Stage 1

Interpreting data

ROYAL SOCIETY OF CHEMISTRY

Education
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Introduction

Chemists often receive information in the form of tables of data. Being able to identify, describe and compare patterns can provide useful information about the relationship between the variables. It can help chemists to predict how other substances may react.

Learning objectives

1. Describe and compare patterns and trends in data.
2. Understand how the variables are related to each other.
3. Use data to draw conclusions about chemical reactions.

Patterns and trends in data

Activity

In chemistry, using a graph displays the data visually so that it is easier to observe patterns or trends. A **pattern** in the data is seen when the data repeats itself in a predictable way. A **trend** in the data shows the general direction of the data over time.

A learner investigated how changing the concentration of hydrochloric acid affected the final volume of hydrogen gas collected in a reaction.

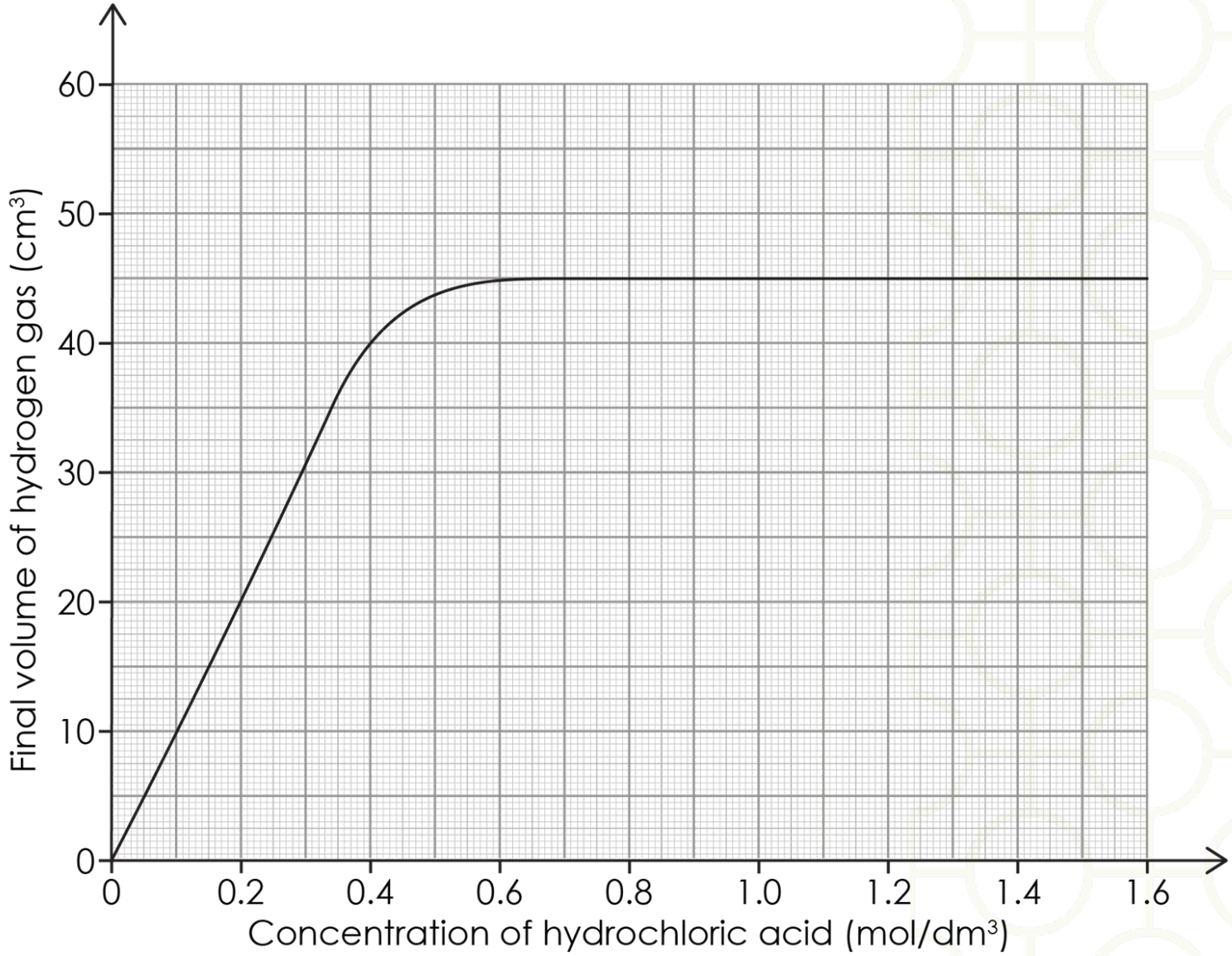
Concentration of hydrochloric acid (mol/dm^3)	Final volume of hydrogen gas collected (cm^3)
0	0
0.1	10
0.2	20
0.3	30
0.4	40

