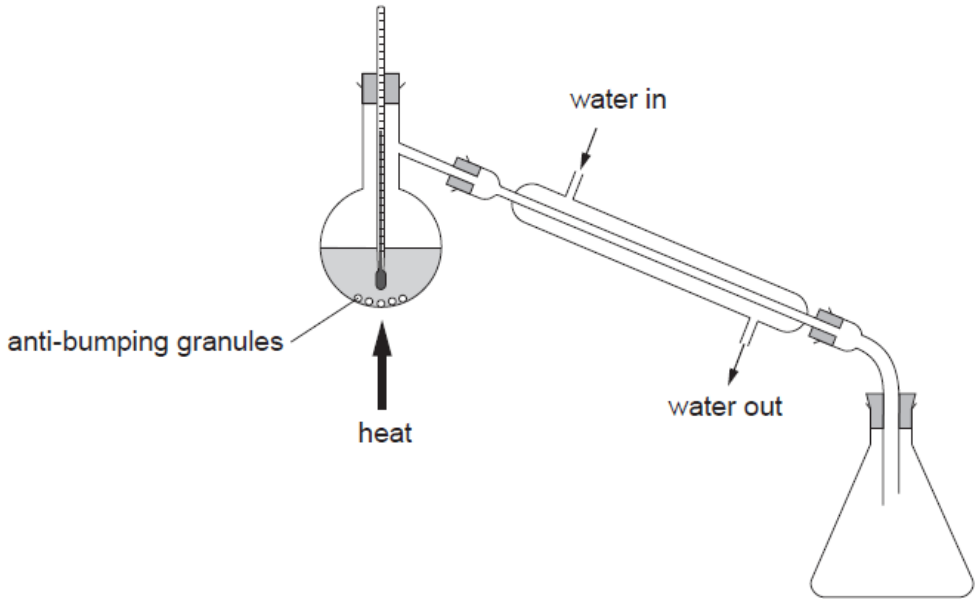
4. *(a)* A student wanted to form a halogenoalkane from an alcohol. He added hydrochloric acid to the alcohol and a mixture of organic and inorganic products formed. The halogenoalkane is the only substance in the mixture that does not dissolve in the inorganic aqueous solution.

(i) Suggest how the student could separate the halogenoalkane from the other compounds. [1]

.....

.....

(ii) The student wants to purify the halogenoalkane by distillation. He sets up the apparatus as shown in the diagram. You may assume that all the equipment is suitably clamped.



I. Anti-bumping granules were placed in the flask.

Suggest why these granules prevent bumping. [1]

.....

.....

II. State **two** changes that must be made to the apparatus for safe and effective use. Give your reason in each case. [4]

.....

.....

.....

.....

.....

.....

(b) Another student wanted to make 1-chloropentane.

She started with pentan-1-ol and obtained 1.62 g of 1-chloropentane. The percentage yield of 1-chloropentane was 67 %.

A fellow student told her that since 67 % is about two-thirds, she must have started with about 2.43 g of pentan-1-ol.

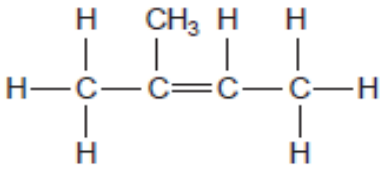
Is the student correct? Justify your answer. [3]

.....

.....

(c) Halogenoalkanes can also be formed from alkenes.

The alkene 2-methylbut-2-ene reacts with hydrogen bromide to form a mixture of 2-bromo-2-methylbutane and 2-bromo-3-methylbutane.



(i) Classify the reaction mechanism. [1]

.....

(ii) Explain why 2-bromo-2-methylbutane is the major product of this reaction. [2]

.....

.....

.....

.....

(iii) Draw the mechanism for the formation of 2-bromo-2-methylbutane. [3]

(d) When 2-bromobutane is heated with potassium hydroxide dissolved in ethanol, two structural isomers are formed.

(i) State the meaning of the term *structural isomers*. [1]

.....

.....

(ii) Draw the structure of both isomers. [2]

(iii) Circle the isomer which exhibits *E*-*Z* isomerism. Explain your choice. [1]

.....

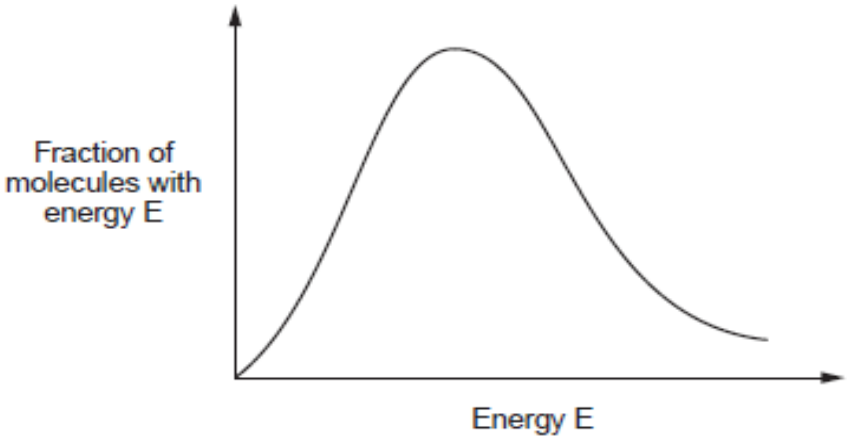
.....

5. *(a)* The decomposition of gaseous hydrogen iodide, HI, is represented by the following equation.

