This paper covers the **full Higher Separate** specification. Higher Tier questions are marked ★. Separate-only questions are marked ◆.

Photosynthesis (4.4.1.1)

Specification reference: 4.4.1.1

Q1. Write the balanced symbol equation for photosynthesis.

[2 marks]

Q2. State where in the cell photosynthesis occurs, and describe the role of chlorophyll.

[3 marks]

Q3. List FOUR ways in which plants use the glucose produced by photosynthesis.

[4 marks]

Limiting Factors of Photosynthesis (4.4.1.2)

Specification reference: 4.4.1.2

Q4. Name the THREE main limiting factors of photosynthesis.

[1 mark]

Q5. A student increases the light intensity on a pondweed but the rate of photosynthesis stops increasing after a certain point. Explain this observation and suggest what the student could do to increase the rate further.

[4 marks]

★ HIGHER TIER

Q6. ★ A lamp is moved from 10 cm to 20 cm from a pondweed. Calculate the change in light intensity as a proportion of the original. Explain why this affects photosynthesis rate.

[3 marks]

Aerobic and Anaerobic Respiration (4.4.2)

Specification reference: 4.4.2

Q7. Write the word equation for aerobic respiration and state where in the cell this takes place.

[2 marks]

Q8. Write the word equation for anaerobic respiration (a) in human muscle cells and (b) in yeast.

[2 marks]

Q9. A sprinter finishes a 100 m race and continues to breathe heavily for several minutes afterwards. Explain this observation using the term oxygen debt.

[4 marks]

★ HIGHER TIER

Q10. ★ Compare aerobic and anaerobic respiration in terms of energy released, products and location in the cell.

[3 marks]

Total: 28 marks

Photosynthesis (4.4.1.1)

Q1 (2 marks)

Write the balanced symbol equation for photosynthesis.

• 6CO■ + 6H■O → C■H■■O■ + 6O■ [2] — award 1 mark if correct but unbalanced or missing light energy notation

Q2 (3 marks)

State where in the cell photosynthesis occurs, and describe the role of chloroph…

• Photosynthesis occurs in the chloroplasts [1]
• Chlorophyll is a green pigment in the chloroplasts [1]
• Chlorophyll absorbs light energy (red and blue light) which drives the photosynthesis reactions [1]

Q3 (4 marks)

List FOUR ways in which plants use the glucose produced by photosynthesis.

• Respiration — releases energy (ATP) for plant processes [1]
• Converted to starch — for storage (insoluble, no osmotic effect) [1]
• Converted to cellulose — for cell walls [1]
• Used to make amino acids (with nitrates) → proteins / converted to lipids for seed storage / sucrose for transport [1] — any four valid uses

Limiting Factors of Photosynthesis (4.4.1.2)

Q4 (1 mark)

Name the THREE main limiting factors of photosynthesis.

• Light intensity, CO■ concentration, temperature [1] — all three required

Q5 (4 marks)

A student increases the light intensity on a pondweed but the rate of photosynth…

• Another factor is now limiting the rate of photosynthesis — not light [1]
• This is likely CO■ concentration or temperature [1]
• Student could increase CO■ concentration (e.g. add NaHCO■ to water) [1]
• Or increase temperature (up to the enzyme optimum) to increase rate of photosynthesis reactions [1]

Q6 (3 marks) [★ HT]

★ A lamp is moved from 10 cm to 20 cm from a pondweed. Calculate the change in l…

• Light intensity ∝ 1/d² so at 20 cm the intensity is 1/4 of the intensity at 10 cm (25%) [1]
• Light intensity has decreased — less energy available per unit area per second [1]
• Fewer photons absorbed by chlorophyll → rate of photosynthesis decreases [1]

Aerobic and Anaerobic Respiration (4.4.2)

Q7 (2 marks)

Write the word equation for aerobic respiration and state where in the cell this…

• Glucose + oxygen → carbon dioxide + water (+ energy/ATP) [1]
• Occurs in the mitochondria [1]

Q8 (2 marks)

Write the word equation for anaerobic respiration (a) in human muscle cells and …

• (a) Glucose → lactic acid (+ small amount of energy) [1]
• (b) Glucose → ethanol + carbon dioxide (+ small amount of energy) [1]

Q9 (4 marks)

A sprinter finishes a 100 m race and continues to breathe heavily for several mi…

• During the sprint, muscles could not receive O■ fast enough → anaerobic respiration occurred [1]

• Lactic acid accumulated in muscles [1]

• After the race, extra oxygen is needed to break down the lactic acid (convert to glucose in the liver) — this is the oxygen debt [1]

• Heavy breathing repays the oxygen debt by supplying the extra O■ needed [1]

Q10 (3 marks) [★ HT]

★ Compare aerobic and anaerobic respiration in terms of energy released, product…

• Aerobic: large amount of energy (38 ATP per glucose); anaerobic: very little energy (2 ATP per glucose) [1]

• Aerobic: CO■ + water produced; anaerobic: lactic acid (animals) OR ethanol + CO■ (yeast) produced [1]

• Aerobic: occurs in mitochondria; anaerobic: occurs in cytoplasm [1]