

# Rate of Reaction using Graphs and Tangents (Higher Tier) Worksheet

Combined Science – Chemistry – Key Stage 4  
The Rate and Extent of Chemical Change

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# Example 1

A student investigated the rate of reaction between calcium carbonate (marble chips) and hydrochloric acid.

The student had collected  $34 \text{ cm}^3$  of gas produced after 20 seconds.

Calculate the mean rate of reaction from 0 to 20 seconds.



## Example 2

A student investigated the rate of reaction between magnesium and hydrochloric acid.

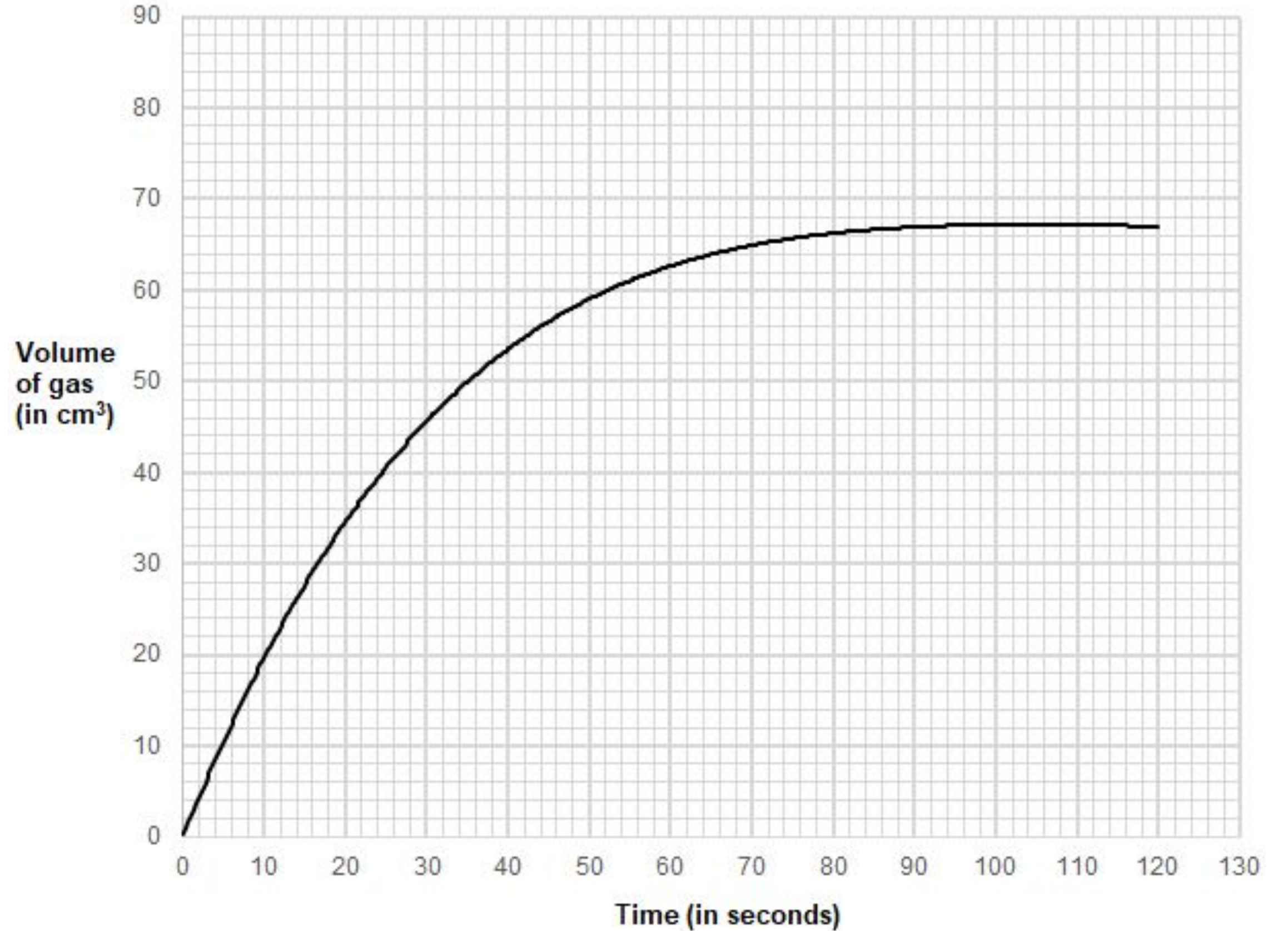
The student had recorded an initial reactant mass of 23 g. The mass of the product recorded was 19.4 g after 30 seconds.

