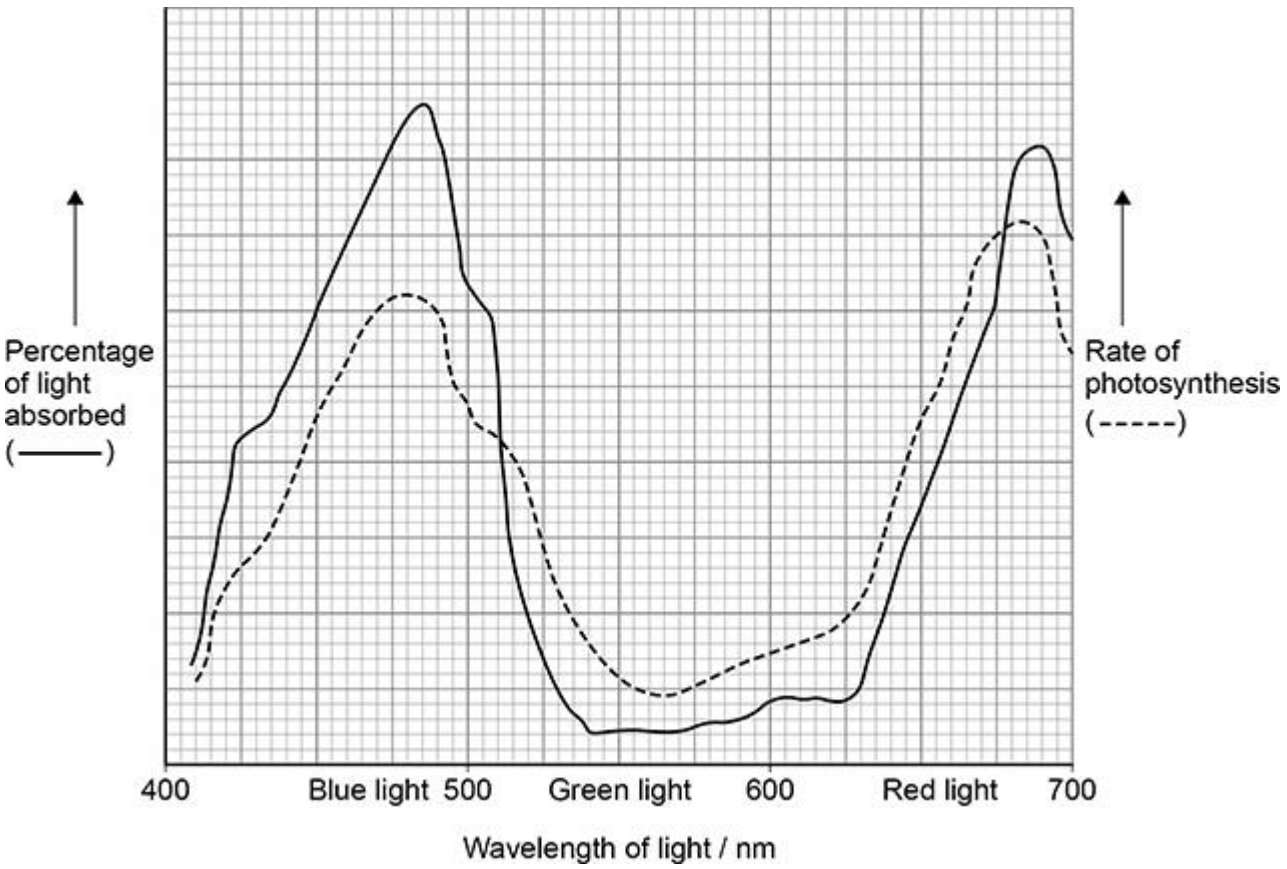
Q1.

(a) A biologist investigated photosynthesis. They:

- measured the percentage of light absorbed by a plant when it was exposed to different wavelengths
- measured the rate of photosynthesis at each wavelength of light.

The graph below shows the results they obtained.



Using the graph above, what can you conclude about the relationship between:

the percentage of light absorbed and the rate of photosynthesis _____

_____

_____

the colour of light and the rate of photosynthesis _____

_____

_____

(2)

(b) Give **three** environmental factors that should be controlled when measuring the rate of photosynthesis in this investigation.

