Mearns Castle High

HIGHER CHEMISTRY
PRELIM EXAMINATION
February 2006

CANDIDATE NAME _____

TEACHER NAME _____

READ THESE INSTRUCTIONS CAREFULLY BEFORE COMMENCING THE EXAMINATION:

- **The examination will last for 2hours 30minutes.**
- **The paper consists of two parts.**
- **Section A consists of 40 multiple choice questions. Your answers should be entered on the answer grid supplied.**
- **Section B takes the form of a questions and answer book. A total of 60 marks are available in paper 2.**
- **There is no choice of questions in either paper.**

Higher Chemistry Prelim February 2006
SECTION A

1. Which of the following pairs of solutions will produce a precipitate

A sodium iodide + potassium bromide
B ammonium chloride + sodium sulphate
C copper (II) chloride + sodium carbonate
D lithium nitrate + sodium sulphate

2. Which of the following processes involves the use of a homogeneous catalyst?

A The Haber process
B The Ostwald process
C The laboratory formation of esters
D The cracking of alkanes

3. Which homologous series contains the functional group **COOH** ?

A Alkanoic acids
B Alkanols
C Alkanals
D Alkanones

4. The **ionic formula** of ammonium sulphate is

A $(NH_3^+)_3SO_4^{2-}$
B $(NH_4^+)_2SO_4^{2-}$
C $(NH_3^+)_2SO_4^{2-}$
D $(NH_4^+)_3SO_4^{2-}$

5. The third member of the **alkene** series is

A propene
B pentene
C ethene
D butene

6. The bonding in diamond is an example of

A discrete covalent
B typical metallic
C molecular covalent
D giant network covalent

7. Metals can conduct electricity because

A their ions are free to move when their lattice is intact
B their outer energy level electrons are mobile
C they have a similar layer structure to graphite
D their ionisation energies are all high

8. An endothermic reaction always has

A a low activation energy
B a negative enthalpy change
C a high activation energy
D a positive enthalpy change

9. Which of the following reactions involves a condensation reaction?

A The decomposition of silver halides in a photographic film.
B The conversion of glucose into starch in green plants.
C The production of biogas.
D The addition of bromine to alkenes.

10. $2C_3H_6 + 9O_2 \rightarrow 6CO_2 + 6H_2O$ $\quad \Delta H = X$ kJ

The enthalpy of combustion of propene is

A $X \div 9$
B $X \times 2$
C X
D $X \div 2$

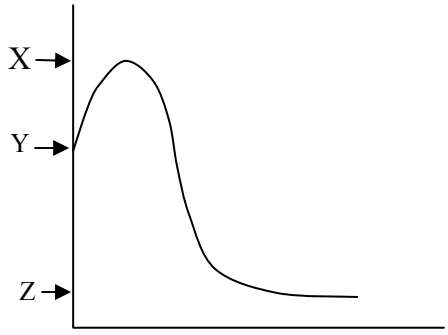
11. Ionisation energies increase across a period because

A the nuclear charge increases across a period
B the number of outer energy level electrons increases across a period
C the size of the atoms increases across a period
D the distance between the nucleus and the outer energy level increases across a period

12. In which of the following substances is permanent dipole-permanent dipole attraction the main intermolecular force present?

A ethane
B ethene
C ethanal
D ethyne

Questions **13 and 14** concern the potential energy diagram below



13. The **ΔH** value for the forward reaction can be represented by

A X – Z
B Z – Y
C X – Y
D Y – X

14. The activation energy for the **reverse** reaction can be represented by

A Y – Z
B Z – Y
C X – Y
D X – Z

15. $H_2 + Cl_2 \rightarrow 2HCl$

The reaction between 20 cm^3 of hydrogen and 30 cm^3 of chlorine will produce a mixture of gases with a volume of

A 10 cm^3
B 20 cm^3
C 30 cm^3
D 50 cm^3

16. Which of the following compounds can be added to petrol in winter to improve the starting of cars?

A butane
B ethanol
C ethane-1,2,3-triol
D octene

17. Esters are compounds formed when

A an alkanol is hydrolysed by an alkanoic acid.
B an alkanoic acid reacts with concentrated sulphuric acid.
C an alkanoic acid condenses with an alkanol.
D an alkanol is dehydrated by concentrated sulphuric acid.