Calculate the mean rate of reaction from 0 to 30 seconds.



# Example 3

Determine the mean rate of reaction in the first 18 seconds



# Question 1: Information

A student investigated how temperature affects the rate of reaction between magnesium carbonate and dilute hydrochloric acid. The table below shows the student's results for hydrochloric acid at 30 °C.

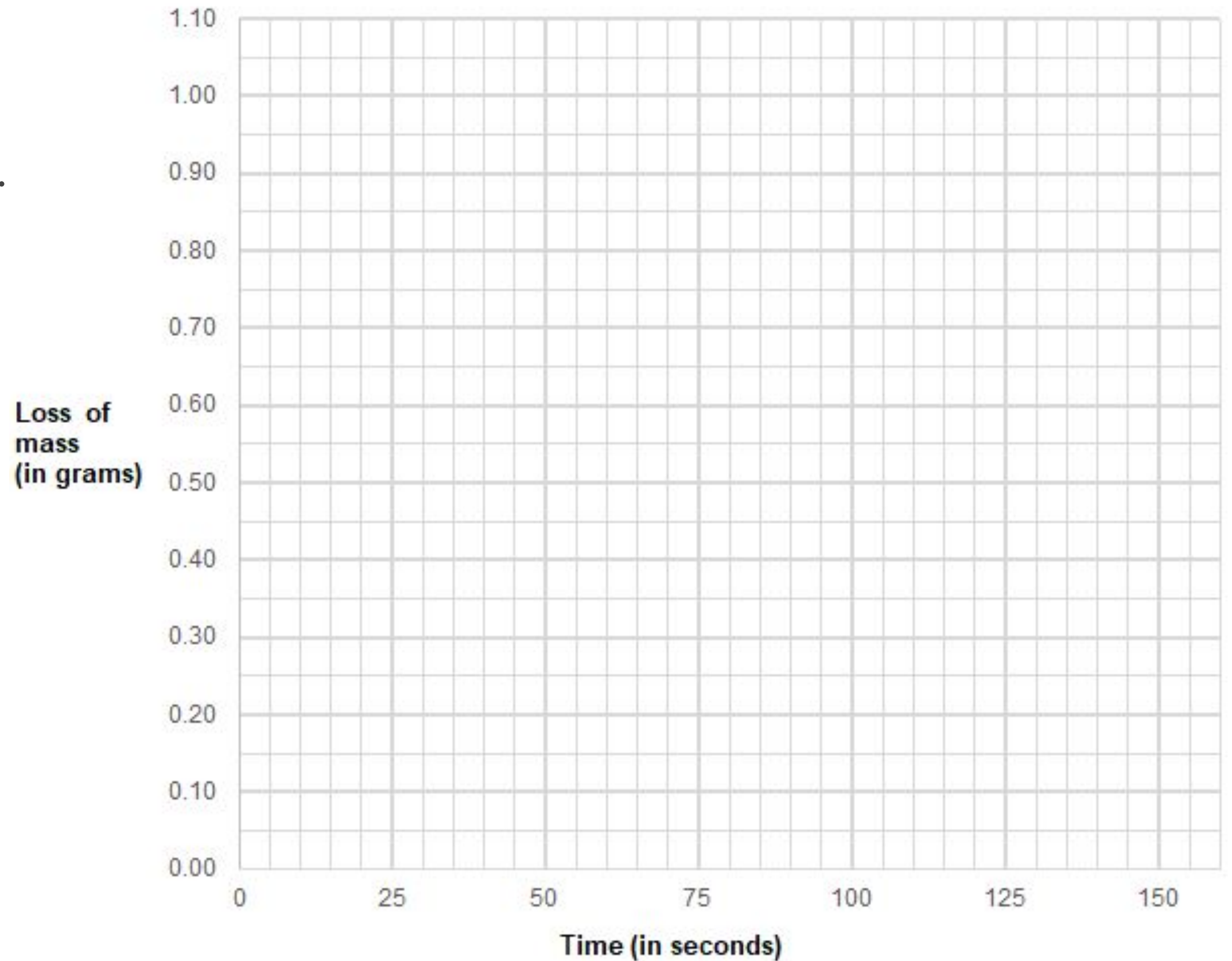
Time (in seconds)	Loss of mass (in grams)
0	0.00
20	0.24
40	0.46
60	0.65
80	0.80
100	0.89
120	0.94
140	0.97



