1(a). Microorganisms are found in milk.

These microorganisms make enzymes that can cause milk to decompose.

Some students design an investigation to see how fast a sample of milk decomposes.

This is the method the students use:

- Pour 20 cm^3 of milk into a beaker.
- Keep the beaker at 25 °C.
- Measure the pH of the milk at different times over 72 hours.

i. Suggest **one** piece of apparatus the students could use to keep the beaker of milk at a constant temperature.

[1]

ii. When milk decomposes, sugars in the milk are turned into lactic acid.

To show how fast the milk decomposes, the students measure the time it takes for the pH to change.

Which term describes the time it takes for the pH to change?

Tick (✓) **one** box.

Control variable ☐

Dependent variable ☐

Independent variable ☐

[1]

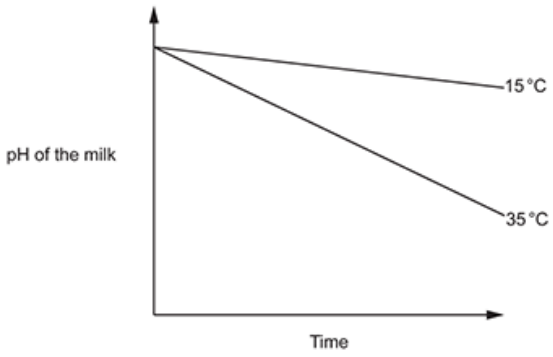
(b). The students repeated the experiment at two other temperatures.

The table shows the results.

	pH of milk				
Temperature (°C)	**At the start**	**After 12 hours**	**After 24 hours**	**After 48 hours**	**After 72 hours**
15	6.5	6.4	6.3	6.1	5.8
25	6.5	6.3	6.2	5.9	5.5
35	6.5	6.3	6.1	5.5	4.9

i. The graph shows the pattern of the students' results for 15 °C and 35 °C.

ii. Draw a line on the graph to show the pattern at 25 °C.



[1]

ii. Complete the sentences to explain the difference between the students' results at 15 °C and 35 °C.

Milk decomposes ..... at 35 °C.

Increasing the temperature increases the ..... of the molecules.

This causes more frequent ..... between enzymes and the

..... molecules.

[4]

iii. The students want to find the temperature at which the enzymes from the microorganisms change shape and stop functioning (denature).

How could they extend their experiment to find this out?

Tick (✓) **two** boxes.

- Repeat at higher temperatures. ☐
- Repeat at lower temperatures. ☐
- Repeat at more temperatures between 15 °C and 35 °C. ☐
- Identify the lowest pH reached. ☐
- Identify the temperature where pH decreases the most. ☐
- Identify the temperature where pH does not decrease. ☐

[2]

2. The diagram shows the order of bases in one strand of DNA.

T	C	A	G	G	A	C

What is the base sequence of the complementary strand of DNA?

A A G T C C T G
B C T G A A G T
C G A C T T C G
D T C A G G A C

Your answer ☐ **[1]**

3. Duckweed is a small plant that floats on the surface of ponds.

Each plant has one leaf and it usually reproduces by dividing into two.

Only occasionally does it reproduce sexually by growing flowers.

A student investigates the effect of acid rain on the reproduction rate of duckweed.

This is the student's method:

- Put pondwater with a pH of 4.5 in four different beakers.
- Add five duckweed plants to each beaker.
- Repeat this with beakers containing pondwater at pH 6.5 and 8.5.
- Leave the beakers for 10 days in the same conditions.
- After 10 days count how many duckweed plants are in each beaker.

The table shows the student's results.

pH of pondwater	Number of duckweed plants after 10 days				
	Beaker 1	**Beaker 2**	**Beaker 3**	**Beaker 4**	**mean**
4.5	6	5	7	6	6
6.5	12	14	11	11	12
8.5	7	6	5	14	8

i. What is the **independent** variable in this investigation?

[1]

ii. Identify the **pH** of the pondwater where the mean number of duckweed plants is the same as the mode for the four beakers.

Tick (✓) **one** box.

4.5 ☐

6.5 ☐

8.5 ☐

[1]

iii. The student thinks that there is a problem with their data at pH 8.5. This resulted in the mean being inaccurate.

Explain how the student could improve their investigation to get a more accurate result for the mean.

[2]

iv. The student concluded that acid pollution slows the rate of duckweed reproduction.

Explain how acid pollution slows the rate of duckweed reproduction.

Use ideas about enzymes and photosynthesis in your answer.

[2]

v. The student also concluded that pH 6.5 is the best pH for duckweed reproduction.

