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BIOLOGY

ENERGY TRANSFERS IN & BETWEEN ORGANISMS

Level & Board	AQA (A-LEVEL)
TOPIC:	PHOTOSYNTHESIS
PAPER TYPE:	QUESTION PAPER - 1
TOTAL QUESTIONS	5
TOTAL MARKS	38

Photosynthesis - 1

1.

(a) Which substances are required for the light-dependent reaction in photosynthesis? **(1)**

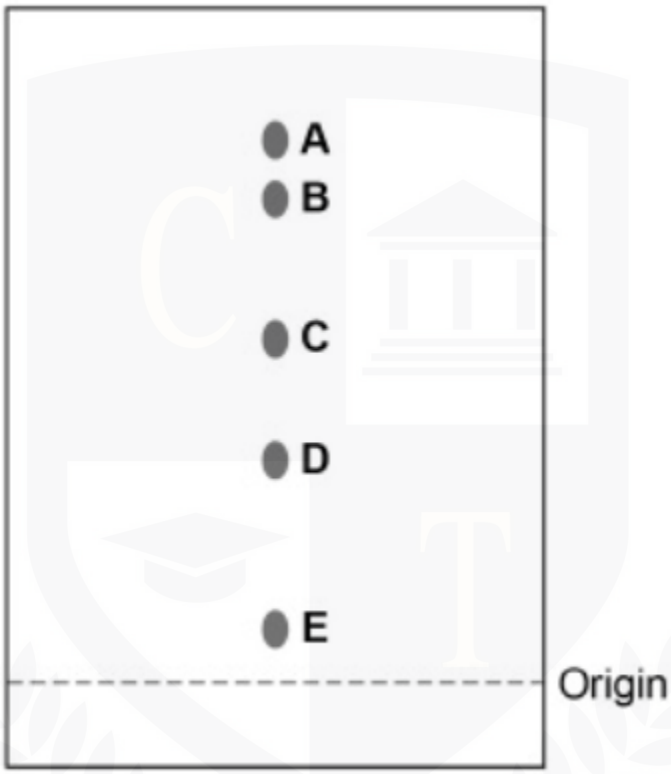
Tick (✓) one box.

Reduced NADP, ADP, Pi, water and oxygen.	☐
NADP, ATP and water.	☐
Reduced NADP, ATP, water and carbon dioxide.	☐
NADP, ADP, Pi and water.	☐

(b) Explain the light-dependent reaction photoionization process**. (2)**

Plant leaves were used to make a coloring solution for a student. The student then separated the pigments using paper chromatography.

The generated chromatogram is depicted in the diagram.



(c) Describe why the pupil chose to use a pencil rather than ink to indicate the origin. **(1)**

(d) After applying the pigment solution to the origin, describe the technique the student used to separate the pigments. **(2)**

(e) Leaf pigments come in a variety of colors. Describe and suggest the benefit of leaves having a variety of colored pigments. **(1)**

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2.

Plants that are exposed to high temperatures for extended periods of time frequently develop heat stress. One of the main factors influencing how quickly photosynthesis occurs is heat stress.

(a) Heat stress reduces photosynthesis's light-dependent reaction.

Describe how this causes the light-independent reaction to decrease. **(2)**

(b) Reduced activity of the enzyme rubisco is another consequence of heat stress. The pace at which an enzyme catalyzes a process slows down when its activity decreases.

The pace of photosynthesis would be constrained by a reduction in the activity of the enzyme rubisco.

Describe your reasoning. **(1)**

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(c) In a cell, where exactly is rubisco found? **(1)**

The impact of temperature on the activity of two enzymes extracted from cotton plant leaf cells was studied by scientists.

- Rubisco
- The enzyme that activates Rubisco is called Rubisco activase

Their findings are shown in Figures 1 and 2.

Figure 1

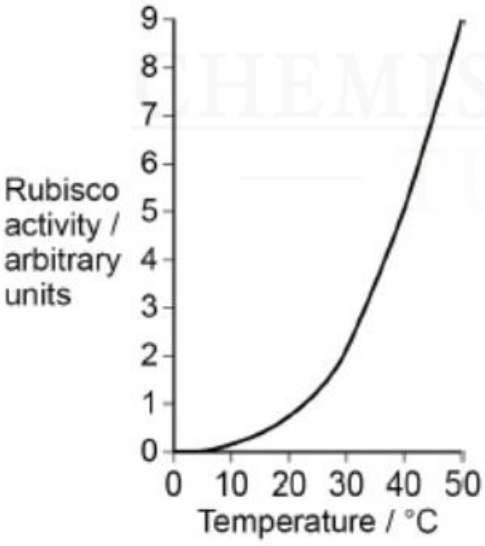
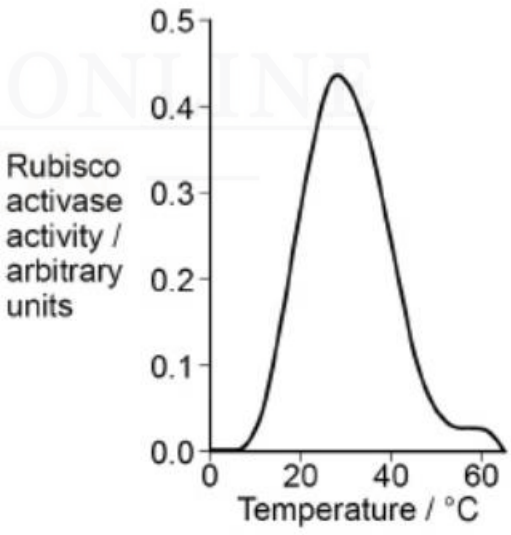


