GCSE Chemistry A (Gateway Science)
J248/04 Chemistry A C4-C6 and C7 (Higher Tier)

Question Set 23

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]**

Concentration of products and reactions are constant.
Rate of forward and backward reactions are equal.

(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.

$$\frac{2.2}{4.0} \times 100 = 55\%$$

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

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

carbon dioxide + hydrogen ⇌ methane + water

$CO_2(g) + 4H_2(g) \rightleftharpoons CH_4(g) + 2H_2(l)$

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%

He predicts that the reaction between carbon dioxide and hydrogen is endothermic and involves a reduction in the volume of gases.

Describe and explain whether his predictions are supported by the reaction and results in the table. **[6]**

Temperature:
- Yield decreases with increase in temperature.
- This implies that the equilibrium is shifting away from the products.
- With temperature increase equilibrium shifts to the endothermic side, so the forward reaction is exothermic, to remove added heat so doesn't support prediction

Pressure:
- Yield increases with increase in pressure.
- This implies that the equilibrium is shifting towards the products.
- With pressure increase equilibrium shifts to the side with least gas volume ⇒ products are lower volume, to reduce volume to ease the increasing pressure so support prediction

Total Marks for Question Set 23: 10