a) Plot a line graph and draw a suitable line of best fit.
b) Describe the trend.

Patterns and trends in data – example graph

Answers

a)



Patterns and trends in data – describing the trend

Answer

b) As concentration increases the final volume of hydrogen gas also increases. This is a positive linear relationship because it goes upwards towards the right and is a straight line.

Identifying a pattern using the periodic table

Activity

Chemists use the periodic table to help identify patterns. They can predict how new elements may behave and react.

Element	Number of protons	Atomic mass	Metal/non-metal
Sodium	11	22.99	metal
Magnesium	12	24.31	metal
Aluminium	13	26.98	metal
Silicon	?	?	?
Phosphorus	15	30.97	non-metal
Sulfur	16	32.07	non-metal
Chlorine	17	35.45	non-metal
Argon	18	39.95	non-metal

a) Describe any patterns you notice in the data.

b) Predict the approximate missing values for silicon.

c) Complete the sentence about the relationship between the number of protons and atomic mass:

The greater the number of protons …

Identifying a pattern using the periodic table – answer a

Answers

a)

Pattern 1: The atomic numbers increase by one each time as you move across the period from left to right. They go up in order: each element has one more proton than the element before it.

Pattern 2: The atomic masses increase as you go across the period from left to right. The mass goes up from 22.99 (sodium) to 39.95 (argon). The pattern shows that elements get heavier as the atomic number increases.

Pattern 3: The period starts with metals on the left (sodium, magnesium, aluminium), then it changes to non-metals on the right (phosphorus, sulfur, chlorine, argon). Argon is also a noble gas.

Identifying a pattern using the periodic table – answers b–c

Answers

b) Silicon has 14 protons and an atomic mass of approximately 28 units. It is a metalloid which has properties of both metals and non-metals.

c) The greater the number of protons the greater the atomic mass. This is a positive relationship.

Using data

A learner is investigating the reaction between calcium carbonate chips and hydrochloric acid.

They place a conical flask containing the calcium carbonate chips and hydrochloric acid onto a digital balance.