Figure 2



(d) The researchers came to the conclusion that heat stress alters rubisco activase, which in turn lowers the activity of rubisco in plant leaves.

To assess their conclusion, consider all the available data**. (4)**

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3.

To create a chloroplast suspension, a student separated the chloroplasts from spinach leaves and added them to a solution. He examined the light-

dependent reaction of photosynthesis using the DCPIP solution and chloroplast suspension. When reduced, DCPIP solution is colorless; when oxidized, it is blue.

Three test tubes were arranged by the student as follows:

• Tube 1 – 1 cm^3 of solution without chloroplasts and 9 cm^3 of DCPIP solution in light.

• Tube 2 – 1 cm^3 of chloroplast suspension and 9 cm^3 of DCPIP solution in darkness.

• Tube 3 – 1 cm^3 of chloroplast suspension and 9 cm^3 of DCPIP solution in light.

At the beginning and after the tubes were kept at 20 °C for 30 minutes, the student noted the color of the DCPIP in each tube.

His findings are displayed in the table.

Tube	Colour of DCPIP in tube	
	At start	After 30 minutes
1	blue	blue
2	blue	blue
3	blue	colourless

(a) The student's solution and the chloroplasts shared the same water potential when they were made into a suspension.

Describe the significance of these water potentials being equal. **(2)**

(b) Justify the student's setup of Tube 1. **(2)**

(c) Describe the Tube 3 results**. (2)**

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(d) The student assessed the capacity of several compounds to stop DCPIP from becoming discolored in chloroplast suspensions in order to determine how efficient they were as weed-killers.

He introduced various amounts of each substance to suspensions of DCPIP-containing chloroplasts that were lit. The IC50 for each chemical was then ascertained by him. The chemical concentration that prevents DCPIP from decolorizing by 50% is known as the IC_{50}.

Describe the benefits of the student using the IC_{50} for this research. **(1)**

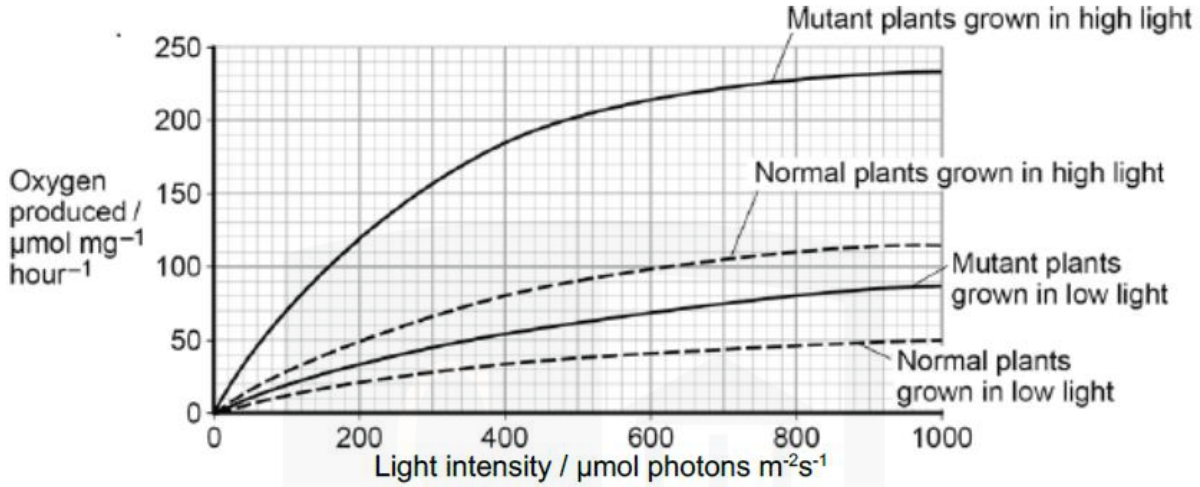
4.

Chlorophyll a and b are found in chloroplasts. Researchers discovered tobacco plants that were mutated to produce higher levels of chlorophyll b than typical tobacco plants. They looked into how this mutation affected the rate at which photosynthesis occurs.

The following investigation was conducted by the scientists.