# Question 1

Task: Plot the data from the table and draw a line of best fit.

Time (in seconds)	Loss of mass (in grams)
0	0.00
20	0.24
40	0.46
60	0.65
80	0.80
100	0.89
120	0.94
140	0.97



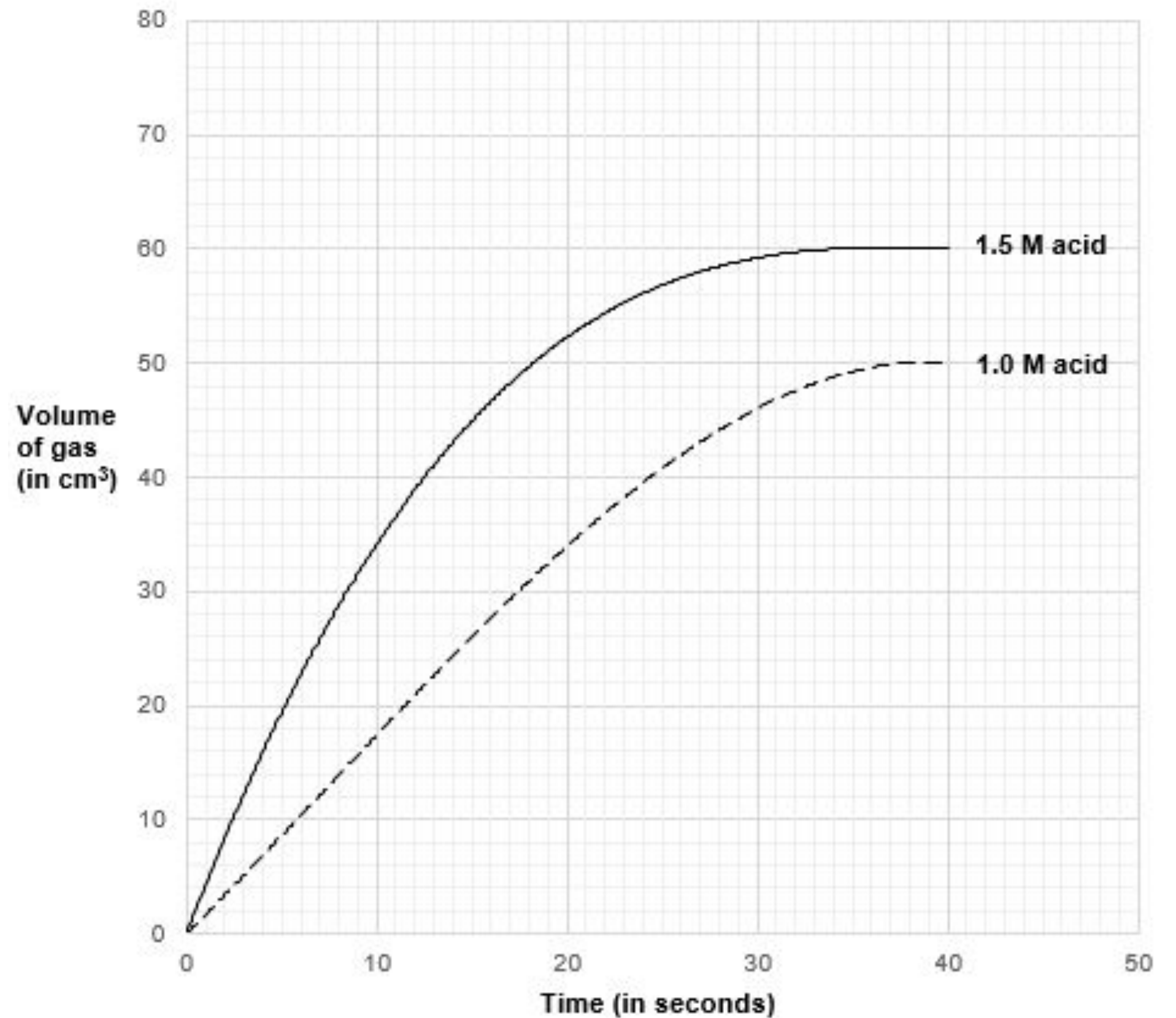


## Question 2

(a) Determine the rate of reaction at 10 seconds when:

- i) Concentration of acid used is 1.0M
- ii) Concentration of acid used is 1.5M

(b) From question (a), determine which reaction was faster at 10 seconds.



# Example 1 answer

A student investigated the rate of reaction between calcium carbonate (marble chips) and hydrochloric acid.

The student had collected 34 cm<sup>3</sup> of gas produced after 20 seconds. Calculate the mean rate of reaction from 0 to 20 seconds.

$$\text{Mean rate of reaction} = \frac{\text{quantity of product formed}}{\text{time taken}}$$

$$= \frac{34 \text{ cm}^3}{20 \text{ s}}$$

$$= 1.7 \text{ cm}^3/\text{s}$$





## Example 2 answer

A student investigated the rate of reaction between magnesium and hydrochloric acid.

The student had recorded an initial reactant mass of 23 g. The mass of the product recorded was 19.4 g after 30 seconds.

Calculate the mean rate of reaction from 0 to 30 seconds.

$$\text{Mean rate of reaction} = \frac{\text{quantity of reactant used}}{\text{time taken}}$$

