

- (d) (i) Any sensible answer, eg:

In drought conditions, stomata close, so restricting carbon dioxide uptake and photosynthesis / limiting transpiration and so mineral uptake.

For discussion of reduced transpiration and mineral uptake, there is no need to mention stomatal closure.

(Do *not* credit answers such as "Plants were wilting." unless these are extended to include reference to how the position of the wilted leaves impairs light capture. Allow also answers which discuss how, with limited water availability, there is reduced cell expansion and a reduced surface area of leaf for photosynthesis.

Do *not* credit statements such as "Water is needed for photosynthesis; without water, growth is restricted." or comments relating to decreased transport of growth hormones.) (1)

- (ii) With the stomata closed, sulphur dioxide was unable to enter the leaves, so causing little damage.

Allow also answers such as "Lack of water is the limiting factor. Until this is remedied, sulphur dioxide is not limiting." and, similarly, other comments which relate back to (i) and indicate that sulphur dioxide could not make things worse.

Also acceptable are answers such as "Sulphur dioxide inhibits growth by limiting water uptake. With limited water availability, further inhibition is not seen."

If in (i), candidates discuss the lack of water, allow comments such as "There is little water to dissolve sulphur dioxide gas, so it does not come into contact with the plant." (1)

- (e) The soil was deficient in sulphur / plants require sulphur to grow (1), remedied/provided by the addition of sulphate in the fertiliser (1). The sulphur dioxide in polluted air (rather than damaging the crop) also alleviates the sulphur-deficiency (1).

To gain any marks, answers must go beyond merely restating or highlighting aspects of the data. Do not necessarily reward answers referring to "potassium sulphate" because the candidate may believe it is the potassium that is important. (3)

(Total 11)

#### 4

- (a) (i) To break down cell walls / membranes / to make them permeable to iodine solution/ ethanol/chlorophyll / to remove waxy cuticles.

Do not penalise additional comments of "to release starch", "to burst cells" or "to kill the leaves" if the correct answer is also given but on their own, these must *not* be credited. (1)

- (ii) So that any colour change with iodine can be more easily seen.

Do *not* reward "To remove pigments/chlorophyll"; the question states that the leaf discs have been decolourised. Such a response must be extended. Similarly, an answer such as "So that a starch test can be performed giving a blue-black colour." is inadequate. (1)

- (b) Glucose is converted to starch\* using energy\* released in respiration\*. This conversion does not occur when temperatures are too low\* because enzyme action is inhibited\* or when there is no oxygen\* available.

The question is best tackled as involving 6 half marks, scoring the points asterisked above. However, do *not* round up if odd numbers of half marks are gained. (Show half marks awarded by '-' and then total.)

Do *not* penalise answers in which there *is* discussion of low temperature and absence of oxygen but no reference is made to Investigations 2 and 3 or, in a slip, the two investigations are reversed.

Do *not* allow references to "air" instead of "oxygen", nor enzymes "denatured" at low temperatures. (3)

(c) Oxygen (1) from photosynthesis collects in the leaf discs (1). However, do *not* credit incidental references to photosynthesis or oxygen in an answer which clearly shows the candidate's lack of understanding. (2)

(d) When awarding marks, please indicate using I, II or III (or 1,2,3) which section marks have been awarded for. This will help to ensure that maximum mark limits are not exceeded.

I Description of how leaf discs from a destarched plant (1) would be exposed to light air and water (but if use glucose - *no* mark) (1). (Description can be a reference to "As in figure 1." but *not* "figure 2", but unless the candidate specifically states that water is used instead of glucose - *no* mark. Extra mark available for discussion of checking that destarching was actually achieved, by testing sample leaf discs for starch before starting.)

Use of a range of wavelengths by passing light beam through prism or using filters (or other term) (1). (There is *no* requirement to give details of how the filters are positioned relative to the leaf discs but at least three filters must be used and a sensible range of colours chosen/wavelengths investigated.)

Exposed to light for sufficient length of time (not < 12 hours). (1)

Discs tested for starch. (1) (There is no need to state how the starch test would be carried out but if the answer goes on to give an inadequate description, eg, just "using a colorimeter" do *not* give credit. However, do *not* penalise if comments about colorimetry are appended to a correctly described iodine test on the leaf discs.)

If leaf discs are boiled/decolourised and tested for starch *before* the experiment is set up, the maximum for marks in section I is *reduced to 3*. **MAX 4**

II Light of same intensity for each wavelength. (1) Allow an additional mark for an appreciation of the need to compensate for different light intensities with different colour filters. (If, however, answers state that the lamp is a constant distance from the leaf discs, as equivalent to ensuring that light intensity is kept constant, do *not* award the additional mark. If the answer states that filters are used which allow the same light intensity to pass through when the light source is the same distance away, *allow* the additional mark.)

Replication using several leaf discs for each wavelength/ whole investigation repeated several times. (1) (Reference merely to the use of "leaf discs" should not be construed as indicating an awareness of the need to replicate data.)

Leaf discs cut from the same leaf/plant. (1)

Leaf discs in normal light/dark (but not "black light"!) as a control. (1)

Temperature kept the same/constant/at room temperature / at a stated temperature not <20 °C nor >40 °C / description of setting up a heat filter / immersing closed syringes in a water bath in order to prevent lamps heating the plants. (1)

A description of how light sources other than the wavelengths investigated would be excluded. (1) (This may involve comments such as "Work in a darkened room." or arise out of the description of how the apparatus was set up in section I. For example, filters wrapped round syringes, or filters incorporated into the lid of a box enclosing the apparatus containing the leaf discs.)

Do *not* credit answers such as "Same amount of air or water.", "Same size of leaf discs used." or "Keep all conditions the same." **MAX 3**