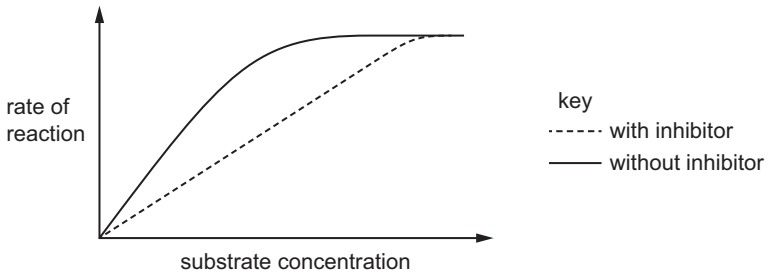
**12** The graph shows the effect of substrate concentration on an enzyme-catalysed reaction with and without a competitive inhibitor.




What is the effect of the competitive inhibitor on $V_{max}$ and $K_m$?

**A** $V_{max}$ decreases and $K_m$ decreases.

**B** $V_{max}$ stays the same and $K_m$ decreases.

**C** $V_{max}$ stays the same and $K_m$ increases.

**D** $V_{max}$ decreases and $K_m$ stays the same.



**14** How is the Michaelis–Menten constant ($K_m$) used?

**A** to determine the number of collisions between the enzyme and substrate

**B** to compare the affinity of enzymes for their substrates

**C** to find the maximum velocity of an enzyme ($V_{max}$)

**D** to find the optimum rate of reaction





**15** Some students investigated the effect of pH on the rate of starch digestion by amylase at 20 °C.

- They added 2 $cm^3$ of a 1% amylase solution and 1 $cm^3$ of pH 4 buffer to a test-tube.
- They added 2 $cm^3$ of a starch solution, containing 0.02 g of starch, to the test-tube.
- They measured the time taken for the starch to be digested (to disappear).

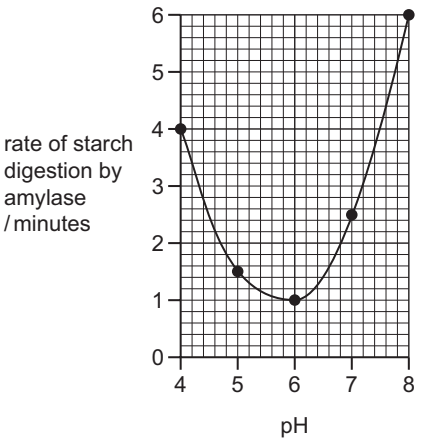
The students then repeated these steps with pH 5, pH 6, pH 7 and pH 8 buffers.

The table shows the results.

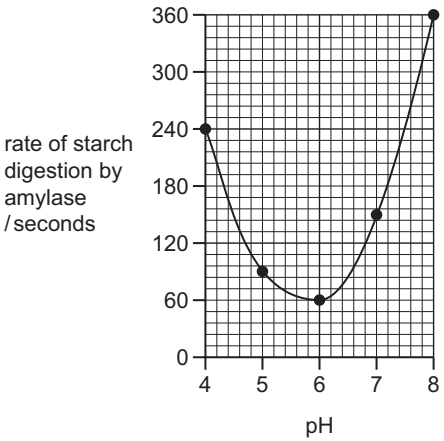
| pH | time taken for starch to be digested / minutes |
|---|---|
| 4 | 4.0 |
| 5 | 1.5 |
| 6 | 1.0 |
| 7 | 2.5 |
| 8 | 6.0 |

Which graph is correct for these data?