$$= \frac{23 - 19.4 \text{ g}}{30 \text{ s}}$$

$$= 0.12 \text{ g/s}$$



# Example 3 answer

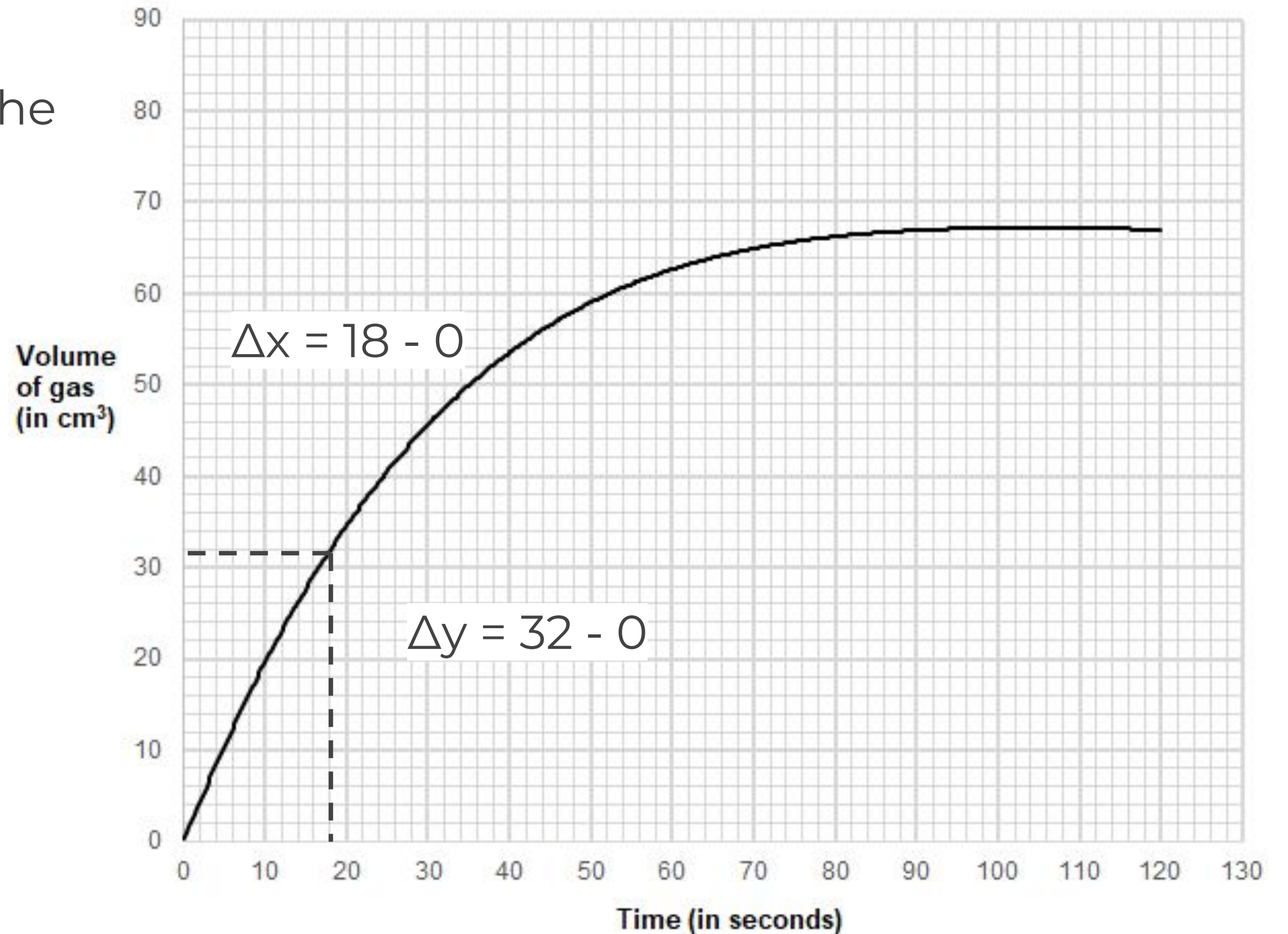
Mean rate of reaction in the first 18 seconds

