For Examiner's Use

Answer **all** the parts.

Introduction

In this Practical Test you will carry out some experiments involving iodine.

You are provided with

- an aqueous solution of iodine, **F**: **Irritant** 
- a solution of iodine (dissolved in aqueous potassium iodide), **G**: **Irritant** 
- solid hydrated sodium thiosulphate, $Na_2S_2O_3.5H_2O$, **H**.

Iodine vapour can be unpleasant. Ensure that the stoppers are replaced on to the bottles of iodine solutions whenever they are not in use.

Note: you will use two different solutions of iodine. Take care not to mix them up.
Solution **F** is used in Part 1.
Solution **G** is used in Part 3.

Part 1 Investigating the nature of aqueous iodine
Skills I and A (Implementing and Analysis) [8 marks]

When iodine dissolves in water, it reacts reversibly giving hydroiodic acid, HI, and iodic(I) acid, HIO. Equation 1.1, shown below, is the ionic equation for this reaction.

$$I_2(aq) + H_2O(l) \rightleftharpoons 2H^+(aq) + IO^-(aq) + I^-(aq)$$ **equation 1.1**

The $IO^-(aq)$ ion is colourless in solution.

(a) Silver nitrate test

Pour about a 1 cm depth of aqueous iodine, **F**, into a test tube.
Add an equal volume of aqueous silver nitrate.

aqueous silver nitrate: **Irritant** 

Record **two** observations.

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Name the species that reacted with silver ions.
(Refer to equation 1.1.)

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(b) Colour

Name the species in equation 1.1 that is responsible for the colour of aqueous iodine.

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(c) Explain how evidence obtained from **(a)** and **(b)** shows that there is a chemical equilibrium in an aqueous solution of iodine.

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(d) Pour about a 1 cm depth of aqueous iodine, **F**, into a test tube.
Add an equal volume of dilute aqueous sodium hydroxide.

aqueous sodium hydroxide: **Irritant** 

State the observation.
Use Le Chatelier's principle to help you to explain your observation.
(Refer back to equation 1.1.)

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Part 2 Reaction of potassium iodide with hydrogen peroxide
Skills I and A (Implementing and Analysing) [5 marks]

Pour about a 2 cm depth of aqueous potassium iodide into a test tube.
Add an equal volume of dilute sulphuric acid.

dilute sulphuric acid: Irritant 

Then add about 10 drops of aqueous hydrogen peroxide and shake the test tube thoroughly.

aqueous hydrogen peroxide: Irritant 

(a) Record the observation made after adding the aqueous hydrogen peroxide.

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(b) Explain what happens to iodide ions in this reaction.
Include an ionic half-equation in your answer.

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(c) Safety

State and explain what you would do if some of the aqueous hydrogen peroxide used in this test splashed on to your hand.

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Part 3 Titration of the solution containing iodine, G
Skill I (Implementing) [10 marks]

In this part, you will titrate the solution containing iodine in aqueous potassium iodide, **G**, with an aqueous solution of hydrated sodium thiosulphate, $Na_2S_2O_3.5H_2O$.

The word equation for the reaction is:

iodine + sodium thiosulphate $\longrightarrow$ sodium tetrathionate ($Na_2S_4O_6$) + sodium iodide

Record all your readings in a suitable format on page 7.

Weigh the bottle provided containing hydrated sodium thiosulphate, **H**.
Transfer all of the solid into a beaker.
Weigh the empty bottle and lid.

Dissolve solid **H** in about 100 cm^3 of distilled (or de-ionised) water.
Transfer all this solution into a 250 cm^3 volumetric flask.
Add distilled or de-ionised water to make the solution up to exactly 250 cm^3.
Invert the solution in the volumetric flask several times before use.

Fill the burette with the solution of sodium thiosulphate that you have made.
Record burette readings to 0.05 cm^3.

Using a pipette and filler, transfer 25.0 cm^3 of the iodine solution, **G**, into a conical flask.

Carry out a trial titration with no indicator.
As sodium thiosulphate solution is run into the conical flask, the solution changes colour from dark red to pale yellow.
The end-point occurs when the pale yellow colour disappears to leave a colourless solution.

Repeat the titration procedure until you obtain **two** accurate results.
However, this time add **5 drops of starch indicator** at the point when the solution in the conical flask turns a pale yellow.
The end-point occurs when the solution turns from dark blue to colourless.

Results

Use the space below to record all your readings.
Calculate the mass of H used and the mean titre.

Part 4 Calculating the concentration of I_2 in G
Skill A (Analysing) [7 marks]

In this section your working must be shown clearly.
All answers should be quoted to **three** significant figures.

(a) Calculate the amount, in moles, of hydrated sodium thiosulphate, **H**, in the 250 cm^3 of solution you made up.
The relative formula mass of hydrated sodium thiosulphate is 248.

answer = ... mol

(b) Calculate the amount, in moles, of $Na_2S_2O_3$ used in your mean titre.

answer = ... mol

(c) Balance the equation for the reaction of iodine with sodium thiosulphate.

$$I_2 + Na_2S_2O_3 \longrightarrow Na_2S_4O_6 + NaI$$

(d) Calculate the concentration of I_2, in mol dm^{-3}, present in solution **G**.

answer = ... mol dm^{-3}

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(e) Calculate the mass of iodine needed to make up 1.00 dm^3 of solution **G.**

answer = ... g

Part 5 Evaluation (Skill E) [14 marks]

(a) How would the titration readings have been affected if the volumetric flask had not been inverted several times before use?

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(b) Use information on your pipette to calculate the % accuracy when you measured out 25.0 cm^3 of solution **G**. Show your working.

(c) State and explain whether the mass of solid **H** or the volume of solution **G** was measured more accurately.

(d) In your trial titration, you did not use any starch solution as indicator.
Explain the advantage of using starch indicator as you did for the accurate titrations.

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(e) Do you think that your accurate titrations were **reliable**? Justify your answer.

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(f) Suggest why a back-titration procedure (as used in your Plan to determine the concentration of chlorine) is likely to be **less** accurate than the titration procedure you used to determine the concentration of iodine.

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(g) The solution of iodine, **G**, used for your titration with sodium thiosulphate in Part 3, was made by dissolving solid iodine in an aqueous solution of potassium iodide.

A student thought that the titration would be inaccurate because the iodide ions present in potassium iodide would increase the mean titre.
State and explain whether or not you agree with this suggestion.

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END OF QUESTION PAPER