**AS LEVEL CHEMISTRY**

**PAPER 2**

**PRACTICE PAPER 6**

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.** Ethanol is an important industrial compound.

(a)     Ethanol can be produced by the hydration of ethene.  
The equation for the equilibrium that is established is

H2C=CH2(g)   +   H2O(g)       CH3CH2OH(g) Δ*H* = −42 kJ mol−1

The operating conditions for the process are a temperature of 300 oC and a pressure of 7 MPa.  
Under these conditions, the conversion of ethene into ethanol is 5%.

(i)      Identify the catalyst used in this process.  
Deduce how an overall yield of 95% is achieved in this process without changing the operating conditions.

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**(2)**

(ii)     Use your knowledge of equilibrium reactions to explain why a manufacturer might consider using an excess of steam in this process, under the same operating conditions.

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**(3)**

(iii)    At pressures higher than 7 MPa, some of the ethene reacts to form a solid with a relative molecular mass greater than 5000.

Deduce the identity of this solid.

Give **one** other reason for **not** operating this process at pressures higher than 7 MPa.  
Do **not** include safety reasons.

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**(2)**

(b)     Write an equation for the reaction that has an enthalpy change that is the standard enthalpy of formation of ethanol.

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**(2)**

(c)     When ethanol is used as a fuel, it undergoes combustion.

(i)      Define the term *standard enthalpy of combustion*.

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**(3)**

(ii)     Consider these bond enthalpy data.

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| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | C–H | C–C | C–O | O=O | C=O | O–H |
|  | **Bond enthalpy / kJ mol−1** | 412 | 348 | 360 | 496 | 805 | 463 |

Use these data and the equation to calculate a value for the enthalpy of combustion of gaseous ethanol.

CH3CH2OH(g)   +   3O2(g)        2CO2(g)   +   3H2O(g)

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**(3)**

(d)     Gaseous ethanol can be used to convert hot copper(II) oxide into copper.

(i)      Deduce the role of ethanol in this reaction.

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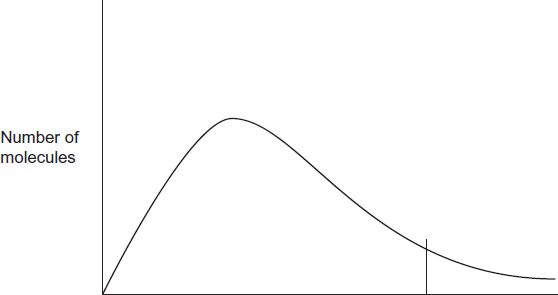
**(1)**

(ii)     Draw the structure of the organic compound with *M*r = 60 that is produced in this reaction.

**(1)**

**(Total 17 marks)**

**2.** The diagram shows the Maxwell–Boltzmann distribution for a sample of gas at a fixed temperature.  
*E*a is the activation energy for the decomposition of this gas.



Energy Ea

*E*mp is the most probable value for the energy of the molecules.

(a)     On the appropriate axis of this diagram, mark the value of *E*mp for **this** distribution.

On this diagram, sketch a new distribution for the same sample of gas at a **lower** temperature.

**(3)**

(b)     With reference to the Maxwell–Boltzmann distribution, explain why a decrease in temperature decreases the rate of decomposition of this gas.

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**(2)**

**(Total 5 marks)**

**3.**         Tetrafluoroethene, C2F4, is obtained from chlorodifluoromethane, CHClF2, according to the equation:

2CHClF2(g)  C2F4(g) + 2HCl(g)             Δ*H*~~ο~~ = +128kJ mol–1

(a)     A 1.0 mol sample of CHClF2 is placed in a container of volume 18.5 dm3 and heated.

When equilibrium is reached, the mixture contains 0.20 mol of CHClF2

(i)      Calculate the number of moles of C2F4 and the number of moles of HCl present at equilibrium.

*Number of moles of C2F4* ...................................................................

*Number of moles of HCl* .....................................................................

(ii)     Write an expression for *K*c for the equilibrium.

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(iii)     Calculate a value for *K*c and give its units.

*Calculation* ..........................................................................................

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*Units* ....................................................................................................

**(6)**

(b)     (i)      State how the temperature should be changed at constant pressure to increase the equilibrium yield of C2F4

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(ii)     State how the total pressure should be changed at constant temperature to increase the equilibrium yield of C2F4

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**(2)**

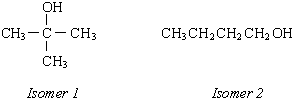
(c)     C2F4 is used to manufacture the polymer polytetrafluoroethene, PTFE. Name the type of polymerisation involved in the formation of PTFE.

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**(1)**

**(Total 9 marks)**

**4.**     (a)     The structural formulae of two of the four possible alcohols of molecular formula C4H10O are shown below.



(i)      What type of alcohol is Isomer 1? Suggest a reason why this type of alcohol is not easily oxidised.

*Type of alcohol* ...................................................................................

*Reason ..*.............................................................................................