The student's teacher says that they need to extend the experiment to be sure of this.

Describe how the student should extend their experiment.

[2]

4(a). A student investigates the effect of pH on an enzyme called catalase.
Catalase breaks down hydrogen peroxide into water and oxygen.

The student collects the oxygen produced by the reaction.
The table shows their results.

pH	Volume of oxygen collected (cm^3)
2	1
4	12
6	24
8	26
10	8

When collecting data, it is important that it is accurate, valid and repeatable.

Draw lines to link each **improvement** the student could make to the **effect** this improvement has on the data.

Improvement	Effect
The experiment is completed three times for each pH.	makes the data more accurate
Use a measuring cylinder, not a beaker, to measure the volume of enzyme.	allows the identification of any anomalous results
Place the mixture of catalase and hydrogen peroxide in a waterbath. This will keep the temperature the same for each pH.	makes the data more valid

[2]

(b). The student wants to increase their confidence in finding the correct optimum pH for catalase.

What should the student do?

Tick (✓) **one** box.

Repeat the experiment at a higher temperature. ☐

Repeat the experiment using less enzyme. ☐

Repeat the experiment using pH 1, 3, 5, 7, 9 and 11. ☐

Repeat the experiment using pH 6.5, 7, 7.5, 8 and 8.5. ☐

[1]

5. Put ticks in the table to show whether each statement is **true** or **false** about the structure of DNA.

Tick (✓) **one** box in each row.

Statement about DNA	**True**	**False**
DNA is a polymer.		
DNA is made of 4 strands.		
The strands in DNA form a double helix.		
A DNA nucleotide is made of a sugar, a phosphate group and a base.		
The 4 bases found in DNA are A, C, G and U.		

[3]

6(a). A student investigates the effect of pH on an enzyme called catalase.
Catalase breaks down hydrogen peroxide into water and oxygen.

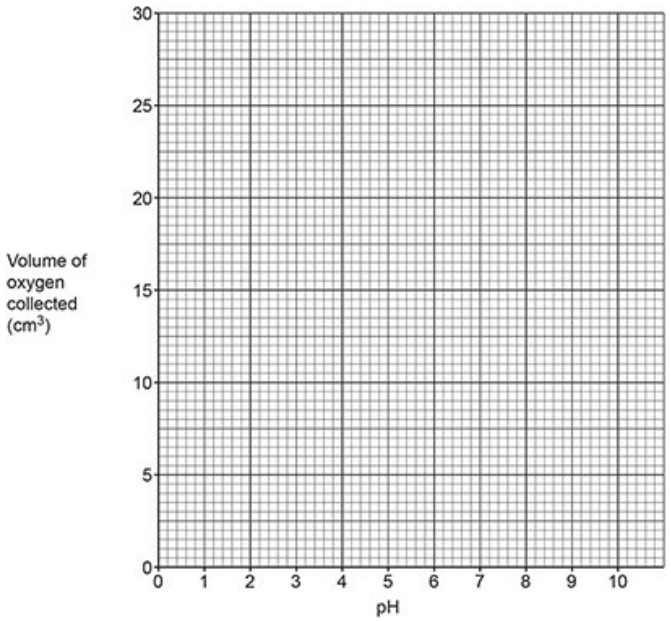
The student collects the oxygen produced by the reaction.
The table shows their results.

pH	**Volume of oxygen collected (cm^3)**
2	1
4	12
6	24
8	26
10	8

i. Plot a graph of the results.

[2]

ii. Draw a line of best fit.

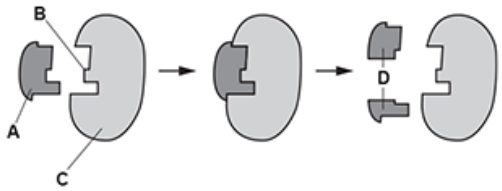


[1]

(b). Write down a conclusion for the student's results.
Include data in your answer.

[2]

7. The diagram shows the lock and key hypothesis of how enzymes work.



Which letter, **A, B, C** or **D** represents the active site of the enzyme?

Your answer ☐ **[1]**

8. DNA consists of two strands.
This is the base sequence found in one strand:

ATT

Which is the complementary base sequence of the second strand?

A ATT
B CAG
C CGG
D TAA

Your answer ☐ **[1]**

9. What does one DNA nucleotide consist of?

A A phosphate and sugar backbone
B A sugar, a phosphate and a base
C Four bases, A, C, T and G
D Two different sugars and a base

Your answer ☐ **[1]**

END OF QUESTION PAPER