

Worksheet 4 - Temperature, pH and Substrate Concentration

IB Biology C1.1 - Trimester assessment practice
SL core emphasis with IB-style questioning.

IB Biology C1.1	Total marks: 27
Suggested time: 50 minutes	Name: _____ Class: _____ Date: _____

Section A - Multiple choice

Q1. Why does the rate of an enzyme-catalysed reaction usually increase as temperature first rises? [1]

- A. Substrate concentration always increases.
- B. Molecules move faster, causing more frequent successful collisions.
- C. The enzyme becomes permanently denatured.
- D. The equilibrium position moves to the products.

Q2. Why can very low or very high pH reduce enzyme activity? [1]

- A. pH changes can alter charges and disrupt bonding in the enzyme or substrate.
- B. pH directly adds ATP to the active site.
- C. pH prevents all molecular motion.
- D. pH always increases substrate concentration.

Q3. Why does the rate level off at high substrate concentration when enzyme concentration is constant? [1]

- A. All substrates become denatured.
- B. Every enzyme active site is occupied as fast as possible.
- C. The reaction has stopped permanently.
- D. The pH becomes neutral.

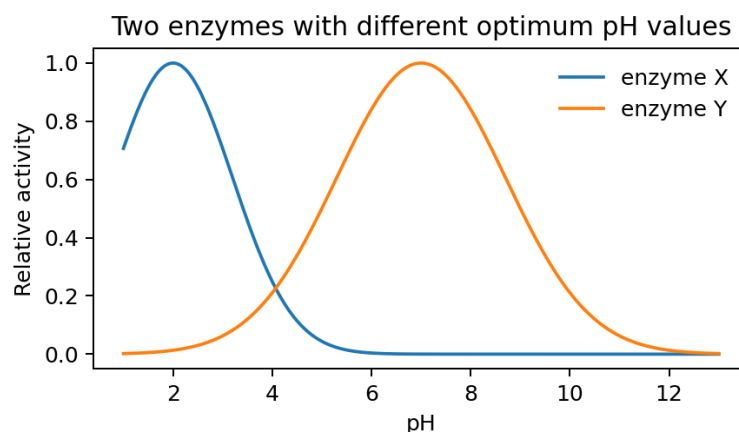
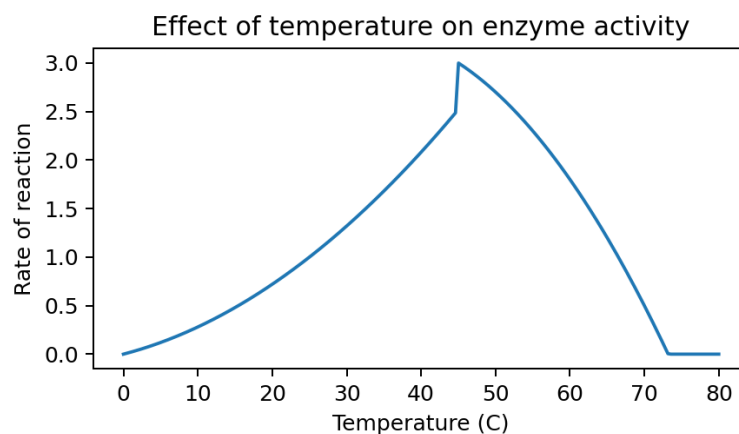
Section B - Short answer

Q4. Explain the effect of increasing temperature on an enzyme-catalysed reaction, using collision theory and denaturation. [4]

Q5. Explain how pH can affect matching between a substrate and an enzyme active site. [3]

Section C - Data response / case study

Study the graphs below showing how enzyme activity changes with temperature and with pH.



Q6.

- (a) On the pH graph, which enzyme is more likely to function in the stomach: enzyme X or enzyme Y? [1]
- (b) Justify your answer to (a) using the graph. [2]
- (c) Explain why the temperature graph rises before falling. [2]
- (d) Predict the effect of doubling enzyme concentration while keeping substrate concentration very low. [2]
- (e) Describe how you would recognise, from a graph of rate against substrate concentration, that all active sites are saturated. [4]

Section D - Extended response

Q7. Explain how environmental factors influence enzyme activity and why organisms must control these factors carefully. [6]

Continue on extra paper if needed.

Answer key and marking guidance

Teacher guidance is indicative and is designed for classroom assessment practice rather than as an official IB markscheme.

Section A - Multiple choice

Q1. Correct answer: **B**. Award [1] for B only.

Q2. Correct answer: **A**. Award [1] for A only.

Q3. Correct answer: **B**. Award [1] for B only.

Section B - Short answer

Q4. Indicative answer:

- As temperature rises, molecules move faster and collide more often.
- More collisions have sufficient energy, so rate rises.
- Beyond the optimum, intramolecular bonds in the enzyme are disrupted.
- The active site changes shape and the enzyme denatures, so rate falls.

Marking guidance: Award [1] each for increased motion, more successful collisions, bond disruption, denaturation/shape change.

Q5. Indicative answer:

- Changes in pH alter hydrogen ion or hydroxide ion concentration.
- These ions can interact with charged groups on amino acids or on the substrate.
- This changes charge interactions / bonding, reducing binding or causing denaturation if the change is extreme.

Marking guidance: Award [1] each for pH changes ions, effect on charged groups, reduced binding/denaturation.

Section C - Data response / case study

Q6.

(a) **Answer:** Enzyme X.

(a) **Marking guidance:** [1] enzyme X

(b) **Answer:** Enzyme X has its optimum activity at a very low pH, whereas the stomach is strongly acidic. Enzyme Y has an optimum nearer neutral pH.

(b) **Marking guidance:** [1] low optimum pH for X, [1] links to acidic stomach

(c) **Answer:** At first, higher temperature increases molecular motion and successful collisions. At higher temperatures, the enzyme begins to denature, so the active site is altered and the rate decreases.

(c) **Marking guidance:** [1] increased collisions, [1] denaturation at higher temperature

(d) **Answer:** The rate may increase only slightly or not by much because substrate is limiting. Many active sites would remain unused due to too few substrate molecules.

(d) **Marking guidance:** [1] little / limited increase, [1] substrate limiting

(e) **Answer:** The curve would rise as substrate concentration increases and then level off to a plateau. Further increases in substrate concentration would not increase the rate. This indicates all enzyme molecules are working at maximum rate / active sites occupied.

(e) **Marking guidance:** [1] rise then plateau, [1] more substrate no longer increases rate, [1] all active sites occupied, [1] maximum rate idea

Section D - Extended response

Q7. Indicative content for a high-scoring response:

- Temperature changes molecular motion and collision frequency.
- Each enzyme has an optimum temperature beyond which denaturation can reduce activity.
- pH affects the ionisation of groups involved in substrate binding and catalysis.
- Large pH changes can disrupt bonding and alter enzyme shape.
- Increasing substrate concentration increases rate only until active sites are saturated.

- Cells and organisms regulate internal conditions to maintain metabolism and homeostasis.

Suggested level guidance:

- 5-6: Scientifically accurate, well linked explanation using correct terminology and at least two relevant examples.
- 3-4: Some correct biology with partial linkage between ideas; minor omissions or weak examples.
- 1-2: Limited or fragmented response; little connection between concepts.
- 0: No relevant content.