**AS LEVEL CHEMISTRY**

**PAPER 2**

**PRACTICE PAPER 5**

Answer all questions

Max 80 marks

|  |  |  |
| --- | --- | --- |
|  | Name …………………………………………………………….. |  |
|  | Mark ……../80 ……....% Grade ……… |  |

**Note – the multiple choice questions used in this paper are recycled from the assessed homeworks, tests and assessment points for the AS-level/1st Year course**

**1.**          (a)     Define the term *standard enthalpy of combustion*, ∆*Hc*~~ο~~

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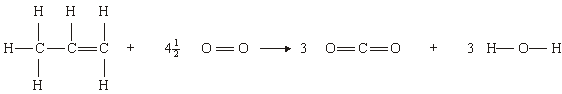
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**(3)**

(b)     Use the mean bond enthalpy data from the table and the equation given below to calculate a value for the standard enthalpy of combustion of propene. All substances are in the gaseous state.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Bond | C == C | C—C | C—H | O == O | O == C | O—H |
| Mean bond enthalpy/ kJ mol–1 | 612 | 348 | 412 | 496 | 743 | 463 |



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**(3)**

(c)     State why the standard enthalpy of formation, ∆*H*f~~ο~~, of oxygen is zero.

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**(1)**

(d)     Use the data from the table below to calculate a more accurate value for the standard enthalpy of combustion of propene.

|  |  |  |  |
| --- | --- | --- | --- |
| Compound | C3H6(g) | CO2(g) | H2O(g) |
| Standard enthalpy of formation, ∆*H*f ~~ο~~/ kJ mol–1 | +20 | –394 | –242 |

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**(3)**

(e)     Explain why your answer to part (b) is a less accurate value than your answer to part (d).

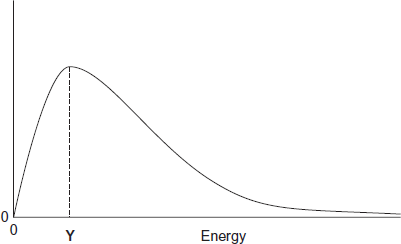
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**(2)**

**(Total 12 marks)**

**2.** The following figure shows the Maxwell.Boltzmann distribution of molecular energies in a sample of gas at temperature *T*.



(a)     One of the axes is labelled.  
Label the other axis.

**(1)**

(b)     State why the curve starts at the origin.

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**(1)**

(c)     Which of the following, **A**, **B** or **C**, describes what the value of **Y** represents in the figure?  
Write the correct letter, **A**, **B** or **C**, in the box.

**A**  The energy needed for a successful collision  
**B**  The minimum energy needed for a reaction to occur  
**C**  The most probable energy



**(1)**

(d)     On the figure above, draw a distribution of molecular energies in this sample of gas at a **higher** temperature.

**(2)**

(e)     The pressure of the original sample of gas is doubled at temperature *T*.

State the effect, if any, of this change on the value of **Y**.

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**(1)**

**(Total 6 marks)**

**3.**      Methanol can be synthesised from carbon monoxide by the reversible reaction shown below.

CO(g)  +  2H2(g)    CH3OH(g)              Δ*H* = –91 kJ mol–1

The process operates at a pressure of 5 MPa and a temperature of 700 K in the presence of a copper-containing catalyst. This reaction can reach dynamic equilibrium.

(a)     By reference to rates and concentrations, explain the meaning of the term *dynamic equilibrium.*

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**(2)**

(b)     Explain why a high yield of methanol is favoured by high pressure.

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**(2)**

(c)     Suggest **two** reasons why the operation of this process at a pressure much higher than 5 MPa would be very expensive.

*Reason 1*.......................................................................................................

*Reason 2*.......................................................................................................

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**(2)**

(d)     State the effect of an increase in temperature on the equilibrium yield of methanol and explain your answer.

*Effect*.............................................................................................................

*Explanation*....................................................................................................

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**(3)**

(e)     If a catalyst were not used in this process, the operating temperature would have to be greater than 700 K. Suggest why an increased temperature would be required.

