

Question number	Answer	Marks	Guidance
1 a	carbon dioxide oxygen	1 1	
1 b i	sunlight	1	
1 b ii	absorbed by chlorophyll in chloroplasts	1 1	
1 c	temperature: frost indicates below 0 °C, reaction rates slower in low temperatures light intensity: short day length and low light intensity in winter, light provides energy for endothermic reaction	1 1	
1 d	Any three from: <ul style="list-style-type: none"> • energy for cell functions • growth • reproduction • building up smaller molecules into bigger molecules • conversion into starch for storage • making cellulose • making amino acids • building up fats and oils for food store in seeds 	3	

1 e	Plants need carbon dioxide, water, and light for photosynthesis to make sugars for conversion to starch. Temperature unlikely to be limiting factor for photosynthesis at around 20 °C. Plants also need to make other molecules such as amino acids to build proteins and chlorophyll for photosynthesis. This requires minerals such as nitrates and magnesium from the soil. Plant grown in pure water cannot make proteins or chlorophyll.	1 1 1 1	
2 a	Award marks for well-drawn graph correctly labelled.	4	
2 b	Plants in higher light intensity photosynthesise faster, producing more food and growing well. Light will not limit them, carbon dioxide or temperature levels might. Light constant limiting factor for plants in lower light intensity, which photosynthesise more slowly and grow less	1 1 1 1	
3 a	leaves green stems	1 1	
3 b	roots	1	
3 c	Perform iodine test on leaves from plant exposed to light for 24 hours so can photosynthesise and plant kept in dark for 24 hours so starch made by photosynthesis used up in respiration. Treat leaves by boiling in ethanol to destroy cuticle and remove colour. Rinse in hot water to soften and add iodine solution. Leaf kept in light changes to blue-black colour indicating presence of starch, product of photosynthesis. Leaf kept in dark remains yellow-brown as no starch present, starch made by photosynthesis used up in respiration.	1 1 1 1 1	

4 a	conditions good for photosynthesis – plenty of light, water, and warm temperatures allow rapid photosynthesis with few limiting factors promoting rapid growth.	1 1 1	
4 b	glucose made in photosynthesis	1	
4 c	as energy store for developing plant embryo as seed germinates and grows but before it can photosynthesise	1 1	
4 d	respiration to release energy for plant cells for growth building complex carbohydrates (e.g., cellulose for plant cell walls, starch for storage) combining with nitrates from soil to make amino acids and proteins	1 1 1	
5 a	hydroponic growing eliminates limiting factors so more photosynthesis takes place	1 1	
5 b	rice, potatoes, tomatoes, peas, and cucumbers as these are crops for which hydroponic growing gives biggest percentage increase in yield so economically sound	4	1 mark for three correct crops, 2 marks for five correct crops. 2 marks for explanation.
5 c	wheat and cabbage as hydroponic growing offers relatively small increase in yield for these crops so not cost effective	1 1 1	

5 d i	<p>Any three from:</p> <p>benefits:</p> <ul style="list-style-type: none"> • relatively easy and cheap • no specialist equipment needed • can use natural growing cycle <p>problems:</p> <ul style="list-style-type: none"> • open to pests and weeds • weather can affect growth • limiting factors such as temperature and light levels mean plants don't photosynthesis at maximum rate and don't achieve maximum growth 	3	<p>Must have at least one benefit and one problem to gain full marks.</p> <p>Credit any other valid points.</p>
5 d ii	<p>Any three from:</p> <p>benefits:</p> <ul style="list-style-type: none"> • maximum growth • no limiting factors • relatively easy to control pests and weeds • can grow out of season • crops clean when harvested • not affected by changes in the weather • good working conditions indoors <p>problems:</p> <ul style="list-style-type: none"> • high set-up costs • expensive to run • vulnerable to failings in technology 	3	<p>Must have at least one benefit and one problem to gain full marks.</p> <p>Credit any other valid points.</p>