$$= \frac{\Delta y}{\Delta x}$$

$$= \frac{32}{18}$$

$$= 1.777\dots$$

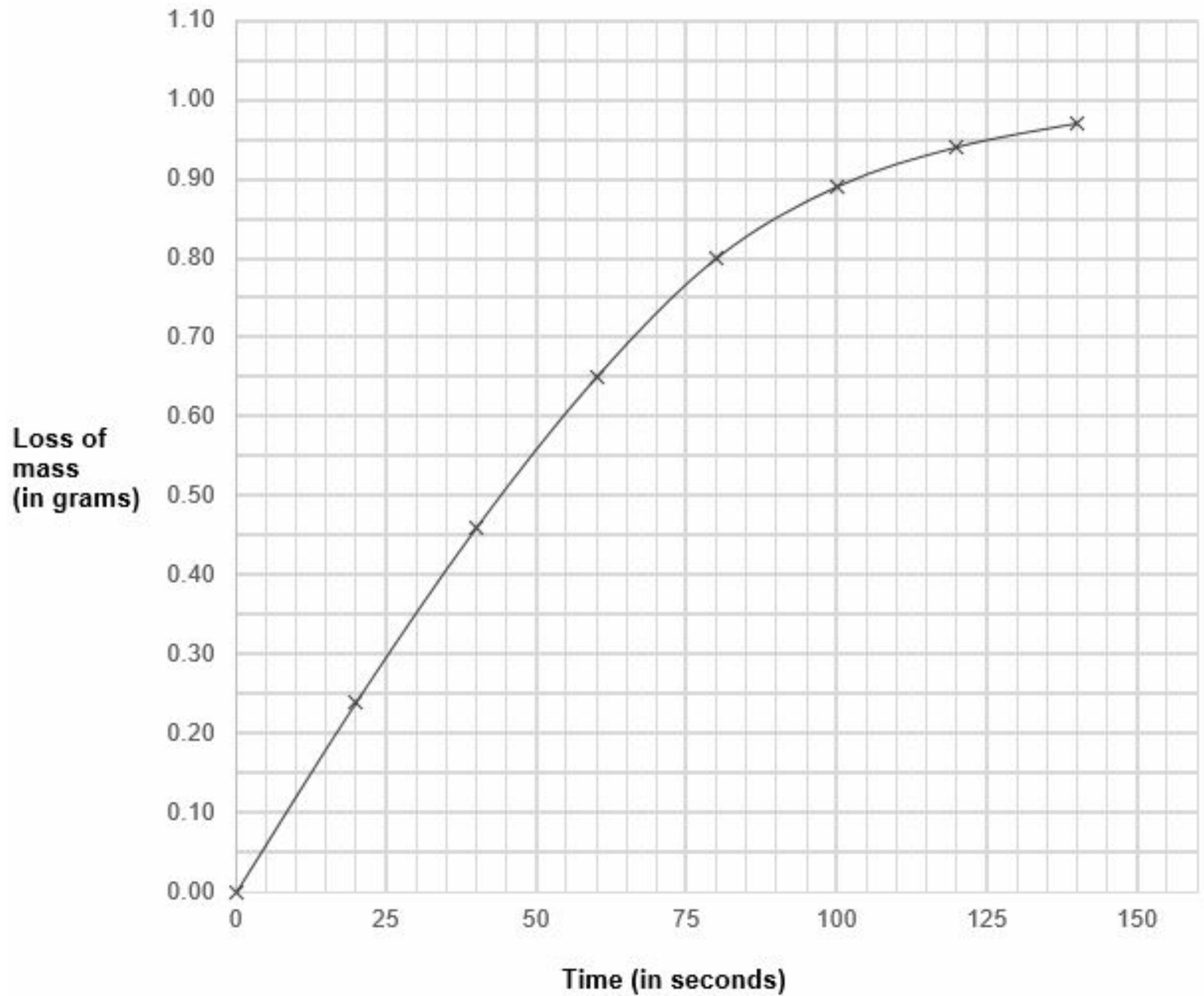
$$= 1.78 \text{ cm}^3/\text{s}$$



# Question 1 answer

Plot the data from the table and draw a line of best fit.

Time (in seconds)	Loss of mass (in grams)
0	0.00
20	0.24
40	0.46
60	0.65
80	0.80
100	0.89
120	0.94
140	0.97