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**(1)**

**(Total 10 marks)**

**4.**      The reaction of bromine with ethane is similar to that of chlorine with ethane. Three steps in the bromination of ethane are shown below.

Step **1**                          Br2  2Br•

Step **2**         Br• + CH3CH3  CH3CH2• + HBr

Step **3**         CH3CH2• + Br2CH3CH2Br + Br•

(a)     (i)      Name this type of mechanism.

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(ii)     Suggest an essential condition for this reaction.

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(iii)     Steps **2** and **3** are of the same type. Name this type of step.

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(iv)    In this mechanism, another type of step occurs in which free-radicals combine. Name this type of step. Write an equation to illustrate this step.

*Type of step* .......................................................................................

*Equation*..............................................................................................

**(5)**

(b)     Further substitution in the reaction of bromine with ethane produces a mixture of liquid organic compounds.

(i)      Name a technique which could be used to separate the different compounds in this mixture.

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(ii)     Write an equation for the reaction between bromine and ethane which produces hexabromoethane, C2Br6, by this substitution reaction.

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**(2)**

**(Total 7 marks)**

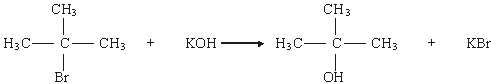
**5.**     (a)     Name and outline a mechanism for the reaction of 2-bromo-2-methylpropane with ethanolic potassium hydroxide to form the alkene 2-methylpropene, (CH3)2C=CH2

*Name of mechanism* ....................................................................................

*Mechanism*

**(4)**

(b)     When 2-bromo-2-methylpropane reacts with aqueous potassium hydroxide,   
2-methylpropan-2-ol is formed as shown by the following equation.



State the role of the hydroxide ions in this reaction.

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**(1)**

(c)     Write an equation for the reaction that occurs when CH3CH2CH2CH2Br reacts with an excess of ammonia. Name the organic product of this reaction.

*Equation .*.....................................................................................................

*Name of product* ..........................................................................................

**(3)**

**(Total 8 marks)**

**6.** Calamine lotion can contain a mixture of zinc carbonate and zinc oxide in suspension in water. A manufacturer of calamine lotion claims that a sample contains 15.00 g of zinc carbonate and 5.00 g of zinc oxide made up to 100 cm3 with distilled water.

(a)     A chemist wanted to check the manufacturer’s claim. The chemist took a 20.0 cm3 sample of the calamine lotion and added it to an excess of sulfuric acid.

The volume of carbon dioxide evolved was measured over time. The chemist’s results are shown in the table.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Time / s** | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 |
|  | **Volume / cm3** | 0 | 135 | 270 | 380 | 470 | 530 | 560 | 570 | 570 | 570 |

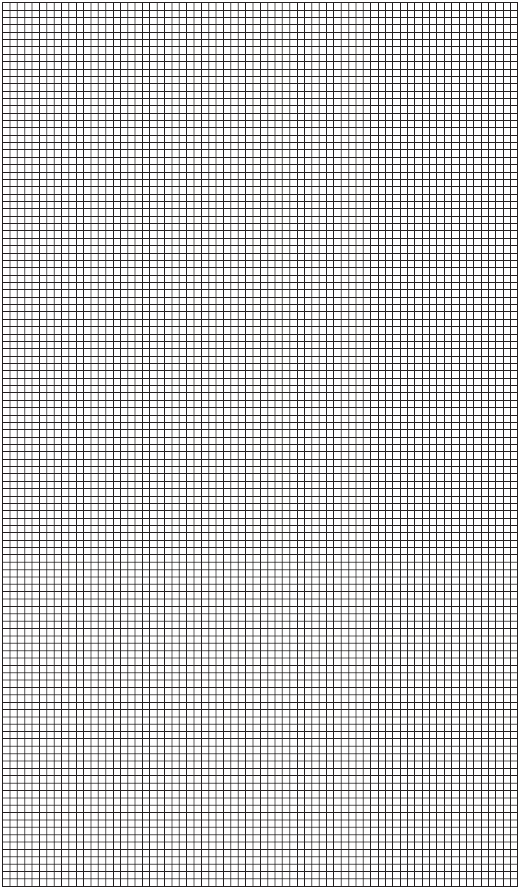
(i)      Plot a graph of the results in the table on the grid. The volume should be on the *y*-axis. Draw a best-fit curve through **all** the points.