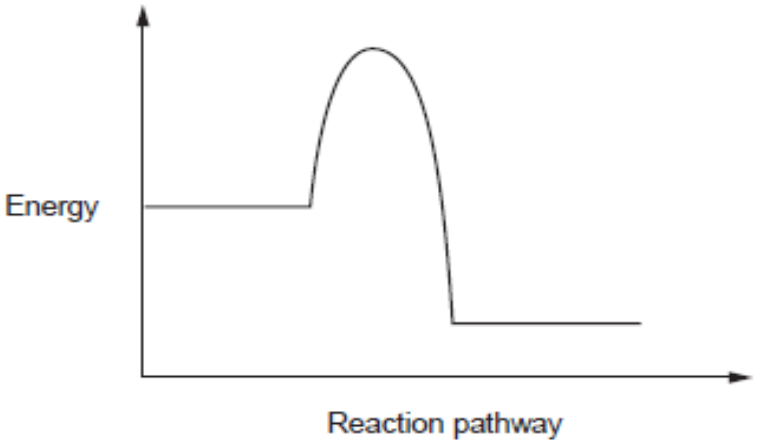
$$2HI(g) \rightleftharpoons H_2(g) + I_2(g) \qquad \Delta H = -53\,kJ\,mol^{-1}$$

(i) Its energy distribution curve at a certain temperature is shown below.

On the same axes, draw another curve to show the distribution at a higher temperature. [1]



(ii) The energy profile for this reaction is shown below.



I. Label the position that represents the transition state of the reaction. [1]

II. **On the same axes**, draw the energy profile for the same reaction if it were catalysed. [1]

(iii) The activation energy of the forward reaction (E_f) is 195 kJ mol^{-1}.

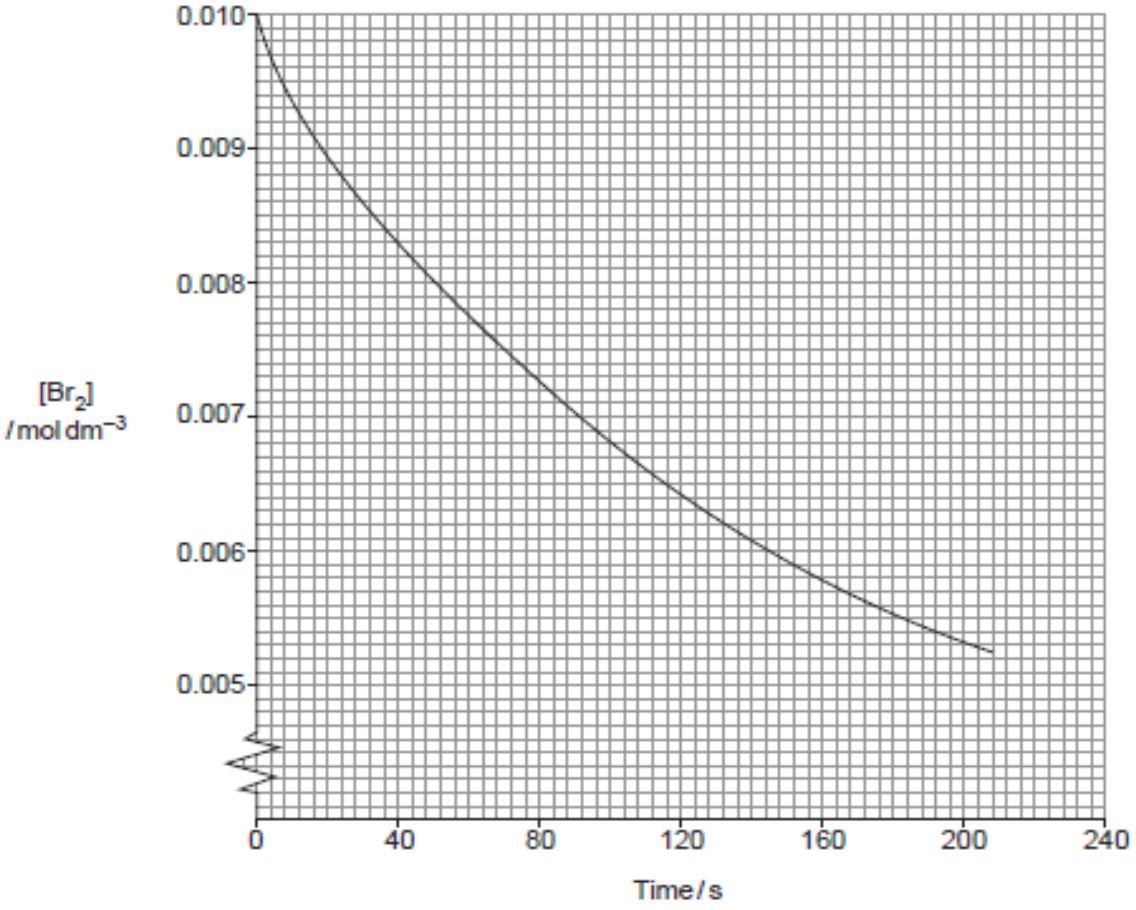
Calculate the activation energy of the reverse reaction (E_b). [1]

E_b = ... kJ mol^{-1}

(b) Bromine oxidises methanoic acid according to the following equation.

$$Br_2(aq) + HCOOH(aq) \longrightarrow 2H^+(aq) + 2Br^-(aq) + CO_2(g)$$

The graph below shows how the concentration of bromine changes in the initial stages of the reaction.



(i) Calculate the initial rate of the reaction from the graph and give its unit. **Show your working.** [4]

Initial rate = ...

Unit .....

(ii) Suggest **two** ways in which the rate of this reaction could be measured. [2]

.....

.....

.....

.....

(iii) I. State how the graph shows that the rate decreases as the reaction proceeds. [1]

.....

II. Use collision theory to explain why the rate of the reaction decreases as the reaction proceeds. [2]

.....

.....

.....

.....

(iv) State why it is necessary to keep the temperature constant during this experiment. [1]

.....

.....