18. Polypropene is an example of a

A thermoplastic addition polymer.
B thermosetting natural polymer.
C natural condensation polymer.
D synthetic condensation polymer.

19. Which of the following statements is true for **all** fat and oil molecules.

A They hydrolyse to produce three molecules of a fatty acid and one molecule of glycerol.
B They hydrolyse to produce one molecule of a tri acid and three molecules of ethanol.
C They hydrolyse to produce three molecules of glycerol and one molecule of a fatty acid.
D They hydrolyse to produce one molecule of glycerol and one molecule of a fatty acid.

20. $CH_3COOCH_2CH_2CH_3$

This compound is called

A propan-2-one
B propan-2-ol
C ethyl propanoate
D propyl ethanoate

SECTION B

1. A pupil used the reaction between acidified potassium iodide and hydrogen peroxide to study the relationship between reaction rate and concentration. The reaction can be shown by the **unbalanced** equation below:

$$H_2O_2(aq) + H^+(aq) + I^-(aq) \rightarrow H_2O(l) + I_2(aq)$$

a) Balance the equation above. **1**

b) Potassium ions are also present in the above reaction mixture. Why is it unnecessary to include them in the equation?

1

The pupil obtained the following set of results for her experiment:

Volume of KI(aq) (cm^3)	**Volume of water (cm^3)**	**Time (s)**	**Rate(1/time x 10^{-3}) (s^{-1})**
25	0	22	46
20	5	27	37
15	10	35	29
10	15	54	19
5	20	110	

c) Complete the table by calculating the missing rate.

1

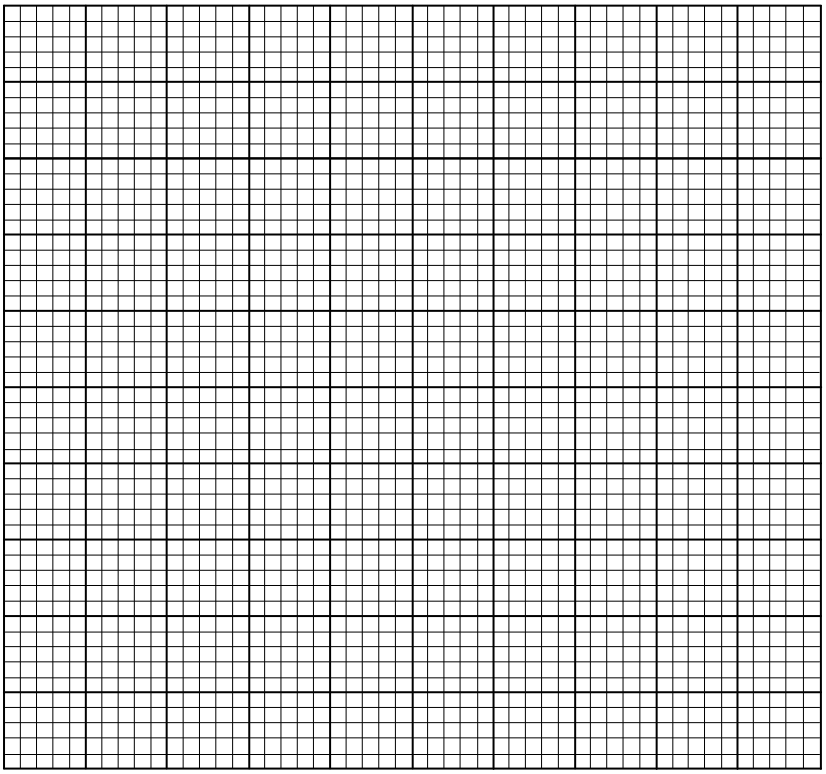
[continued]

[continued]

d) To keep the experiment fair the overall volume of the reaction mixture for each different concentration of potassium iodide solution is kept constant by varying the relative volumes of potassium iodide solution and water used.
Which factor is being kept constant by using the above procedure?

1

e) On the graph paper below, draw a line graph of **rate** versus **volume of KI(aq)**



2
(6)

2. A photochemical reaction is one in which the **activation energy** is supplied by light. The decomposition of **silver(I)halide** compounds in a photographic film is one such reaction. In darkness, the decomposition does not proceed. When exposed to white light, the decomposition is extremely rapid.

