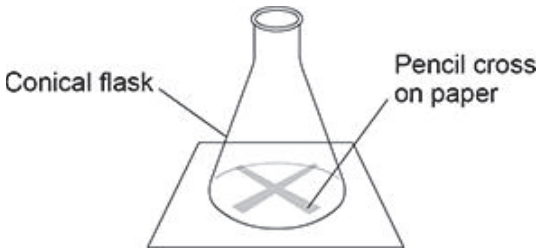
All questions are for both separate science and combined science students

Q1.

A student investigated the rate of the reaction of sodium thiosulfate solution with hydrochloric acid.

When sodium thiosulfate solution reacts with hydrochloric acid, the mixture becomes cloudy.

The figure below shows the apparatus.



This is the method used.

1. Put 75 cm^3 of sodium thiosulfate solution in a conical flask.
2. Draw a pencil cross on paper.
3. Put the conical flask on the pencil cross.
4. Add 15 cm^3 of hydrochloric acid to the contents of the conical flask.
5. Swirl the conical flask to mix the contents and immediately start a timer.
6. Stop the timer when the pencil cross is no longer visible through the reaction mixture.
7. Repeat steps 1 to 6 using different concentrations of sodium thiosulfate solution.

(a) Explain why a 50 cm^3 conical flask is unsuitable to use in this method.

_____

_____

_____

_____

(2)

(b) Name a piece of equipment suitable for measuring the volume of sodium thiosulfate solution.

_____

(1)

(c) The student measured the time taken for the pencil cross to be no longer visible for different concentrations of sodium thiosulfate solution.

Draw **one** line from each type of variable to the variable in this investigation.

Type of variable	**Variable in this investigation**
	Concentration of sodium thiosulfate solution
Dependent variable	Size of conical flask
	Temperature of sodium thiosulfate solution
Independent variable	Time for pencil cross to become no longer visible
	Volume of hydrochloric acid

(2)

(d) What effect will using a darker pencil cross have on the time taken for the cross to be no longer visible?

Tick (✓) **one** box.

- The time taken will decrease. ☐
- The time taken will be the same. ☐
- The time taken will increase. ☐

(1)

(e) The table below shows the results.

Concentration of sodium thiosulfate solution in g/dm^3	Time for cross to become no longer visible in seconds
8	120
16	60
24	40
32	30

Which concentration of sodium thiosulfate solution had the highest rate of reaction?

Tick (✓) **one** box.

8 g/dm^3 ☐

16 g/dm^3 ☐

24 g/dm^3 ☐

32 g/dm^3 ☐

(1)

(f) Increasing the concentration of sodium thiosulfate solution changes the rate of the reaction with hydrochloric acid.

Which **two** statements explain the effect of increasing the concentration?

Tick (✓) **two** boxes.

The particles are closer together. ☐

The particles are further apart. ☐

The particles collide less frequently. ☐

The particles collide more frequently. ☐

The particles move faster. ☐

The particles move slower. ☐

(2)

(g) The effect on the time taken for the cross to disappear can also be investigated by:

- changing the temperature of the hydrochloric acid
- changing the concentration of the hydrochloric acid.

Complete the sentences.

Choose the answers from the box.

decreases	**stays the same**	**increases**

If the temperature of the hydrochloric acid is **increased**, the time taken for the cross to disappear _____.

If the concentration of the hydrochloric acid is **decreased**, the time taken for the cross to disappear _____.

(2)

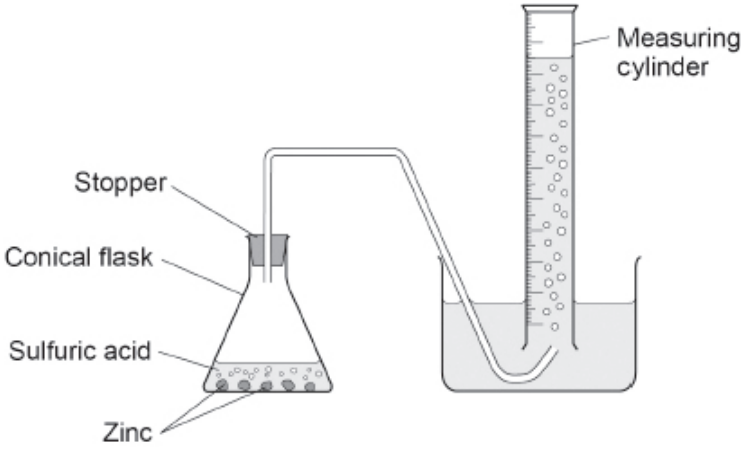
(Total 11 marks)

Q2.