Do **not** include features of the plant in your answer.

1 _____

_____

2 _____

_____

3 _____

_____

(2)

(c) Describe how the products of the light-dependent reaction are used in the light-independent reaction to produce triose phosphate.

Do **not** include the role of ribulose bisphosphate (RuBP) in your answer.

_____

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_____

(3)

(Total 7 marks)

Q2.

(a) A student used chromatography to separate the different photosynthetic pigments in a chlorophyll solution. She had the following materials.

Chromatography paper
A ruler and pencil
Suitable glassware
A solvent (solvent **A**)
2 cm^3 of the chlorophyll solution

Describe how she could use these materials to separate the photosynthetic pigments by chromatography.

(4)

(b) Using solvent **A**, the student separated five pigments. She then repeated her method using a different solvent, **B**. Using solvent **B**, she separated six pigments.

Explain the difference between these results.

(2)

(Total 6 marks)

Q3.

(a) In the following passage the numbered spaces can be filled with biological terms.

During photosynthesis, plants produce __(1)__ compounds which contain carbon, such as carbohydrates, lipids and proteins. Most of the sugars synthesised by plants are used by the plant in __(2)__. The rest are used to make other groups of biological molecules. These biological molecules form the biomass of the plants. Biomass can be measured in terms of mass of __(3)__ per given area per given time. The chemical energy store in dry biomass can be estimated using __(4)__.

Write the correct biological term beside each number below, that matches the space in the passage.

(1) _____

(2) _____

(3) _____

(4) _____

(2)

(b) Describe the **light-independent** reaction of photosynthesis.

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(6)

(Total 8 marks)

Q4.

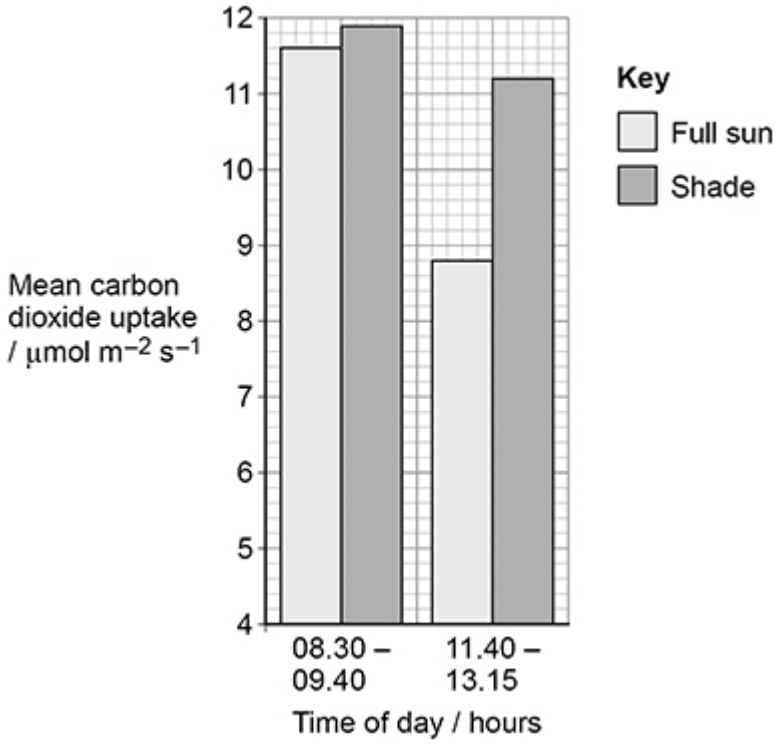
Scientists investigated the effect of full sun and shade on the rate of photosynthesis in a species of shade-tolerant tree.

To estimate the rate of photosynthesis, the scientists measured uptake of carbon dioxide by trees in a forest. They measured uptake of carbon dioxide during two parts of the day:

- 08.30 – 09.40 hours
- 11.40 – 13.15 hours.

Figure 1 shows the scientists' results.

Figure 1



(a) Calculate the total uptake of carbon dioxide between 11.40 and 13.15 hours in trees exposed to full sun in a forest that is 12 000 m^2 in area.