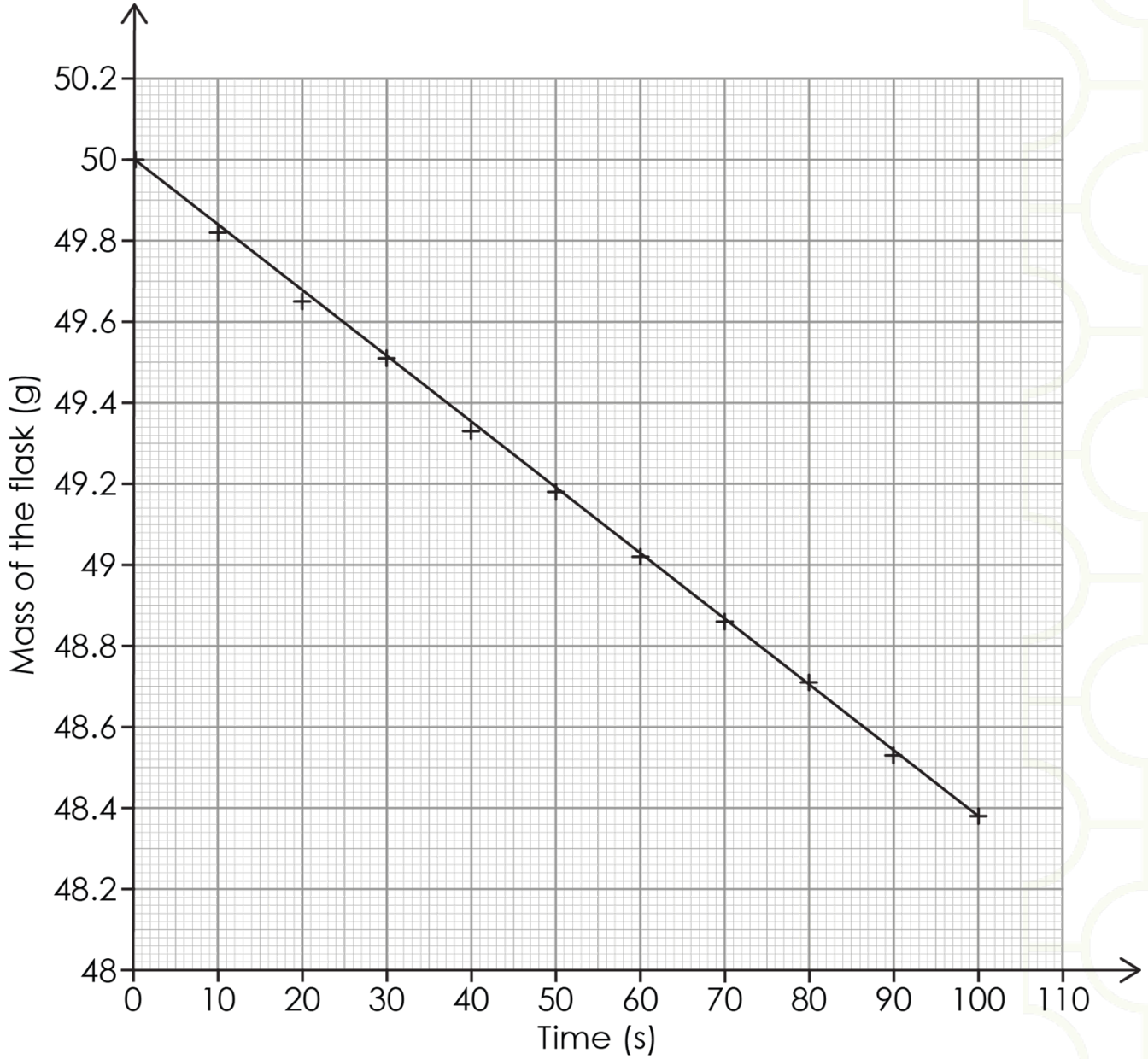
As the reaction occurs carbon dioxide gas is released and escapes into the air. The learner records the mass of the flask and its contents every 10 seconds.

a) Plot the data from the table onto a graph.
b) Describe the relationship between the variables.
c) Predict the mass of the conical flask and its contents at 55 seconds.

Time (s)	Mass (g)
0	50.00
10	49.82
20	49.65
30	49.51
40	49.33
50	49.18
60	49.02
70	48.86
80	48.71
90	48.53
100	48.38

Using data – example graph

a)



Answers

Using data – answers b–c

b) As time increases, the mass of the flask and contents decreases. There is a negative linear relationship between the variables.

c) The mass at 55 seconds is 49.10 g (accept 49.05 to 49.15 g).