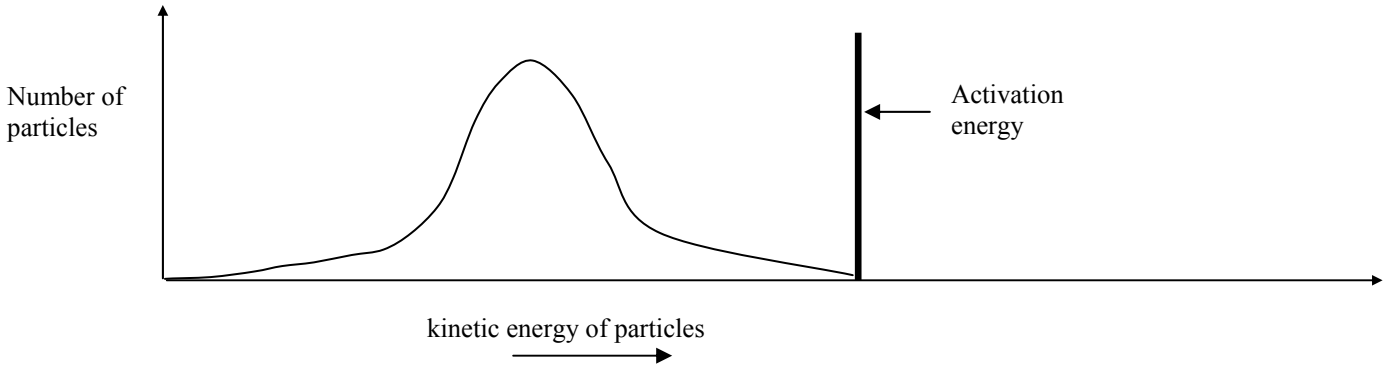
a) Explain the term **activation energy.**

1

b) Write the formula of the **silver(I)halide** compound containing the halide in the **fourth period** of the periodic table.

1

c) The distribution of kinetic energies of the **silver(I)halide** particles in a photographic film in darkness and the **activation energy** for decomposition is shown on the graph below:



Redraw the curve on the above graph to show the effect of light on the energy distribution.

1
(3)

3. A sample of a **hydrocarbon** containing **0·2 mole** of the compound was burned in excess oxygen and the resulting gas mixture was found to contain **0·8 moles of carbon dioxide and 0·8 moles of water.**
A further sample of the hydrocarbon decolourised bromine water immediately.

a) What is the molecular formula of the hydrocarbon?

1

b) Name and draw the full structural formulae of

i. a **straight chained** version of the hydrocarbon.

1

ii. a **branched** version of the hydrocarbon.

1

c) Another hydrocarbon was found to have the molecular formula $\mathbf{C_4H_{10}}$. 1 g of this compound was found to have a volume of **430 ml** at room temperature. Calculate the molar volume of this gaseous hydrocarbon at room temperature.

2
(5)

4. The fractional distillation of crude oil produces a fraction called naphtha. This fraction has a similar boiling range to petrol but, before it can be used to produce commercial petrol, it must be **reformed.**

a) What does the term **reformed** mean?

1

b) Explain why unreformed naphtha would be unsuitable for use in a petrol engine.

1

c) Modern petrol has any sulphur containing compounds removed in the refinery Explain why this is an important step to protect the environment.

1

d) Many modern petrol engines are described as **lean burn engines**.
The production of which gaseous pollutant is minimised in these engines?

1

e) One of the compounds present in modern petrol is **2,2,3-trimethypentane.**
Draw the full structural formula for this compound.

1
(5)

5. A pupil was studying the ionisation energy information concerning **magnesium** and **calcium** on page 10 of the data book.

a) The pupil stated that the figures confirmed that both the elements must be in group 2. Explain the pupil's reason for making this statement.

2

b) The standard molar enthalpy of atomisation of an element is the energy required to change one mole of a solid element into its gaseous form (see page 17 of data book). Use this and page 10 to calculate the energy required to bring about the following process:

$$\mathbf{Ca(s) \rightarrow Ca^{2+}(g)}$$

2

(4)

6. Two different compounds have the molecular formula $\mathbf{C_2H_6O}$.
One of these compounds has a significantly higher boiling point than the other due to the presence of a hydroxyl group. The other compound contains two methyl groups.

a) Explain why the presence of the hydroxyl group causes an increase in boiling point.

