Q1. A green solution, **X**, is thought to contain $[Fe(H_2O)_6]^{2+}$ 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 cm^3 sample of solution **X** was added to 50 cm^3 of dilute sulfuric acid and made up to 250 cm^3 of solution in a volumetric flask.

A 25.0 cm^3 sample of this solution from the volumetric flask was titrated with a 0.0205 mol dm^{-3} solution of $KMnO_4$
At the end point of the reaction, the volume of $KMnO_4$ solution added was 18.70 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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(2)

(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^3 measured with a burette with an uncertainty of ±0.1 cm^3. ⬭

B Volume of 25 cm^3 measured with a measuring cylinder with an uncertainty of ±0.5 cm^3. ⬭

C Mass of 0.150 g measured with a balance with an uncertainty of ±0.001 g. ⬭

D Temperature change of 23.2 °C measured with a thermometer with an uncertainty of ±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.

$$(C_6H_5NH_3)_2SO_4 + 2(CH_3CO)_2O \rightarrow 2C_6H_5NHCOCH_3 + 2CH_3COOH + H_2SO_4$$

(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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(2)

(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 ± 0.05 cm^3
Burette ± 0.15 cm^3

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

Use an average titre 24.25 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)