Teacher Resource Bank

GCE Chemistry

PSA6: AS Physical Chemistry

- Investigate how the rate of a reaction changes with temperature

Technical Sheet

To investigate how the rate of the reaction of sodium thiosulfate with hydrochloric acid changes as the temperature of the reaction is changed.

Whenever possible, students should work individually.
If it is essential to work in a pair or in a small group, because of the availability of apparatus, supervisors must be satisfied that they are able to assess the contribution from each student to the practical activity.

<u>Requirements</u>

- thermometer(-10 ^{o}C to 110 ^{o}C)
- 400 cm^{3} beaker (for use as a water bath)
- 250 cm^{3} conical flask
- 50 cm^{3} measuring cylinder
- 10 cm^{3} measuring cylinder
- 0.25 mol dm^{-3} sodium thiosulfate solution (or 40 g dm^{-3})
- 2.0 mol dm^{-3} hydrochloric acid
- stopwatch
- test tube
- clamp and stand
- tripod, gauze and heat-proof mat
- plain paper marked with a cross
- graph paper

Centres are expected to carry out and be responsible for their own safety risk assessments.

Student Sheet

It is the responsibility of the student to carry out and be responsible for their own safety risk assessment before carrying out this experiment. Wear safety glasses at all times. Assume that all of the reagents and liquids are toxic, corrosive and flammable.

Dilute hydrochloric acid will be added to sodium thiosulfate solution at different temperatures in a series of experiments.
The Table shows the approximate temperatures for five experiments.

Experiment	1	2	3	4	5
Approximate Temperature / ^oC	**room***	**~25**	**~35**	**~45**	**~55****

[* The temperature of the room is likely to be 15 to 18 ^{o}C]
[** The temperature should **not** exceed 55 ^{o}C]

It is not necessary for these exact temperatures to be used although the temperature used should **not** exceed 55 ^{o}C. What is important is to make sure that the temperature at which each experiment is carried out is known as accurately as possible. One way that this can be achieved is to measure both the initial temperature and the final temperature and then use a mean temperature when plotting your graph.

Experiment
a) Using a 50 cm^3 measuring cylinder, measure out 10 cm^3 of the 0.25 mol dm^{-3} sodium thiosulfate solution provided and 40 cm^3 water and pour this mixture into a conical flask.
b) Using a 10 cm^3 measuring cylinder, measure out 5 cm^3 of the 2.0 mol dm^{-3} hydrochloric acid into a test tube.
c) Prepare a water bath by half-filling a beaker with water and placing the beaker on a tripod and gauze.
d) Clamp the conical flask in the water bath and also place the test tube in the water bath.
e) Place the thermometer in the conical flask and very gently heat the water bath until the contents of the flask reach the required temperature for the experiment.
f) Remove the conical flask and the test tube from the water bath.
g) Place the conical flask on the paper marked with a cross and immediately add the acid from the test tube and start the stopwatch. Gently stir the mixture with the thermometer and record the initial temperature.

h) Observe the cross from above through the solution and stop the stopwatch as soon as the cross disappears from view.

i) Record the time taken for the cross to be obscured and also record the final temperature of the mixture.

j) Repeat the experiment for each of the five temperatures suggested in the Table and record all of your results.

Analysing the data

The ability to calculate rates from recorded times and to plot a graph is NOT part of the PSA but this is a useful task to complete.
Your teacher can help you with this part of the work.

- calculate the mean temperature of each reaction mixture.

- for each of the five temperatures, calculate $\frac{1}{t}$ to 3 significant figures, where t is the time taken for the cross to be obscured.

- plot a graph of $\frac{1}{t}$ (y-axis) against average temperature (x-axis).

- This task may be more straightforward if you multiply all of the values for $\frac{1}{t}$ by a common factor (e.g. 10^4)

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Teacher Notes and Marking Guidance.

The specific marking guidance in the specification is as follows

2 marks: All areas of the task are carried out competently.
The quantities of reagents are appropriate and the apparatus is safe.
Heating is carried out with due care and only as long as necessary.
The change in the measured rate is within the expected range.

1 mark: One of the areas of the task is performed poorly.
The quantities of reagents are inappropriate or the apparatus is unsafe **OR**
Heating is carried out with insufficient care or longer than necessary **OR**
The change in the measured rate is not within the expected range.

0 marks: At least two of the areas of the task are performed poorly.
The quantities of reagents are inappropriate or the apparatus is unsafe.
Heating is carried out with insufficient care or longer than necessary.
The change in the measured rate is not within the expected range.

Guidance for Teachers and Students

Teachers are expected to exercise professional judgement in assessing the competence of their candidates in following the instructions.

Candidates should have been given guidance in the correct use of equipment and this guidance **can continue during the practical session** for which this PSA forms a part.

If, however, the guidance required is fundamental or frequent, then the student should **not** be awarded 2 marks.

Judgement of 2 marks, 1 mark or 0 marks will depend on whether the candidate is able to measure the volumes of reagents with appropriate care and carry out the heating of the solution and the measurement of the time to obscure the cross in a safe manner.

It is possible to judge whether or not the results lead to points on the rate graph which fall on a relatively smooth curve. Teacher judgement is called for here to decide whether the data is within the expected range or not.

It is important to remember when marking these practical exercises that PSA is about student competence and that for a student to score full marks on this exercise **perfection is neither expected nor required**.

AQA