A student investigated the rate of the reaction between zinc and sulfuric acid.

Hydrogen gas is produced during this reaction.

The figure below shows the apparatus.



This is the method used.

1. Add 50 cm^3 of sulfuric acid to a conical flask.

2. Add 2.0 g of zinc to the conical flask.

3. Quickly put a stopper in the conical flask and start a timer.

4. Measure the time taken to collect 20 cm^3 of gas.

5. Repeat steps 1 to 4 three more times.

(a) Suggest why the stopper must be put in the conical flask as quickly as possible in **step 3**.

_____

_____

(1)

(b) The student calculated the rate of the reaction for each trial.

The table below shows the results of the calculations.

	Trial 1	Trial 2	Trial 3	Trial 4
Rate of reaction in cm^3/s	0.78	0.81	0.68	0.81

Determine the mean time taken to collect 20 cm^3 of gas.

Do **not** include any anomalous results.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{volume of gas collected}}{\text{mean time taken}}$$

Mean time taken = _____ s

(5)

(c) The student changed the investigation so that the mean time taken to collect 20 cm^3 of gas was greater.

Which **two** changes would increase the mean time taken to collect 20 cm^3 of gas?

Tick (✓) **two** boxes.

Use a catalyst	☐
Use a larger conical flask	☐
Use a lower temperature	☐
Use smaller pieces of zinc	☐
Use sulfuric acid of a lower concentration	☐

(2)

(d) Hydrogen gas is produced during this reaction.

Describe the test for hydrogen gas.

Give the result of the test.

Test _____

_____

Result _____

_____

(2)

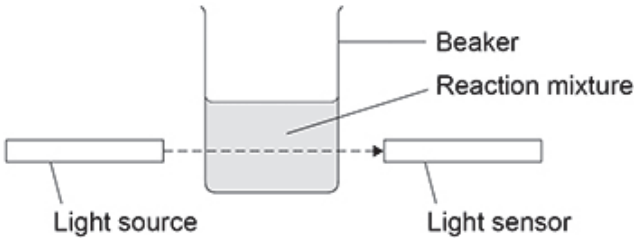
(Total 10 marks)

Q3.

A student investigated the rate of reaction between sodium thiosulfate solution and hydrochloric acid.

Figure 1 shows the apparatus used.

Figure 1



When hydrochloric acid is added to sodium thiosulfate solution, the mixture gradually becomes cloudy.

A smaller percentage of light from the light source reaches the light sensor as the mixture becomes more cloudy.

This is the method used.

1. Measure 50 cm^3 of sodium thiosulfate solution into the beaker.
2. Add 10 cm^3 of hydrochloric acid to the sodium thiosulfate solution.
3. Immediately start a timer.
4. Record the percentage of light from the light source that reaches the light sensor every 20 seconds for 120 seconds.

(a) Balance the equation for this reaction.

$$Na_2S_2O_3 + 2\ HCl \rightarrow \_\_\_\_\ NaCl + H_2O + SO_2 + S$$

(1)

(b) The mixture becomes cloudy because the sulfur produced is a solid.

What is the state symbol for a solid?

Tick (✓) **one** box.

- (aq) ☐
- (g) ☐
- (l) ☐
- (s) ☐

(1)

(c) The student monitored the cloudiness of the reaction mixture using a light sensor.

What other piece of equipment could be used to monitor the cloudiness of the reaction mixture?