• Both regular and mutant tobacco plants flourished there. They extracted samples of chloroplasts from mature plants of both types, cultivated some of each in low light and others in high light, and then assessed the amount of oxygen produced by the chloroplasts they had taken from the plants.

The scientists' findings are depicted in the image below.



(a) Justify the scientists' measurement of the oxygen production rate in this study. **(2)**

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The researchers took 15 minutes to gather oxygen for each attempt.

(b) Determine how much more oxygen the chloroplasts of the mutant plants cultivated in low- and high-light conditions produced at 500 µmol photons

m^{-2} s^{-1}.

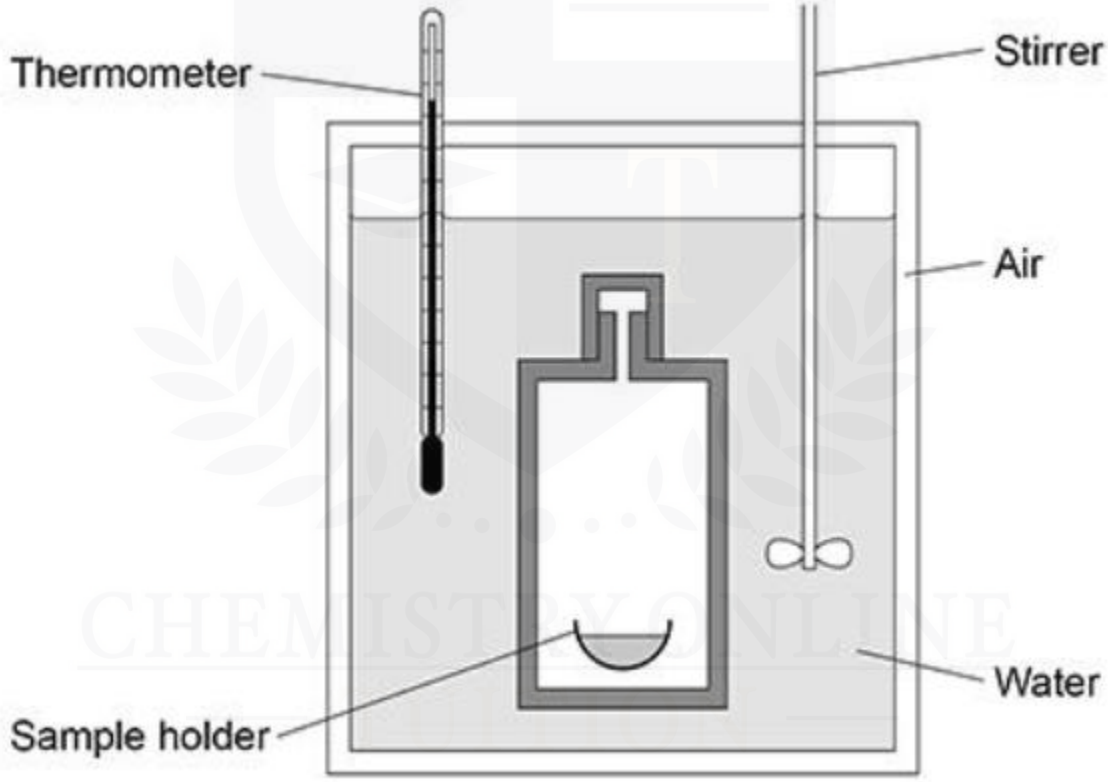
Display your work. **(2)**

(c) According to the scientists, mutant plants that produce higher amounts of chlorophyll b would develop more quickly than regular plants under all lighting conditions.

Describe how this recommendation is supported by the data. **(4)**

5.

One kind of calorimeter is depicted in the diagram below.



It is possible to ascertain the chemical energy store of biomass using a calorimeter. In a calorimeter, a known mass of biomass is burned completely. The temperature of the water in the calorimeter rises due to the heat energy

emitted during this combustion. It is noted when a known volume of water's temperature rises.

(a) Describe how two characteristics of the calorimeter depicted in the above diagram, in addition to the thermometer, would allow a reliable assessment of the total amount of heat energy released. **(2)**

(b) In a calorimeter, a 2 g sample of biomass was burned completely.

There were 100 cm^3 of water in the calorimeter.

The reported temperature increase was 15.7 °C.

For every cm3 of water, one °C of temperature gain requires 4.18 J of energy.

Determine the amount of heat energy released in kJ per gram of biomass using this information.

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Display your work. **(2)**

Biofuels are fuels produced by plants and algae. Chlorella has been employed by scientists to create biofuel. A genus of single-celled photosynthetic algae is called Chlorella.

Both fermenters and open ponds can be used to grow chlorella.

(c) The majority of light that falls on producers in natural ecosystems is not utilized for photosynthesis.

Give two explanations for this. **(2)**

(d) The light-dependent process makes advantage of the light that chlorophyll absorbs.

Identify the two light-dependent reaction products that are needed for the light-independent reaction. **(2)**

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