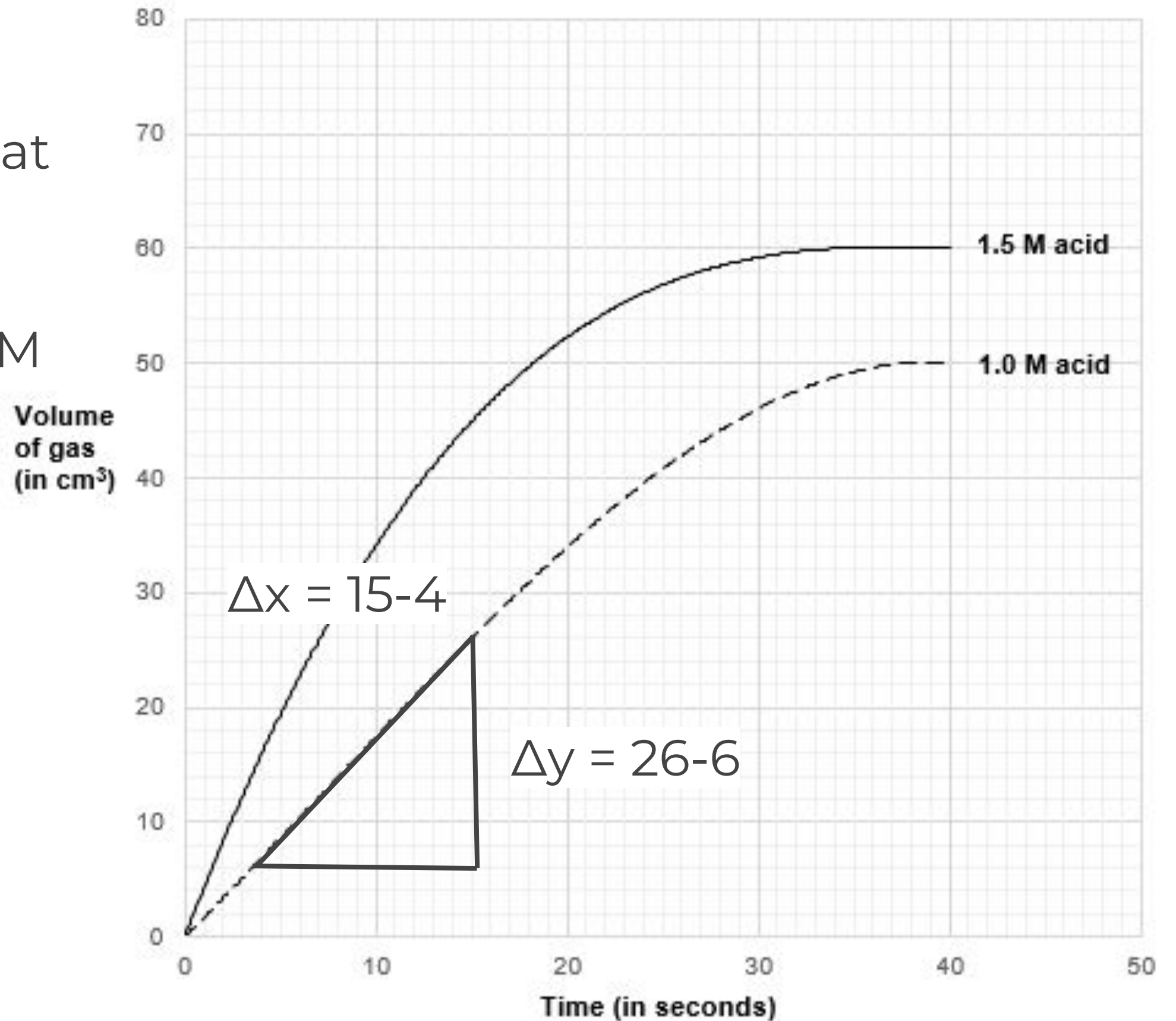


## Question 2 answer

(a) Determine the rate of reaction at 10 seconds when:

i) Concentration of acid used is 1.0M

$$\begin{aligned}\text{Rate} &= \frac{\Delta y}{\Delta x} \\ &= \frac{26 - 6 \text{ cm}^3}{15 - 4 \text{ s}} \\ &= \frac{20 \text{ cm}^3}{11 \text{ s}} \\ &= 1.81 \text{ cm}^3/\text{s}\end{aligned}$$