1

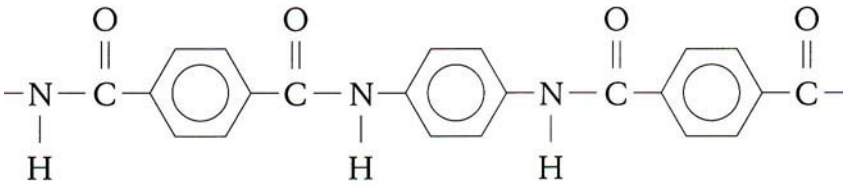
b) Draw the **full structural formula** of the two compounds.

2
(3)

7. The mixing of $0 \cdot 1\,\text{mol}\,\text{l}^{-1}$ hydrochloric acid with $0 \cdot 1\,\text{mol}\,\text{l}^{-1}$ sodium hydroxide solution produced $5 \cdot 7\,\text{kJ}$ of energy.
Use these results to calculate the **enthalpy of neutralisation** for this reaction.

(2)

8.



The diagram above shows part of the structure of the polymer **kevlar.** It is very strong and is used to make bullet proof vests. It is produced by a reaction between a basic and an acidic monomer.

a) Draw the **full** structural formula of the **acidic** monomer used to produce kevlar.

1

b) Kevlar and nylon are both the same type of condensation polymer. Name this type of condensation polymer.

1

c) Kevlar's strength is due to the fact that it forms layers which are strongly attracted to each other. Which type of bonding causes this attraction?

1

d) Both monomers used to produce kevlar contain a benzene ring. This ring is unaffected by all the chemical processes involved in the production of the polymer. What is it that gives the benzene ring this extra chemical stability?

1
(4)

9. Haemoglobin is a **globular** protein with a formula mass of **67000**. Its very specific shape allows the inclusion of iron ions within its structure.

a) Blood mainly consist of Haemoglobin and water. What property of haemoglobin, allows the easy transport of haemoglobin molecules around the body by the blood?

1

b) Calculate how many haemoglobin molecules are present in 1 g of the protein?

2

c)

i) Haemoglobin contains **0·335%** iron. Calculate the mass of iron present in 1g of Haemoglobin.

1

ii) How many iron ions are present in 1g of haemoglobin.

1

iii) Use your answers to 9(b) and 9(c) part ii) to calculate the number of iron ions present in in each haemaglobin molecule.

1

d) Name another globular protein found in the human body.

1

(7)

10. Amyl acetate is an organic compound which has a strong smell of pears. It is often used as a flavouring.
When **hydrolysed**, amyl acetate produces a mixture of an **alkanol** and an **alkanoic acid**.

a) To which group of organic compounds does amyl acetate belong?

1

b) What does the term **hydrolysed** mean?

1

c) The alkanoic acid produced smells strongly of vinegar and has a molecular mass of **60.** Name this acid.

1

d) The alkanol, on mild oxidation, produced **3-methylbutanal.** Use this information to draw the full structural formula of **Amyl acetate.**

1
(4)

11. Alkanals and alkanones can be distinguished by their different reactions when heated gently with mild oxidising agents.

a) Complete the table below.

Oxidising agent	**propanal**	**propanone**
Reaction with Acidified potassium dichromate solution		No reaction
	Blue solution to brick red precipitate	
Reaction with Tollen's reagent		No reaction

2

b) **Name** the functional group present in alkanals and alkanones.

1

c) Which **ion** present in Tollen's reagent is acting as an oxidising agent?

1

d) Suggest a safety precaution which should be employed, other than wearing safety goggles, when heating the mixtures.

1
(5)

12. Cigarette lighters use propane as their fuel.
A pupil decided to use a cigarette lighter to heat some water in a boiling tube and use the results obtained to calculate the **enthalpy of combustion of propane.**
During the experiment he noticed a build up of carbon on the bottom of the boiling tube.
He obtained the following results:

Volume of water heated	20 ml
Initial temperature of the water	25^{o}C
Final temperature of the water	35^{o}C
Initial mass of lighter	18·39 g
Final mass of lighter	18·35 g

a) What caused the build up of carbon on the boiling tube?