**(3)**

(ii)     Estimate the time taken for the reaction to be completed.

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**(1)**

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(b)     (i)      The volume of carbon dioxide in part (a) was measured at 293 K and at a pressure of 100 kPa.

Use information from your graph to calculate the maximum amount, in moles, of carbon dioxide evolved from the zinc carbonate in this 20.0 cm3 sample.

The gas constant, *R* = 8.31 J K−1 mol−1

Show your working.

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**(3)**

(ii)     Use your answer to part (i) to calculate the mass of zinc carbonate in the 20.0 cm3 sample of calamine lotion.

(If you were unable to complete part (i), you may assume that the amount of carbon dioxide evolved was 0.0225 mol. This is **not** the correct answer.)

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**(2)**

(iii)    Calculate the difference between your answer to part (ii) and the manufacturer’s claim that there are 15.00 g of zinc carbonate in 100 cm3 of the calamine lotion.

Express this difference as a percentage of the manufacturer’s claim.

(If you were unable to complete part (ii), you may assume that the mass of zinc carbonate in the 20 cm3 sample of calamine lotion was 2.87 g. This is **not** the correct answer.)

Difference .............................................................................................

Percentage ...........................................................................................

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**(2)**

(c)     Draw a diagram of a suitable apparatus needed to perform the experiment outlined in part (a). Include in your diagram a method for collecting and measuring the carbon dioxide. The apparatus should be airtight.

**(2)**

**(Total 13 marks)**

|  |  |
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| **7.** |  |

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**(Total 8 marks)**

**8.** Which one of the following molecules or ions is pyramidal in shape?

**A**       BF3

**B**       CH

**C**       CH

**D**       SF

**(Total 1 mark)**

**9.** Given the following data

C(s) + 2H2(g) → CH4(g)                       *∆H* = −75 kJ mol−1

  H2(g) → 2H(g)                           *∆H* = +436 kJ mol−1

which one of the following is the enthalpy change, in kJ mol−1, of the reaction below?

CH4(g) → C(s) + 4H(g)

**A**       −947

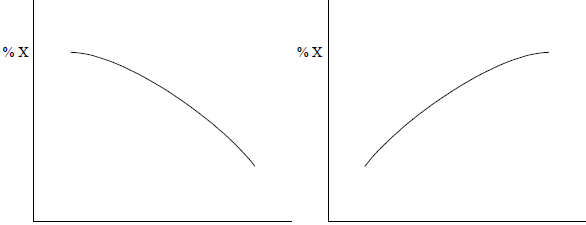
**B**       +511

**C**       +797

**D**       +947

**(Total 1 mark)**

**10.** A compound **X** is formed during a gas phase reaction. The graphs below show how the percentage of a compound **X** present at equilibrium varies with temperature and pressure.



|  |  |  |  |
| --- | --- | --- | --- |
|  | Temperature |  | Pressure |

Which one of the following statements concerning the formation of **X** is correct?

