Solutions

Each answer shows the steps, then the **result**.

2.1

- divide 1000 by each time

$$\frac{1000}{100} = \mathbf{10} \qquad \frac{1000}{50} = \mathbf{20} \qquad \frac{1000}{40} = \mathbf{25}$$

- the units are "arbitrary units" here, because 1000 was only chosen to keep the numbers tidy

2.2

- **40 °C**
- it took the **shortest time** (40 s), and a shorter time means a faster rate

2.3

- independent variable: the **temperature**
- dependent variable: the **time taken for the starch to be broken down**

2.4

- any **two** of: the volume or concentration of amylase; the volume or concentration of starch; the pH; the volume of iodine solution used for each test

2.5

- at 40 °C the molecules have more **kinetic energy**, so they move faster
- enzyme and substrate molecules **collide more often**, and more of those collisions are successful
- so more enzyme-substrate complexes form each second and the starch is broken down faster

2.6

- 70 °C is far **above the optimum temperature** for amylase
- the heat has **changed the shape of the active site**, so starch no longer fits it
- the enzyme is **denatured**, and the change is permanent, so no starch was broken down and the iodine stayed blue-black

3.1 B

- turn each time into a rate, or divide the longer time by the shorter one

$$\frac{250\text{ s}}{50\text{ s}} = \mathbf{5}\text{ times faster}$$

- **A** is the division upside down, $50 \div 250$; **C** is the difference $250 - 50$; **D** is the sum $250 + 50$. None of those compares two rates.

3.2

(a)

- divide 1000 by each time

$$\text{pH 2: } \frac{1000}{60} = \mathbf{17} \qquad \text{pH 4: } \frac{1000}{200} = \mathbf{5.0}$$

(b)

- **pH 2**
- it gave the **shortest time**, 60 s, so the fastest rate; the times get longer on both sides of it

(c)

- pH 7 is far from pepsin's optimum pH, so the **shape of the active site has changed** and the protein no longer fits
- the enzyme is **denatured**, so no enzyme-substrate complexes can form

3.3

(a)

- independent variable: the **temperature**
- dependent variable: the **volume of juice collected**

(b)

- any **two** of: the mass of crushed apple (20 g); the volume of pectinase (2 cm^3); the time the tubes were left (20 minutes); the same apple variety; the same filter paper

(c)

- the volume of juice **rises** as the temperature rises from 10 °C to 40 °C, from 3.0 cm^3 to 12.5 cm^3
- the **maximum** volume is at **40 °C**
- above 40 °C the volume **falls sharply**, to only 0.5 cm^3 at 60 °C
- a description quotes figures off the table; it gives no reasons

(d)

- as the temperature rises the molecules gain **kinetic energy** and move faster
- pectinase and its substrate **collide more often**, and more of the collisions are successful
- so more of the pectin is broken down in the 20 minutes, releasing more juice

(e)

- 60 °C is far **above the optimum temperature** of pectinase
- the heat has **changed the shape of the active site**, so the substrate no longer fits
- the enzyme is **denatured**, so almost no pectin was broken down and almost no extra juice was released

(f)

- **repeat** each temperature at least three times and take a **mean** volume