1

b) Use her results to calculate the **enthalpy of combustion of propane.**

2
(3)

13. Enzymes are biological catalysts involved in very many biochemical processes. They are protein molecules with very specific shapes which allow them to adsorb specific molecules onto their surface.

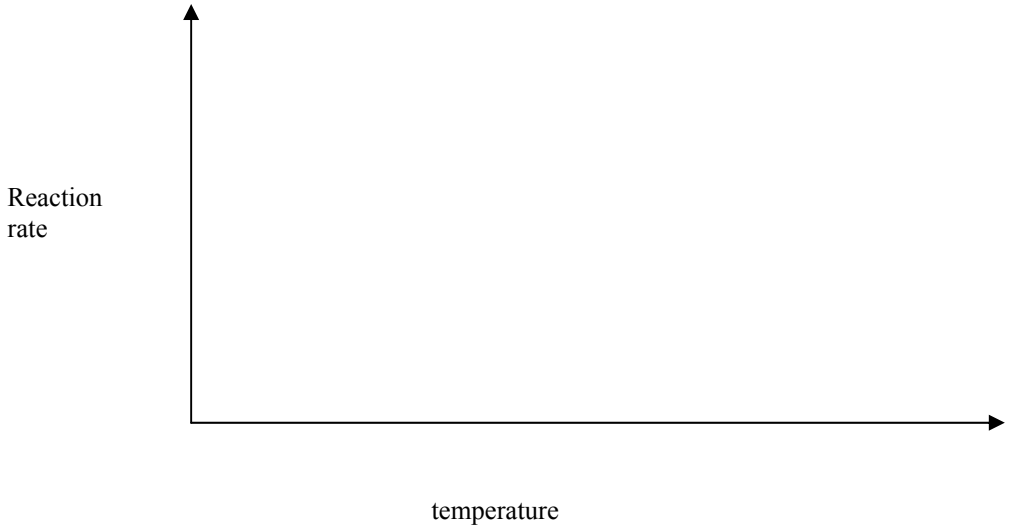
a) The monomers which are used to build the protein structures all belong to which group of organic chemicals?

1

b) Which kind of intermolecular attraction holds the enzyme molecule in its specific shape?

1

c) On the axes below sketch a graph to show the effect of increasing temperature on the reaction rate of an enzyme catalysed reaction.



1

d) Enzymes, like inorganic catalysts can be **poisoned.**
Explain what the term poisoned means in this context.

1

(4)

14. Sulphur dioxide is a well known pollutant in the air of industrial areas. Its concentration in air can be determined by bubbling air through an acidified solution of potassium dichromate in a series of linked test tubes. Each test tube contains **20 ml of a 0·01 mol l^{-1}** of the solution.
All the potassium dichromate has reacted when the solution changes from **orange to green.**
Bubbling 1000 litres of air through such a system caused **three** test tubes to turn **green**. The fourth test tube showed **no** sign of a colour change.
The equation for the reaction taking place is:

$$3SO_2(g) + K_2Cr_2O_7(aq) + 2HCl(aq) \rightarrow Cr_2(SO_4)_3(aq) + H_2O(l) + 2KCl(aq)$$

a) Suggest a **major** source of sulphur dioxide in the air.

1

b) How many moles of potassium dichromate have been used up by the sulphur dioxide in the 1000 litres of air?

1

c) Calculate the % sulphur dioxide present in the air tested.
(molar volume sulphur dioxide is 24 l mol^{-1})

3
(5)

END OF EXAMINATION PAPER

HIGHER CHEMISTRY
ANSWER GRID for PART A

PUPIL NAME: _____ **MARK** _____

TEACHER: _____

number	A	B	C	D
1				
2				
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Part A /40

Part B /60

2006 CHEMISTRY PRELIM
SUGGESTED MARKING SCHEME

Part A

number	A	B	C	D
1			x	
2			x	
3	x			
4		x		
5				x
6				x
7		x		
8				x
9		x		
10				x
11	x			
12			x	
13		x		
14			x	
15				x
16	x			
17			x	
18	x			
19	x			
20				x
21		x		
22		x		
23	x			
24				x
25		x		
26			x	
27		x		
28	x			
29		x		
30		x		
31			x	
32			x	
33			x	
34				x
35			x	
36	x			
37	x			
38		x		
39				x
40		x		

