1

(a) Hydrogen peroxide, H_2O_2, is sold as an aqueous solution.

The concentration of $H_2O_2(aq)$ can be determined by its reaction with acidified manganate(VII) ions.

- **Stage 1** – A 25.0 cm^3 sample of $H_2O_2(aq)$ is added to a 250 cm^3 graduated flask.
- **Stage 2** – Sufficient distilled water is added to the graduated flask to make 250 cm^3 of diluted $H_2O_2(aq)$.
- **Stage 3** – A 10.0 cm^3 sample of diluted $H_2O_2(aq)$ is added to a conical flask.
- **Stage 4** – The diluted sample has 25.0 cm^3 of 1 mol dm^{-3} sulphuric acid added to it.
- **Stage 5** – The contents of the flask are titrated against 0.0200 mol dm^{-3} MnO_4^-.

In **stage 5**, the equation for the reaction between $H_2O_2(aq)$ and acidified MnO_4^- is shown below.

$$5H_2O_2(aq) + 6H^+(aq) + 2MnO_4^-(aq) \rightarrow 2Mn^{2+}(aq) + 5O_2(g) + 8H_2O(l)$$

In **stage 5**, the titre was 28.55 cm^3.

Calculate the concentration, in g dm^{-3}, of the **undiluted** H_2O_2.

concentration of undiluted $H_2O_2(aq)$ = ... g dm^{-3} **[4]**

Essay Practice (adapted from OCR 2816 June 2003)

Buffer solutions have many uses in medicine, cosmetics and toiletries. Buffer solutions can be prepared by mixing aqueous solutions of methanoic acid HCOOH and sodium methanoate, HCOONa.

- Describe what a buffer solution is and how it works. Use the HCOOH/HCOONa system as your example.

[6]

- Calculate the pH of a buffer solution containing equal volumes of 2.5M HCOONa and 1M HCOOH. ($K_a = 1.6 \times 10^{-4}$)

[3]

- Show that the pH of this buffer won't change when the concentration of each component is halved.

[2]

Describe how the human body uses carbon dioxide to buffer the blood. Use equations to illustrate your answer [4]

Part 3

Some data required for this question are given in the table below.

Substance	$\Delta H_f^{\ominus}$/kJ mol^{-1}	$S^{\ominus}$/J K^{-1} mol^{-1}
$NH_3(g)$	−46.2	193
$N_2(g)$	0	192
$H_2(g)$	0	131

(a) Write an equation to represent the formation of one mole of ammonia from its elements.

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(1 mark)

(b) Using data from the table above calculate the entropy change for the formation of one mole of ammonia from its elements.

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(3 marks)

(c) (i) Use your answer from part (b) and data from the table to calculate the value of the free-energy change, ΔG, for the formation of one mole of ammonia from its elements at 700 K. (If you have been unable to calculate an answer to part (b), you may assume that the entropy change for the formation of one mole of ammonia from its elements is $-125\,J\,K^{-1}\,mol^{-1}$. This is not the correct value.)

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(c) (ii) Predict in qualitative terms what would happen to the value of ΔG at temperatures lower than 700 K.

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(3 marks)

(d) Suggest one advantage, in industry, of operating this reaction at temperatures higher than 700 K.

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(1 mark)