Activity

Use data to draw conclusions

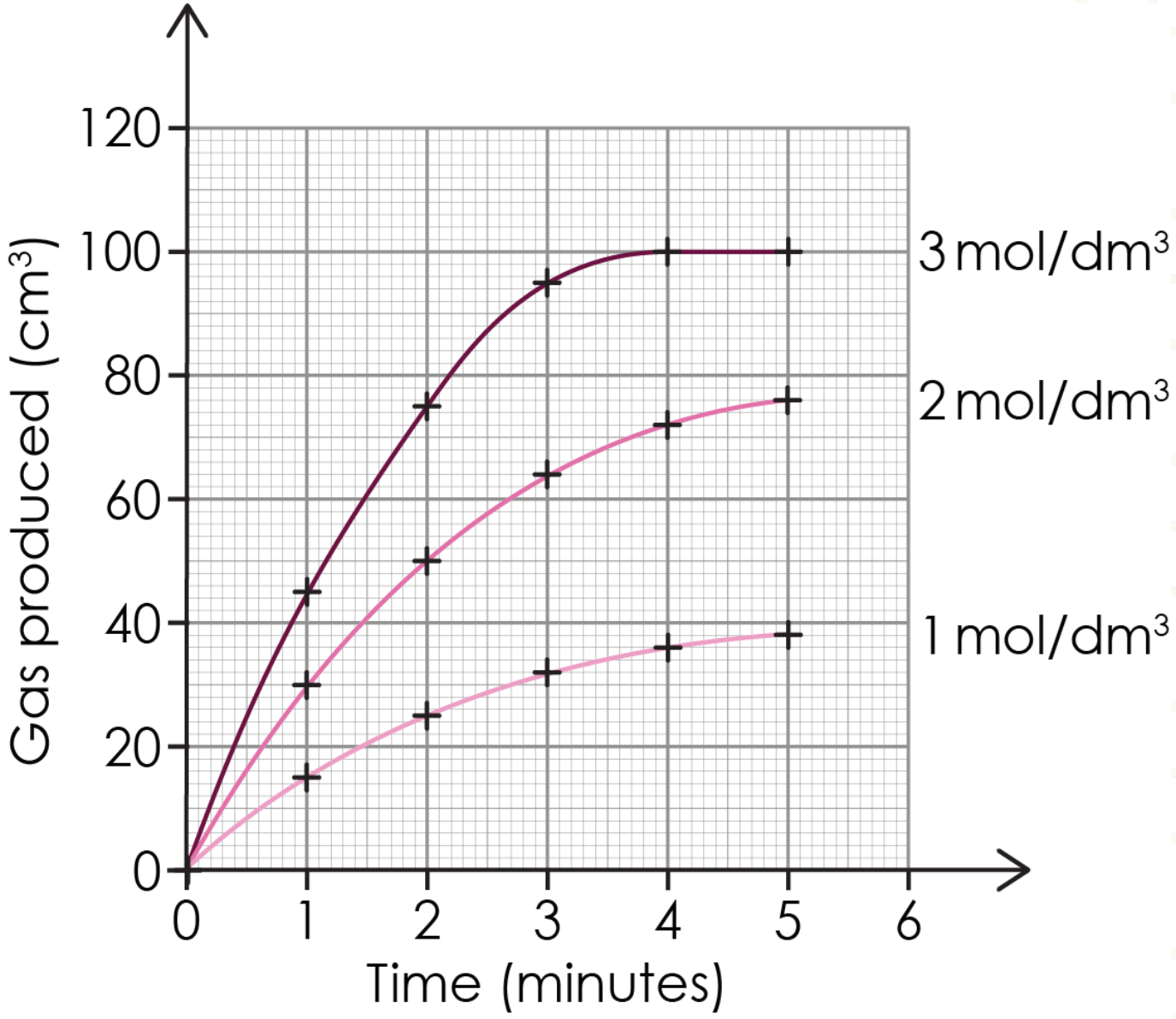
Students investigated the reaction between different hydrochloric acid concentrations and marble chips. The 3 mol/dm^3 hydrochloric acid is the most concentrated. They measured the volume of carbon dioxide gas produced.

Time (minutes)	Gas produced using 1 mol/dm^3 acid (cm^3)	Gas produced using 2 mol/dm^3 acid (cm^3)	Gas produced using 3 mol/dm^3 acid (cm^3)
0	0	0	0
1	15	30	45
2	25	50	75
3	32	64	95
4	36	72	100
5	38	76	100

a) Compare all the trends in the data. What similarities **and** differences do you notice?