Part B
Suggested marking scheme

1. a) $H_2O_2(aq) + 2H^+(aq) + 2\ I^-(aq) \rightarrow 2\ H_2O(l) + I_2(aq)$ 1

b) They are spectator ions. 1

c) 9 1

d) To keep the concentrations of the other reactants constant. 1

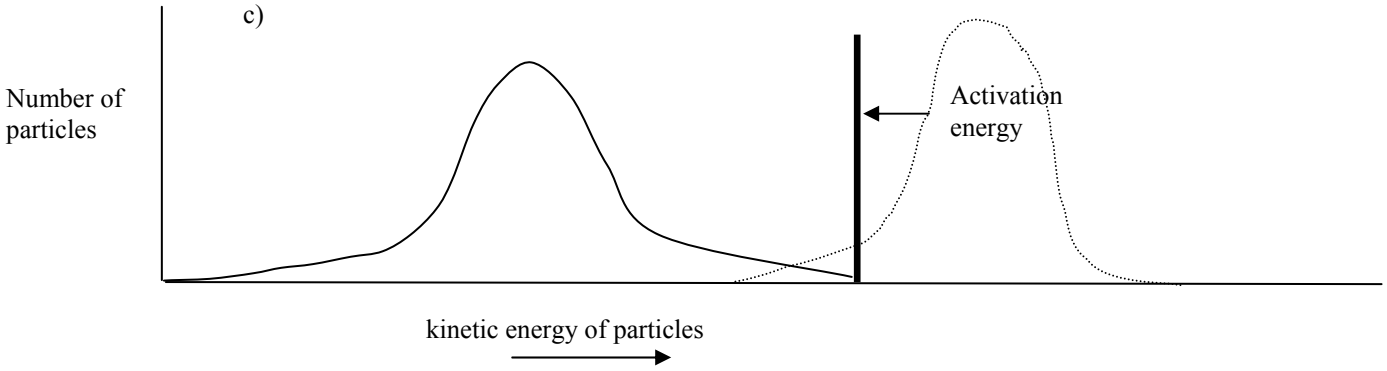
e) Axes correctly labelled as in table. 1
Points correctly plotted and best fitting line drawn. 1 2

[6]

2. a) The minimum energy particles must have to ensure effective collisions.(or similar) 1

b) AgBr 1

c)



1

[3]

3. a) C_4H_8 1

b) i. Accept any straight chain butene. 1

ii. Accept only methylpropene 1

c) formula mass C_4H_{10} = **58**

1 g C_4H_{10} = **430 ml**

58 g C_4H_{10} = **430 x 58 ml** 1

= **24940 ml** 1 2

[5]

4. a) The carbon atoms in the molecule have been rearranged. 1

b) The naphtha fraction contains mostly unbranched alkanes which would cause preignition.(or similar) 1

c) The sulphur would produce sulphur dioxide which would cause acid rain. 1

d) Carbon monoxide. 1

e) Correct structural formula must show all bonds and all hydrogens. 1

[5]

5. a) There is a large jump in ionisation energy values between 2nd and 3rd for both elements. 1
This means the breaking into a new inner shell i.e. the elements have 2 electrons in their outer shell i.e they are gp. 2 elements 1 2

b) $Ca(s) \rightarrow Ca(g)$ 178 kJ mol^{-1}

1st I.E. 596 kJ mol^{-1}

2nd I.E. 1160 kJ mol^{-1} 1

total = **1934 kJ mol^{-1}** 1 2

[4]

6. a) The hydroxyl group causes hydrogen bonding between the molecules. 1

b) One mark each for full structural formula of ethanol and dimethyl ether. 2

[3]

7. 0·1 mole of water is produced by the reaction ½

0·1 mole of water $\rightarrow$ 5·7 kJ ½

$\therefore$ 1 mole of water $\rightarrow$ 57 kJ

Enthalpy of neutralisation = − 57 **kJ mol^{-1}** 1

[2]

8. a) Accept only the structural formula of the diacid.
Minus ½ if benzene ring hydrogens omitted. 1

b) Polyamides. 1

c) Hydrogen bonding. 1

d) The benzene ring has delocalised electrons which give added stability. 1

[4]

