STUDENT NAME:	DATE:

AS Chemistry

Instructions to students

You have **45 minutes** to complete this assessment.

Place all answers in the spaces provided.

If you need more space, an extra sheet for working out is provided at the end of the paper.

A data sheet has been provided for your assistance.

You will also need a scientific calculator, ruler and pen.

AWARDED MARKS

MARK:	GRADE:
/43	

1. A sample of a compound **M** contains 1.46 g of carbon, 0.482 g of hydrogen and 1.69 g of nitrogen.

What is the empirical formula of **M**?

A CH_2N

B C_4HN_4

C CH_4N

D C_2H_4N

Your answer ☐

[1]

2. A chemist collects 1.00×10^{-6} m^3 of a gaseous compound at 295 K and 1.01×10^5 Pa.

What is the correct expression for the amount, in mol, of the gaseous compound?

A $\dfrac{8.314 \times 295}{(1.01 \times 10^5) \times (1.00 \times 10^{-6})}$

B $\dfrac{(1.00 \times 10^{-6}) \times 295}{8.314 \times (1.01 \times 10^5)}$

C $\dfrac{8.314 \times (1.00 \times 10^{-6})}{(1.01 \times 10^5) \times 295}$

D $\dfrac{(1.01 \times 10^5) \times (1.00 \times 10^{-6})}{8.314 \times 295}$

Your answer ☐

[1]

3. The table below shows standard enthalpy changes of formation, $\Delta_f H$.

Compound	$NH_4NO_3(s)$	$H_2O(g)$	$CO_2(g)$
$\Delta_f H$ / **kJ mol^{-1}**	–366	–242	–394

What is the enthalpy change for the following reaction?

$$2NH_4NO_3(s) + C(s) \rightarrow 2N_2(g) + 4H_2O(g) + CO_2(g)$$

A –630 kJ mol^{-1}

B –540 kJ mol^{-1}

C +540 kJ mol^{-1}

D +630 kJ mol^{-1}

Your answer ☐

4. Which equation represents a redox reaction?

A $Mg + 2HCl \rightarrow MgCl_2 + H_2$

B $MgO + 2HCl \rightarrow H_2O + MgCl_2$

C $MgCO_3 + 2HCl \rightarrow CO_2 + H_2O + MgCl_2$

D $Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$

Your answer ☐

[1]

5. Which statement explains why the rate of a reaction increases when the temperature is increased?

A The activation energy for the reaction decreases.

B The activation energy for the reaction increases.

C The proportion of molecules exceeding the activation energy decreases.

D The proportion of molecules exceeding the activation energy increases.

Your answer ☐

[1]

6. Which statement is **not** correct for a system in dynamic equilibrium?

A The concentrations of products and reactants are the same.

B The equilibrium can be achieved from both sides.

C The rate of the forward reaction is equal to the rate of the reverse reaction.

D The system is closed.

Your answer ☐

[1]

7. Carbon monoxide reacts with steam in the following reaction equation:

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g) \qquad \Delta H = -40 \text{ kJ mol}^{-1}$$

Which change will shift the position of equilibrium to the right hand side of the equation?

A decrease in pressure

B increase in pressure

C decrease in temperature

D increase in temperature

☐

8. Nitrogen can be reacted with hydrogen in the presence of a catalyst to make ammonia in the Haber process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92 \text{ kJ mol}^{-1}$$

(a) Describe and explain the effect of increasing the pressure on the rate of this reaction.

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..... **[2]**

(b) A mixture of N_2 and H_2 was left to react until it reached equilibrium. The equilibrium mixture had the following composition:

N_2	1.20 mol dm^{-3}
H_2	2.00 mol dm^{-3}
NH_3	0.877 mol dm^{-3}

(i) Calculate a value for K_c for this equilibrium.

K_c = ... dm^6 mol^{-2} **[3]**

(ii) Explain how the following changes would affect the amount of NH_3 present in the equilibrium mixture.

Use of a catalyst:

.....

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A higher temperature:

.....

.....

[3]

9. The following reaction is used in industry to make sulfur trioxide gas, SO_3.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H^\ominus = -196 \text{ kJ mol}^{-1}$$

This preparation is carried out in the presence of a catalyst.