Give your answer in standard form. Show your working.

Answer _____ μmol

(3)

(b) **Figure 1** shows there is a small difference in the mean uptake of carbon dioxide between 08.30 and 09.40 hours by trees in full sun and by trees in the shade. When the scientists performed a statistical test on these data, they calculated P > 0.5

State what this P value tells you about this difference.

Explain your answer using the words **probability** and **chance**.

_____

_____

_____

_____

_____

_____

(2)

(c) In this species of tree, very high light intensities can inhibit the release of electrons from chlorophyll.

Suggest how this could explain the results shown in **Figure 1** for 11.40 to 13.15 hours.

(4)

Tomato plants grow best in high light intensities. To increase the yield of tomato plants, a farmer uses LED lightbulbs to provide additional light.

The increase in dry mass (D) produced when using additional light can be calculated using this equation.

$$D = \frac{L}{0.4F}$$

Where
L = light used in photosynthesis
F = GPP to NPP conversion factor for tomato plants

The table below shows some of these values for LED lightbulbs.

L / MJ m^{-2} h^{-1}	**F / MJ kg^{-1}**
2.87×10^{-2}	20

(d) Use the equation and the table to calculate the increase in dry mass produced when using LED lightbulbs.

Give your answer in standard form **and** give the units.

Answer _____ Units _____

(2)

(e) Mature leaves from slow-growing, shade-tolerant plants produce poisonous chemicals that are a defence against being eaten by herbivores.

Suggest how this benefits slow-growing, shade-tolerant plants.

_____

_____

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_____

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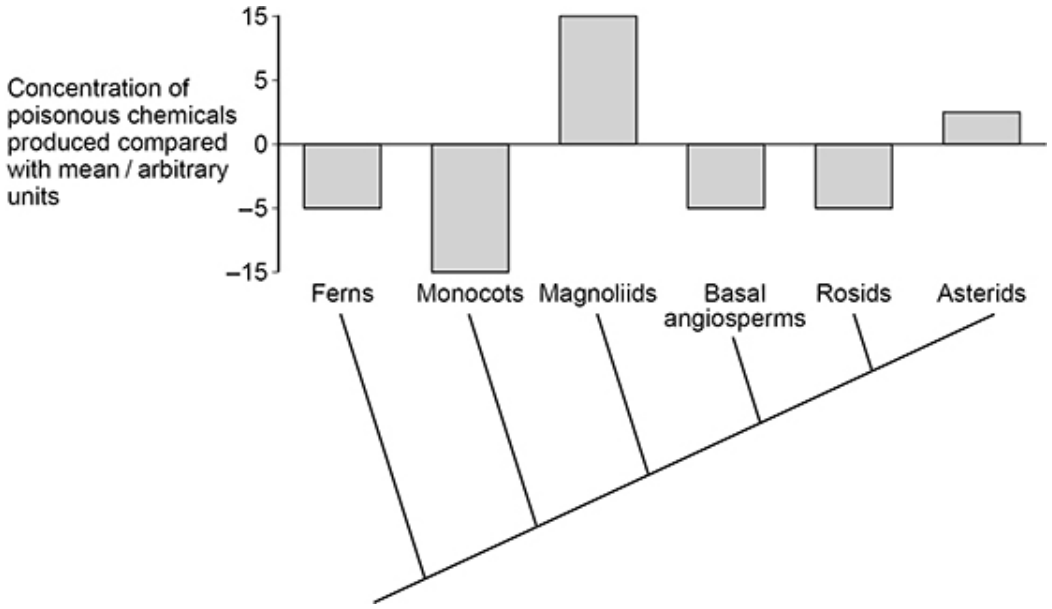
_____

(2)

Scientists measured the concentration of poisonous chemicals produced by shade-tolerant plant species in six taxa. They compared this with the mean concentration of poisonous chemicals produced by all plants and the phylogenetic relationships between the six taxa.

Figure 2 shows the scientists' results.

Figure 2



(f) A journalist published the following summary of these results.

'The more recently a shade-tolerant plant species evolved, the greater the concentration of poisonous chemicals it produces.'

Do the data in **Figure 2** support this summary? Justify your answer.

(2)

(Total 15 marks)