9. a) They are soluble. 1

b) 1 mol of haemoglobin = 6·02 x 10^{23} molecules

67000 g = 6·02 x 10^{23} molecules 1

1 g = 6·02 x 10^{23} molecules ÷ 67000

= **8·99 x 10^{18} molecules** 1 2

c) i) mass of iron present in 1 g haemoglobin= 0·00335 g 1

ii) moles of iron present = 0·00335÷ 55·8 (1/2)

iron ions present = 6 x 10^{-5} x 6·02 x 10^{23}
= 3·6 x 10^{19} ions 1

iii) ratio of molecules to iron ions is 8·99 x 10^{18} to 3·6 x 10^{19}
i.e. there are **4 iron ions in each haemoglobin molecule.** 1

d) Amalase, Insulin etc. 1

(7)

10. a) Esters . 1

b) The breaking up of large molecules into smaller ones by reaction with water. 1

c) Ethanoic acid. 1

d) Ester structure drawn must show the ester link and a methyl group attached to carbon 3 of the butyl section. 1

[4]

11. a)

Oxidising agent	**propanal**	**propanone**
Reaction with Acidified potassium dichromate solution	***Colour change Orange to green***	No reaction
Benedict's solution	Blue solution to brick red precipitate	***No reaction***
Reaction with Tollen's reagent	***Silver mirror appears***	No reaction

4 x ½ 2

b) Carbonyl. 1

c) The silver ion. 1

d) Use a hot water bath for heating mixtures. 1

[5]

12. a) Incomplete combustion of the fuel 1

b) Energy = c M ΔT
= 4·18 x 0·02 x 10
= 0·836 kJ ½

0.04 g propane = 0· 836 kJ

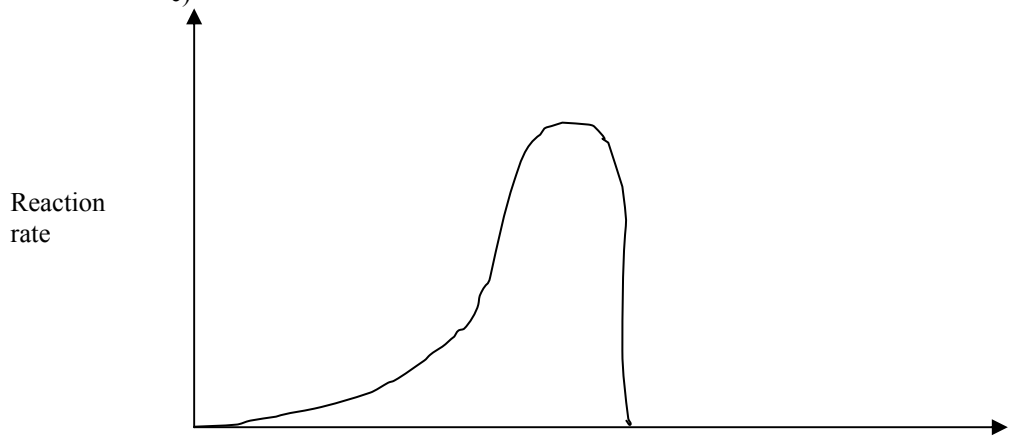
44 g propane = (0· 824 ÷ 0·04) x 44 kJ ½

enthalpy of combustion of propane is **<u>919·6 kJ mol^{-1}</u>** 1
(minus ½ for no or wrong unit) 2
[3]

13. a) Amino acids. 1

b) Hydrogen bonding. 1

c)



1

d) The active sites have been blocked by the "poison species". 1
[4]

14. a) The burning of fossil fuels. 1

b) One test tube contains 0·02 x 0·01 moles of dichromate

three test tubes contain 0·02 x 0·01 x 3 = **<u>0·0006</u>** moles 1

c) From equation, 1 mol dichromate → 3 mol SO_2

moles of SO_2 in 1000 l = 0·0018 1

volume of SO_2 in 1000 l = 0·0018 x 24 = 0·0432 l 1

% SO_2 in air sample = (0·0432 ÷ 1000) x 100

= **<u>0·00432%</u>** 1 3
[5]