(a)* Explain the conditions of temperature and pressure that could be used to obtain the maximum equilibrium yield of sulfur trioxide.

Discuss the importance of a compromise between equilibrium yield and reaction rate when deciding the operational conditions for this process.

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[6]

(b) An experiment is carried out to find the rate of this reaction.

The equation is repeated below.

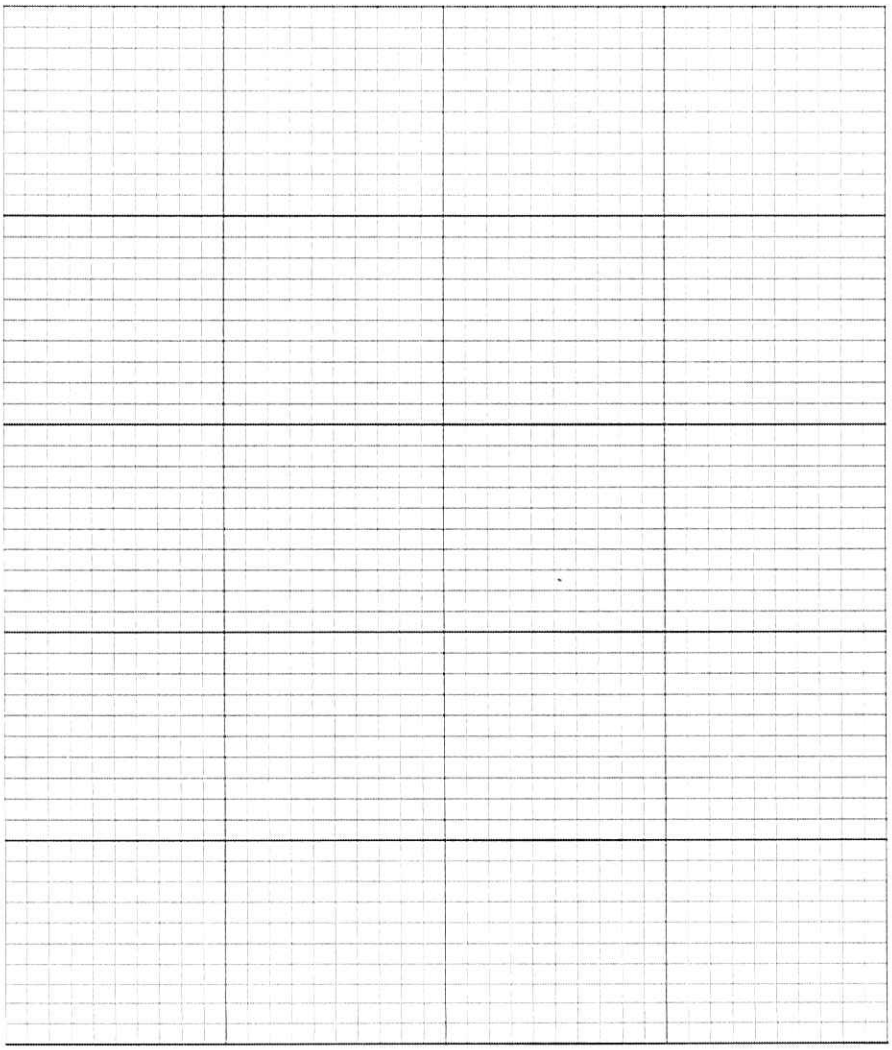
$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The results of the experiment are given in the table below:

Time / s	0	50	100	150	200	250	300	350
Concentration of SO_3 / mol dm^{-3}	0	0.024	0.034	0.038	0.039	0.040	0.041	0.041

(i) Plot a graph from the data provided.

Include a line of best fit.



[3]

(ii) Use the graph to determine the **initial** rate of this reaction.

Show your working below and on the graph.

initial rate = ... mol dm^{-3} s^{-1} **[2]**

(iii) This experiment is repeated in the presence of a catalyst.

Draw and label a line **on the graph** to show the results of the catalysed experiment over the same time period.

[1]

(iv) The use of catalysts in industrial processes can be beneficial to the environment.