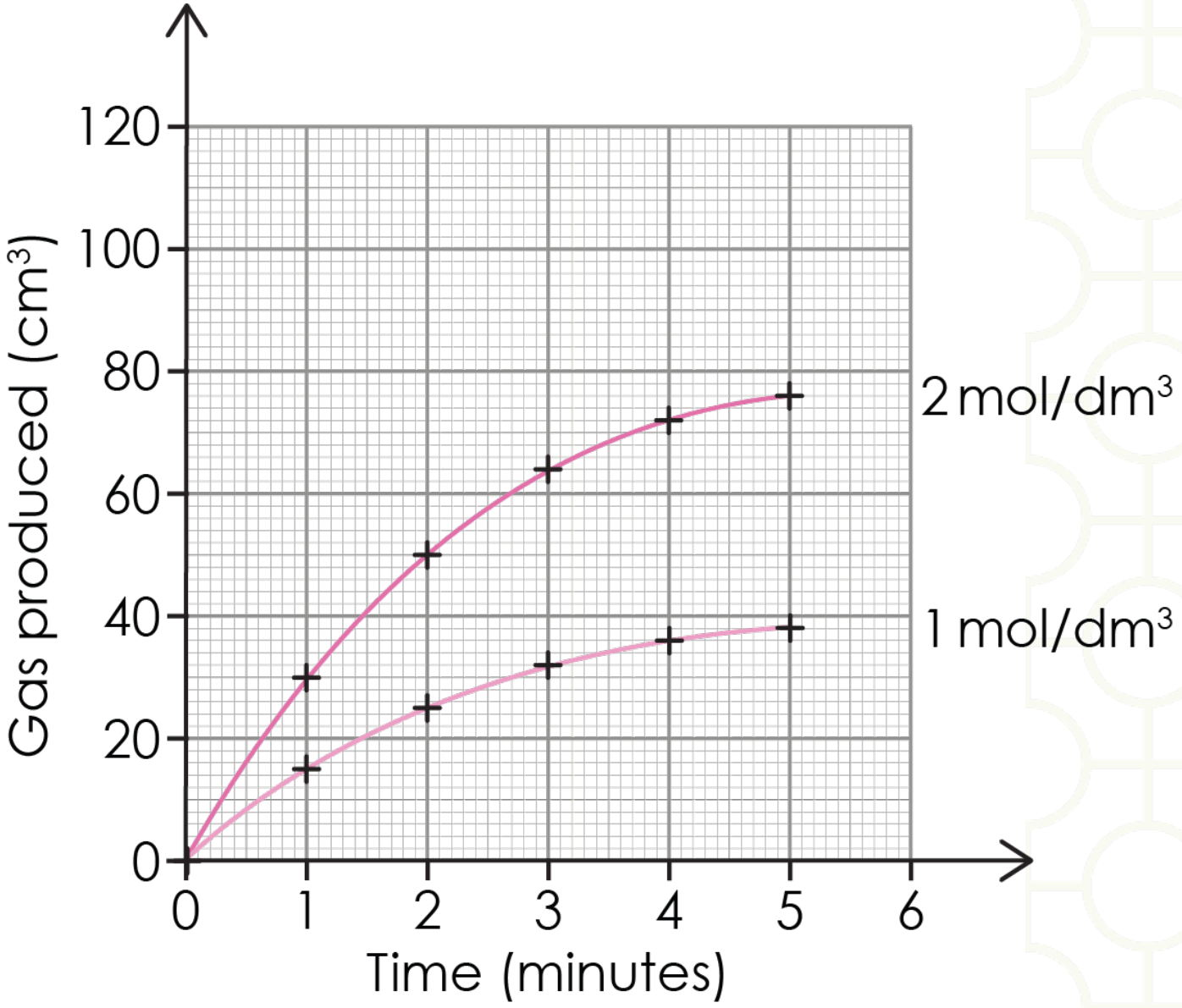
b) Write a conclusion for the investigation.

Use data to draw conclusions: three data sets



Answers

Using data to draw conclusions: two data sets



Answers

Using data to draw conclusions – answer a

Answers

a)

Similarities

- All three reactions start at 0 cm^3.
- All reactions show gas production that increases over time then levels off.
- All reactions follow a similar curve pattern.
- All reactions eventually stop producing gas (reach a plateau).

Differences

- The 3 mol/dm^3 acid produces gas fastest (steepest initial slope).
- The 1 mol/dm^3 acid produces gas slowest (gentlest slope).
- Different total volumes of gas are produced.
- The reactions finish at different times.

Using data to draw conclusions – answer b

Answer

b)

This investigation shows a clear pattern between acid concentration and gas production. It shows a positive relationship between acid concentration and the total amount of gas produced.

The data also shows that doubling the concentration roughly doubles the volume of gas released. When we look at each concentration over time, all three show a similar trend: gas production increases rapidly at first, then slows down and eventually levels off when the reaction finishes.

There is also a pattern in the reaction speeds: higher concentrations react faster.