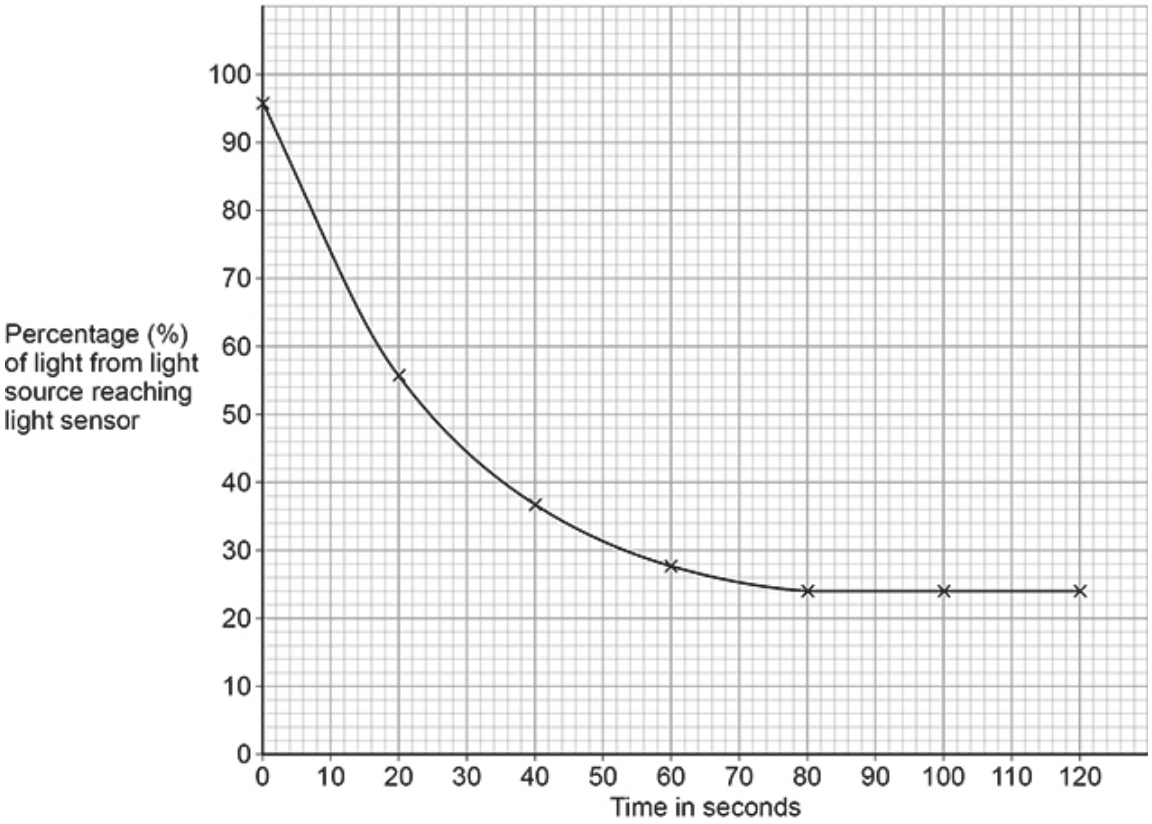
Tick (✓) **one** box.

- A balance ☐
- A cross on a piece of paper ☐
- A gas syringe ☐
- A thermometer ☐

(1)

Figure 2 shows the results.

Figure 2



(d) What happened to the rate of reaction between 40 and 60 seconds?

Use **Figure 2**.

Tick (✓) **one** box.

The rate of reaction decreased. ☐

The rate of reaction stayed at zero. ☐

The rate of reaction increased. ☐

(1)

(e) The student stopped taking measurements after 120 seconds because the percentage of light reaching the sensor stayed constant.

Why did the percentage of light reaching the sensor stay constant?

Tick (✓) **one** box.

- No light was reaching the sensor. ☐
- One of the reactants was used up. ☐
- The reaction was too vigorous. ☐

(1)

(f) The student repeated the experiment using sodium thiosulfate solution of a higher concentration.

How would the line of best fit for sodium thiosulfate solution of a higher concentration compare with the line of best fit on **Figure 2**?

Tick (✓) **one** box.

- Initially the line of best fit would be less steep. ☐
- Initially the line of best fit would be the same steepness. ☐
- Initially the line of best fit would be steeper. ☐

(1)

(g) The student then investigated the effect of changing the temperature on the rate of reaction.

The student used sodium thiosulfate solution and hydrochloric acid which had been kept in an ice bath.

Which are **two** effects of using reactants kept in an ice bath rather than at room temperature?

Tick (✓) **two** boxes.

Fewer reactant particles have the activation energy.	☐
The reactant particles collide more frequently.	☐
The reactant particles have more energy.	☐
The reactant particles move more slowly.	☐
There are fewer reactant particles in the same volume.	☐

(2)

(Total 8 marks)