**A**       The reaction is exothermic and involves a decrease in the number of moles of gas.

**B**       The reaction is exothermic and involves no change in the number of moles of gas.

**C**       The reaction is exothermic and involves an increase in the number of moles of gas.

**D**       The reaction is endothermic and involves a decrease in the number of moles of gas.

**(Total 1 mark)**

**11.** Which one of the following does **not** represent an oxidation?

**A**       propene → propane

**B**       propan-l-ol → propanal

**C**       propan-l-ol → propanoic acid

**D**       propanal → propanoic acid

**(Total 1 mark)**

**12.** Which one of the following is **not** a suitable method for the preparation of ethanol?

**A**       oxidation of ethane

**B**       hydration of ethene

**C**       reduction of ethanal

**D**       hydrolysis of bromoethane

**(Total 1 mark)**

**13.** Which one of the following samples of gas occupies the largest volume?

**A**       1.0 g of ozone (O3) at l00 kPa and 300 K

**B**       1.0 g of oxygen at 100 kPa and 300 K

**C**       1.0 g of water vapour at 250 kPa and 450 K

**D**       1.0 g of methane at 333 kPa and 500 K

**(Total 1 mark)**

**14.** Consider the reactions

C2H4(g) + 2O2(g) → 2CO(g) + 2H2O(g)                            *∆H* = −758 kJ mol−1

2C(s) + 2H2(g) → C2H4(g)                                        *∆H* = +52 kJ mol−1

H2(g) +  O2(g) → H2O(g)                                         *∆H* = −242 kJ mol−1

The enthalpy of formation of carbon monoxide is

**A**       −111 kJ mol−1

**B**       −163 kJ mol−1

**C**       −222 kJ mol−1

**D**       -464 kJ mol−1

**(Total 1 mark)**

**15.** Predict which one of the following has the highest boiling temperature.

**A**       CH3COOCH2CH3

**B**       CH3CH2CH2CH2OH

**C**       CH3CH2CH2CH2CH3

**D**       CH3CH2CH2CHO

**(Total 1 mark)**

**16.** What is the volume occupied by 10.8 g of the freon CCl2F2 at 100 kPa and 273 K?

**A**       2.02 dm3

**B**       2.05 dm3

**C**       2.02 cm3

**D**       2.05 cm3

**(Total 1 mark)**

**17.** Which one of the following contains the greatest number of moles of methanol? (The Avogadro number (*L*) is 6.02 × 1023, the relative molecular mass (*M*r) of methanol is 32.)

**A**       6.6 × 1022 molecules

**B**       3.3 g of methanol

**C**       2.5 × 10−3 m3 of methanol vapour at 300 K and 100 kPa

**D**       70 cm3 of 1.5 M aqueous methanol

**(Total 1 mark)**

**18.** An alkane contains 30 hydrogen atoms per molecule. Its empirical formula is

**A**       C6H15

**B**       C7H15

**C**       C14H30

**D**       C15H30

**(Total 1 mark)**

**19.** Which one of the following is least likely to occur in the reaction between methane and chlorine?

**A**       CH4 + Cl• → CH3• + HCl

**B**       CH3• + HCl → CH3Cl + H•

**C**       CH3• + Cl2 → CH3Cl + Cl•

**D**       CH3Cl + Cl• → CH2Cl• + HCl

**(Total 1 mark)**

**20.** Which one of the following is the correct name for  ?

**A**       2-bromo-3-methylpent-2-ene

**B**       2-bromo-3-ethylbut-2-ene

**C**       3-bromo-2-ethylbut-2-ene

**D**       4-bromo-3-methylpent-3-ene

**(Total 1 mark)**

**21.** Which one of the following samples of gas, when sealed into a vessel of volume 0.10 m3, is at the highest pressure?

**A**       1.6 g of helium (He) at 100 K

**B**       1.6 g of methane (CH4) at 100 K

**C**       1.6 g of oxygen (O2) at 600 K

**D**       1.6 g of sulphur dioxide (SO2) at 1200 K

**(Total 1 mark)**

**22.** How many structural isomers, which are aldehydes, have the molecular formula C5H10O?

**A**       2

**B**       3

**C**       4

**D**       5

**(Total 1 mark)**

**23.** In a vessel of volume 1.80 dm3, a reaction mixture contains 0.0700 mol of SO3(g), 0.0500 mol of SO2(g) and 0.0900 mol of O2(g) at a total pressure of 623 kPa. The temperature in the equilibrium vessel is

**A**       307 °C

**B**       596 K

**C**       337 °C

**D**       642 K

**(Total 1 mark)**