**(2)**

(b)     Isomer 2 was oxidised by adding it dropwise to acidified potassium dichromate(VI) solution and immediately distilling off the product. When this product was treated with Fehling’s solution, a red precipitate was formed.

(i)      State the type of product distilled off during the oxidation by acidified potassium dichromate(VI) solution.

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(ii)     Write an equation for the oxidation by potassium dichromate(VI), showing clearly the structure of the organic product. Use [O] to represent the oxidising agent.

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(iii)     Name and draw a structure for the organic product formed by the reaction with Fehling’s solution.

*Name* ..................................................................................................

*Structure* .............................................................................................

**(5)**

(c)     State **one** advantage and **one** disadvantage of the production of ethanol by the hydration of ethene compared to the fermentation of glucose.

*Advantage* ...................................................................................................

*Disadvantage .*..............................................................................................

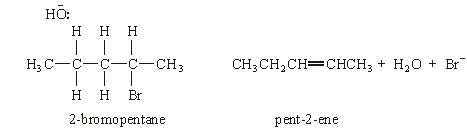
**(2)**

(d)     Outline a mechanism for the dehydration of ethanol to form ethene in the presence of an acid catalyst.

**(4)**

**(Total 13 marks)**

**5.**       (a)     Complete the mechanism below by drawing appropriate curly arrows.



**(3)**

(b)     Pent-1-ene reacts with hydrogen bromide to produce 2-bromopentane as the major product.

(i)      Outline the mechanism for this reaction.

(ii)     Identify the minor product formed in this reaction.

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(iii)     Explain why 2-bromopentane is the major product of this reaction.

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**(7)**

**(Total 10 marks)**

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| **6.** |  | |
|  |  | |
|  | (a) | Draw a best fit straight line on your graph. |
|  | (b) | Use the graph to determine the volume of gas which would have been produced by 0.10 g of **X**.  Volume of gas……………………………………………………………………………………. |
|  | (c) | State the ideal gas equation.  ……………………………………………………………………………………………………………………………………………………………………….. |
|  | (d) | Use your answers to part (b) and part (c) to calculate the Mr of **X**.  ………………………………………………………………………………………………………………………………………………………………………..  ……………………………………………………………………………………………………………………………………………………………………….. |
|  | (e) | Assume the maximum errors for the apparatus used in this experiment were  balance ± 0.01 g  gas syringe ± 1 cm3  Estimate the maximum percentage error in using each piece of apparatus, and hence calculate the overall apparatus error. Use a mass of 0.10 g and the volume from part (b) to calculate these errors.  ………………………………………………………………………………………………………………………………………………………………………..  ………………………………………………………………………………………………………………………………………………………………………..  ………………………………………………………………………………………………………………………………………………………………………..  ……………………………………………………………………………………………………………………………………………………………………….. |
|  | (f) | Consider the graph and comment on the accuracy of the results obtained by the student. Is your line of best fit good enough for you to use with confidence? Identify any anomalous results.  ………………………………………………………………………………………………………………………………………………………………………..  ………………………………………………………………………………………………………………………………………………………………………..  ………………………………………………………………………………………………………………………………………………………………………..  ……………………………………………………………………………………………………………………………………………………………………….. |
|  | (g) | The correct value for the relative molecular mass is 72.0. Calculate the difference between the student’s  value and this correct value. Express this difference as a percentage of the correct value.  Difference………………………………………………………………………  Percentage……………………………………………………………………… |

|  |  |  |
| --- | --- | --- |
|  | (h) | Apart from loss of liquid during transfer to the gas syringe, identify one other source of error in this experiment. Suggest **one** improvement to minimise this source of error.  Source of error………………………………………………………………………………………………………………………………………………..  ………………………………………………………………………………………………………………………………………………………………………..  Improvement……………………………………………………………………………………………………………………………………………......  ……………………………………………………………………………………………………………………………………………………………………….. |
|  | (i) | Would a loss of liquid during transfer to the gas syringe result in a lower value for the Mr of liquid **X**? Explain  your answer.  ………………………………………………………………………………………………………………………………………………………………………..  ………………………………………………………………………………………………………………………………………………………………………..  ………………………………………………………………………………………………………………………………………………………………………..  ………………………………………………………………………………………………………………………………………………………………………..  **(Total 12 marks)** |

**7.** When ethanamide (CH3CONH2) burns in oxygen the carbon is converted into carbon dioxide, the hydrogen is converted into water and the nitrogen forms nitrogen gas.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Substance | ethanamide | carbon dioxide | water |
|  | Enthalpy of formation () / kJ mol−1 | −320 | −394 | −286 |

Using the data above, which one of the following is a correct value for the enthalpy of combustion of ethanamide?

