

**Q1.** A green solution, **X**, is thought to contain  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$  ions.

- (a) The presence of these ions can be confirmed by reacting separate samples of solution **X** with aqueous ammonia and with aqueous sodium carbonate.

Write equations for each of these reactions and describe what you would observe.

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(4)

- (b) A  $50.0 \text{ cm}^3$  sample of solution **X** was added to  $50 \text{ cm}^3$  of dilute sulfuric acid and made up to  $250 \text{ cm}^3$  of solution in a volumetric flask.

A  $25.0 \text{ cm}^3$  sample of this solution from the volumetric flask was titrated with a  $0.0205 \text{ mol dm}^{-3}$  solution of  $\text{KMnO}_4$   
At the end point of the reaction, the volume of  $\text{KMnO}_4$  solution added was  $18.70 \text{ cm}^3$ .

- (i) State the colour change that occurs at the end point of this titration and give a reason for the colour change.

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- (ii) Write an equation for the reaction between iron(II) ions and manganate(VII)

ions.

Use this equation and the information given to calculate the concentration of iron(II) ions in the original solution **X**.

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(5)  
(Total 11 marks)

**Q2.** Which of these pieces of apparatus has the lowest percentage uncertainty in the measurement shown?

- A** Volume of 25 cm<sup>3</sup> measured with a burette with an uncertainty of  $\pm 0.1$  cm<sup>3</sup>.
- B** Volume of 25 cm<sup>3</sup> measured with a measuring cylinder with an uncertainty of  $\pm 0.5$  cm<sup>3</sup>.
- C** Mass of 0.150 g measured with a balance with an uncertainty of  $\pm 0.001$  g.
- D** Temperature change of 23.2 °C measured with a thermometer with an uncertainty of  $\pm 0.1$  °C.

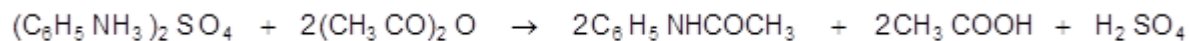
(Total 1 mark)

**Q3.** N-phenylethanamide is used as an inhibitor in hydrogen peroxide decomposition and also in

the production of dyes.

N-phenylethanamide can be produced in a laboratory by the reaction between phenylammonium sulfate and an excess of ethanoic anhydride:

- (a) A student carried out this preparation using 1.15 g of phenylammonium sulfate ( $M_r = 284.1$ ) and excess ethanoic anhydride.



- (i) Calculate the maximum theoretical yield of N-phenylethanamide that could be produced in the reaction. Record your answer to an appropriate precision.

Show your working.

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- (ii) In the preparation, the student produced 0.89 g of N-phenylethanamide. Calculate the percentage yield for the reaction.

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- (b) The student purified the crude solid product, N-phenylethanamide, by recrystallisation.

- (i) Outline the method that the student should use for this recrystallisation.

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- (ii) Outline how you would carry out a simple laboratory process to show that the recrystallised product is a pure sample of N-phenylethanamide.

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- (iii) Assume that the reaction goes to completion.

Suggest **two** practical reasons why the percentage yield for this reaction may **not** be 100%.

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- (c) The reaction to form N-phenylethanamide would happen much more quickly if the student used ethanoyl chloride instead of ethanoic anhydride.

Explain why the student might prefer to use ethanoic anhydride, even though it has a slower rate of reaction.

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(2)  
(Total 15 marks)

**Q4.** The maximum errors for the pipette and the burette are shown below. These errors take into account multiple measurements.

Pipette  $\pm 0.05 \text{ cm}^3$   
Burette  $\pm 0.15 \text{ cm}^3$

Estimate the maximum percentage error in using each of these pieces of apparatus.

Use an average titre  $24.25 \text{ cm}^3$  to calculate the percentage error in using the burette.

Show your working.

Pipette .....

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Burette .....

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(Total 2 marks)