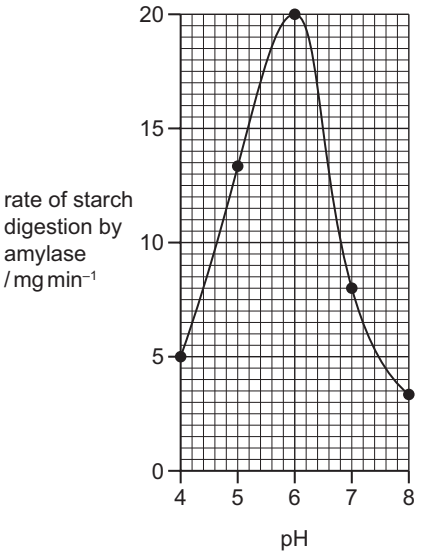
**A**



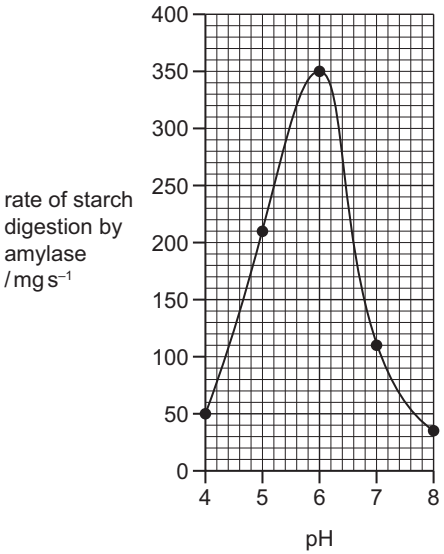

**B**




**C**




**D**




**16** Which statements are correct for a non-competitive inhibitor of enzyme action?

1 Increasing the concentration of the enzyme's substrate will reduce its effect.

2 It reduces the activation energy required for a reaction to take place.

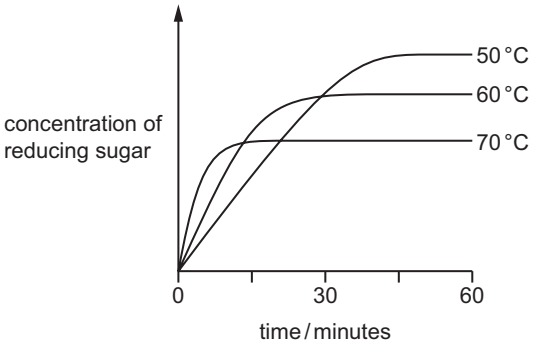
3 It reduces the maximum rate of reaction.

**A** 1 and 3 **B** 1 only **C** 2 and 3 **D** 3 only





**16** The graph shows the results of an investigation into the effect of amylase on starch at three different temperatures.




Which statements are correct conclusions using these results?

1 The optimum temperature is 50 °C.

2 The initial rate of reaction is highest at 70 °C.

3 The higher the temperature the more quickly the enzyme denatures.

**A** 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

**17** The rate of enzyme-catalysed reactions in human cells is regulated.

What may be involved in this regulation?

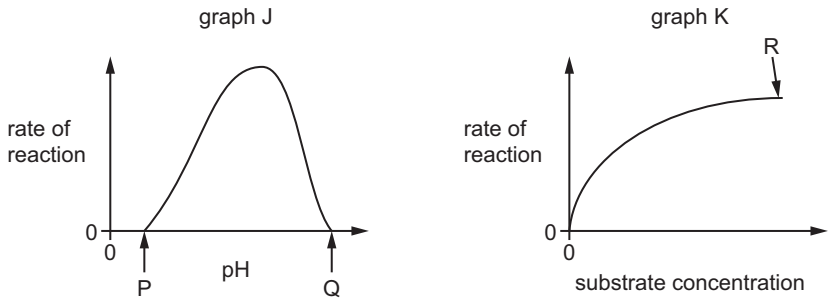
1 a change in enzyme concentration

2 a change in substrate concentration

3 inhibition by the final product of the reaction

**A** 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

**15** Graph J shows the effect of pH on the rate of an enzyme reaction. Graph K shows the effect of substrate concentration on the rate of an enzyme reaction.




A student wrote four statements about the graphs.

1 In graph J, the enzyme is denatured at point Q.

2 In graph J, the enzyme is inactive at point P.

3 In graph K, the rate of reaction is directly proportional to the substrate concentration.

4 In graph K, $V_{max}$ is reached at point R.

Which statements are correct?

**A** 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4





**1** The bacterium *Streptococcus pneumoniae* is commonly found in the throat. *S. pneumoniae* produces hydrogen peroxide as it grows. A sample can be taken from a patient's throat and tested to measure the concentration of hydrogen peroxide. This can be used as a measure of the growth of the bacteria.

You will determine the growth of bacteria by measuring the concentration of hydrogen peroxide in a solution that represents a sample taken from a patient. You will do this by measuring how long it takes for a sample of hydrogen peroxide to cause a colour change in a reaction mixture. The faster the mixture changes to a blue-black colour, the higher the concentration of hydrogen peroxide, and the greater the growth of bacteria.

You will use a range of known concentrations of hydrogen peroxide to estimate the concentration of hydrogen peroxide in a sample.

You are provided with the materials shown in Table 1.1.

**Table 1.1**

| labelled | contents | hazard | volume / $cm^3$ |
|---|---|---|---|
| **R1** | dilute sulfuric acid | irritant | 100 |
| **R2** | starch solution | low | 10 |
| **R3** | potassium iodide solution | low | 10 |
| **R4** | sodium thiosulfate solution | low | 10 |
| **H** | 2.0% hydrogen peroxide solution | irritant | 25 |
| **U** | solution representing patient sample | irritant | 10 |
| **W** | distilled water | low | 100 |

If any solution comes into contact with your skin, wash off immediately with cold water.

It is recommended that you wear suitable eye protection.

You will need to carry out a **serial** dilution of the 2.0% hydrogen peroxide solution, **H**, to reduce the concentration by **half** between each successive dilution.

You will need to prepare **four** concentrations of hydrogen peroxide solution in addition to the 2.0% hydrogen peroxide solution, **H**.

After the serial dilution is completed, you will need to have 10 $cm^3$ of each concentration available to use.

**(a) (i)** Complete Fig. 1.1 to show how you will prepare your serial dilution.

Each beaker should have:

- a labelled arrow to show the volume of hydrogen peroxide solution transferred
- a labelled arrow to show the volume of distilled water, **W**, added
- a label under the beaker to show the concentration of the hydrogen peroxide solution.

0 $cm^3$ of **W**