State **one** reason for this.

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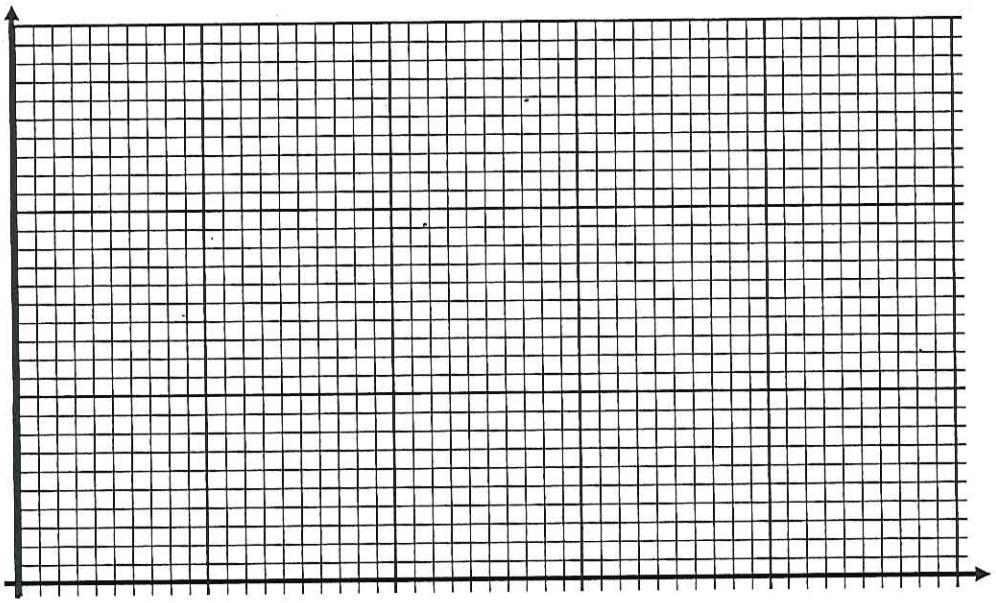
..... **[1]**

(v) Using a fully labelled Boltzmann distribution on the grid below, explain why adding a catalyst increases the rate of a reaction.



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10. Butane, C_4H_{10}, is a highly flammable gas, used as a fuel for camping stoves. Butane reacts with oxygen as in the equation below:

$$C_4H_{10}(g) + 6.5O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l)$$

(a) Explain why this equation represents the standard enthalpy change of combustion of butane.

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..... **[1]**

(b) **(i)** The use of portable heaters in enclosed spaces can result in potential dangers if incomplete combustion takes place.

Explain the potential danger of incomplete combustion.

..... **[1]**

(ii) A portable heater is lit to heat a room.

The heater burns 600 g of butane and consumes 1.50 m^3 of O_2, measured at room temperature and pressure.

Determine whether this portable heater is safe to use.

Show **all** your working.

conclusion, with reason: .....

..... **[3]**

(c) Alkane **X** can also be used as a fuel.

Complete combustion of 0.0117 mol of **X** produces 2.00×10^{-3} m^3 of carbon dioxide gas, measured at 24.0 °C and 101 kPa.

Determine the molecular formula of **X**.

Show **all** your working.

molecular formula of **X** = ... **[4]**

(d) Butane can be produced from decane, $C_{10}H_{22}$, as shown in the equation below.

$$C_{10}H_{22}(l) \rightarrow C_4H_{10}(g) + 2C_3H_6(g)$$

Standard enthalpy changes of combustion, $\Delta_c H^\ominus$, are shown in the table below.

Substance	$\Delta_c H^\ominus$ / kJ mol^{-1}
$C_{10}H_{22}(l)$	–6778
$C_4H_{10}(g)$	–2877
$C_3H_6(g)$	–2058

Calculate the standard enthalpy change of reaction, $\Delta_r H^\ominus$, for the reaction. Include the sign.

$$C_{10}H_{22}(l) \rightarrow C_4H_{10}(g) + 2C_3H_6(g)$$

$\Delta_r H^\ominus$ = ... kJ mol^{-1} **[2]**