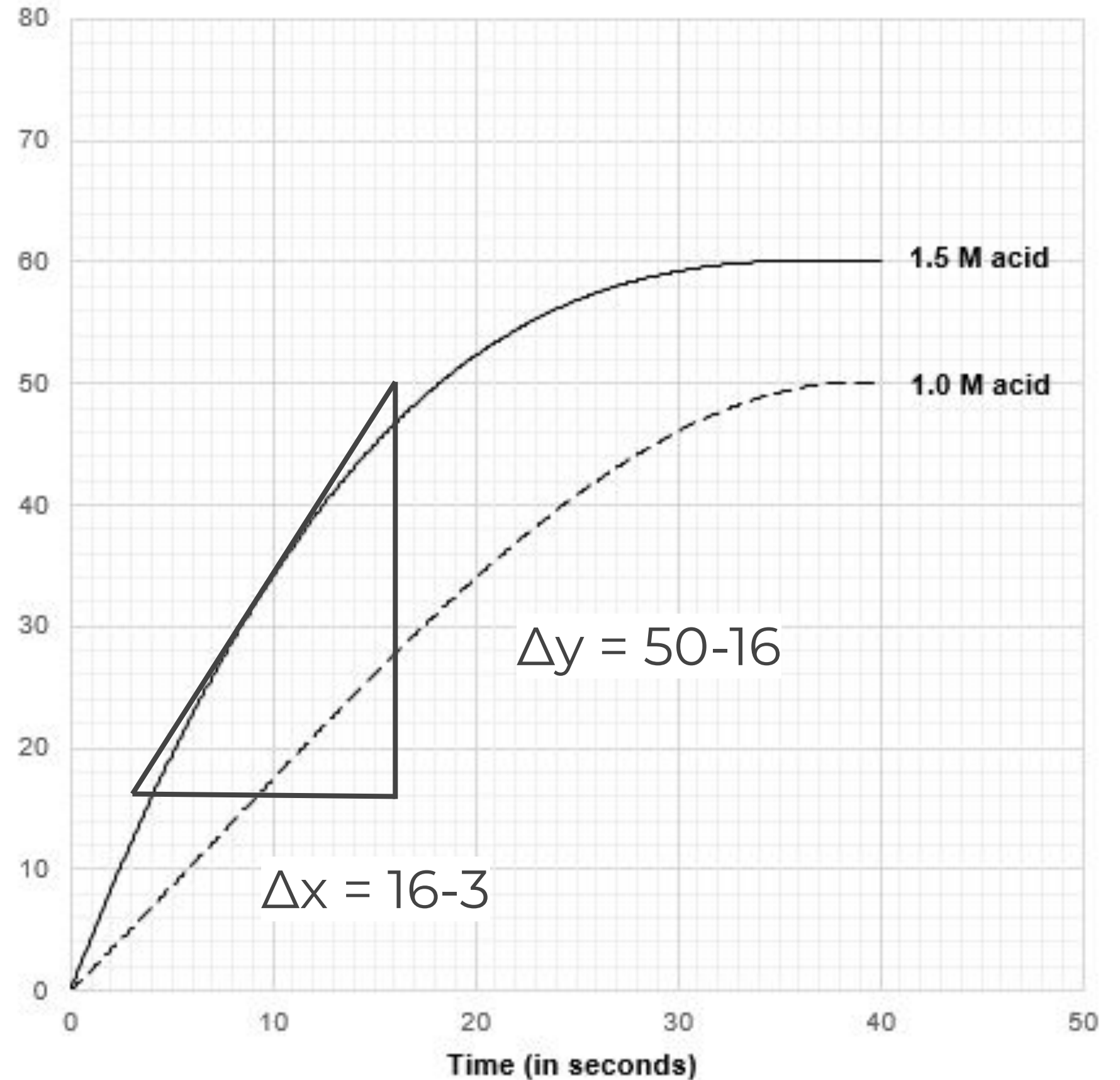
## Question 2 answer

(a) Determine the rate of reaction at 10 seconds when:

ii) Concentration of acid used is 1.5M

$$\begin{aligned}\text{Rate} &= \frac{\Delta y}{\Delta x} \\ &= \frac{50-16 \text{ cm}^3}{16-3 \text{ s}} \\ &= \frac{34 \text{ cm}^3}{13 \text{ s}} \\ &= 2.62 \text{ cm}^3/\text{s}\end{aligned}$$

Volume  
of gas  
(in cm<sup>3</sup>)



## Question 2 answer

(a) The rate of reaction at 10 seconds when:

- i) Concentration of acid used is 1.0M - 1.81 cm<sup>3</sup>/s
- ii) Concentration of acid used is 1.5M - 2.62 cm<sup>3</sup>/s

(b) Reaction with the higher concentration of acid used (1.5 M) was faster at 10 seconds.