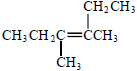
**A**       −1823 kJ mol−1

**B**       −1183 kJ mol−1

**C**       −1000 kJ mol−1

**D**       −360 kJ mo1−1

**(Total 1 mark)**

**8.** The correct systematic name for  is

**A**       2,3-diethylbut-2-ene

**B**       2-ethyl-3-methylpent-2-ene

**C**       4-ethyl-3-methylpent-3-ene

**D**       3,4-dimethylhex-3-ene

**(Total 1 mark)**

**9.** Which one of the following compounds contains the smallest percentage, by mass, of oxygen?

**A**       CH3OCH2CH3

**B**       CH3OCH2NH2

**C**       COS

**D**       C4H9Al(OH)2

**(Total 1 mark)**

**10.** On complete combustion, 0.0150 mol of an organic acid produced 735 cm3 of carbon dioxide (measured at 101 kPa and 298 K). The same amount of acid required 15.0 cm3 of 2.00 M sodium hydroxide solution for neutralisation. Which one of the following could be the formula of the acid?

**A**       HCOOH

**B**       CH3COOH

**C**       HOOCCOH

**D**       HOOCCH2CH2COOH

**(Total 1 mark)**

**11.** Assuming that chlorine exists as two isotopes, and that hydrogen and carbon exist as one isotope each, how many molecular ion peaks will be shown in the mass spectrum of C4H6Cl4?

**A**       2

**B**       3

**C**       4

**D**       5

**(Total 1 mark)**

**12.** The number of structural isomers of C3H2Cl6 is

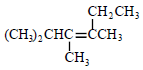
**A**       2

**B**       3

**C**       4

**D**       5

**(Total 1 mark)**

**13.** The correct systematic name for  is

**A**       2-ethyl-3,4-dimethylpent-2-ene

**B**       4-ethyl-2,3-dimethylpent-3-ene

**C**       2,3,4-trirnethylhex-3-ene

**D**       3,4,5-trimethylhex-3-ene

**(Total 1 mark)**

**14.** Certain chemical tests were performed on the pain-relief drug ibuprofen. The results of these tests are given in the table below.

|  |  |  |
| --- | --- | --- |
|  | **Test** | **Result** |
|  | Aqueous sodium carbonate | Effervescence |
|  | Bromine water | Remained orange |
|  | Acidified potassium dichromate(VI) and heat | Remained orange |
|  | Fehling’s solution and heat | Remained blue |

Which one of the following functional groups do these results suggest that ibuprofen contains?

**A**        

**B**        

**C**        

**D**        

**(Total 1 mark)**

**15.** Which one of the following statements about but-2-enal, CH3CH=CHCHO, is **not** true?

**A**       It has stereoisomers.

**B**       It shows a strong absorption in the infra-red at about 1700 cm−1.

**C**       It will turn an acidified solution of potassium dichromate(VI) green.

**D**       It can be dehydrated by concentrated sulphuric acid.

**(Total 1 mark)**

**16.** The ester methyl ethanoate is hydrolysed as shown in the following equation.

    CH3COOCH3(l) + H2O(l)  CH3COOH(l) + CH3OH(l)     Δ*H* = +3 kJ mol−1

The equilibrium yield of ethanoic acid could be increased by

**A**       lowering the temperature.

**B**       adding a catalyst.

**C**       adding more water to the reaction mixture.

**D**       adding more methanol to the reaction mixture.

**(Total 1 mark)**

**17.** The ester methyl ethanoate is hydrolysed as shown in the following equation.

    CH3COOCH3(l) + H2O(l)  CH3COOH(l) + CH3OH(l)     Δ*H* = +3 kJ mol−1

A 3 mol sample of methyl ethanoate was mixed with 3 mol of water and left to reach equilibrium at 298 K. The equilibrium yield of ethanoic acid was 2 mol. The value of *K*c for this reaction at 298 K is

**A**        

**B**        

**C**        2

**D**        4

**(Total 1 mark)**

**18.** The ester methyl ethanoate is hydrolysed as shown in the following equation.

    CH3COOCH3(l) + H2O(l)  CH3COOH(l) + CH3OH(l)     Δ*H* = +3 kJ mol−1

Which one of the following compounds from the reaction mixture has no hydrogen bonding between its molecules when pure?

**A**       CH3COOCH3(l)

**B**       H2O(l)

**C**       CH3COOH(l)

**D**       CH3OH(l)

**(Total 1 mark)**

**19.** The table below shows data for the four hydrocarbons ethyne, propyne, propene and propane. Δ*H*c is the standard enthalpy of combustion of these hydrocarbons.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Compound** | **Name** | ***M*r** | **−Δ*H*c / kJ mol−1** |
|  | HC≡CH | ethyne | 26 | 1300 |
|  | HC≡CCH3 | propyne | 40 | 1940 |
|  | H2C=CHCH3 | propene | 42 | 2060 |
|  | CH3CH2CH3 | propane | 44 | 2220 |

The complete combustion of 2.0 g of one of the above hydrocarbons releases exactly 100 kJ of heat energy.

This hydrocarbon is

**A**       ethyne

**B**       propyne

**C**       propene

**D**       propane

**(Total 1 mark)**

**20.** How many different alkenes are formed when 2-bromo-3-methylbutane reacts with ethanolic potassium hydroxide?

**A**       2

**B**       3

**C**       4

**D**       5

**(Total 1 mark)**