Oxford Cambridge and RSA

GCSE Chemistry A (Gateway Science)

J248/02 C4-C6 and C7 Foundation (Foundation Tier)

Question Set 5

1 The reversible reaction between carbon dioxide and hydrogen makes methane and water.

carbon dioxide + hydrogen ⇌ methane + water

(a) In a sealed container, this reversible reaction forms a **dynamic equilibrium**.

What is meant by the term dynamic equilibrium?

Refer to both concentration and rate of reaction in your answer. **[2]**

In the closed system the rate of the forward and backward reactions are equal that the concentration of reactants and products are constant (not equal to each other)

(b) A student investigates this reaction between carbon dioxide and hydrogen.

He predicts that 11.0 g of carbon dioxide should make 4.0 g of methane. In an experiment, he finds that 11.0 g of carbon dioxide makes 2.2 g of methane.

Calculate the percentage yield of methane.

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

$$= \frac{2.2}{4} \times 100 = 55\%$$

Answer = ... 55 % **[2]**

(c)* The student investigates the effect of changing pressure and changing temperature on this reaction.

carbon dioxide + hydrogen ⇌ methane + water

The table shows the percentage yield of methane in the equilibrium mixture under different conditions.

		Pressure (in atmospheres)			
		100	**200**	**300**	**400**
Temperature (in °C)	**300**	35%	52%	65%	80%
	600	30%	46%	58%	74%
	900	23%	37%	47%	62%
	1200	14%	25%	36%	48%

Describe what happens to the percentage yield as the pressure and temperature change and explain the effect of increasing the pressure on the rate of reaction.

[6]

- As pressure increases, the percentage yield increases
- $CO_2 + 4H_2 \rightleftharpoons CH_4 + 2H_2O$
- This is because equilibrium shifts to the right with increased pressure as less gaseous moles on RHS (3 moles while LHS has 5 moles)
- As temperature increases, the percentage yield decreases.
- This is because equilibrium shifts to the left with increased temperature favouring the backwards exothermic reaction

Total Marks for Question Set 5: 10