A Level Biology B

H422/02 Scientific literacy in biology

Question Set 9

1. (a) In 1908, American plant breeder George F. Freeman published a paper called 'A method for the quantitative determination of transpiration in plants'. Freeman was working on breeding drought- resistant varieties of alfalfa. He reasoned that individual plants with the lowest rates of transpirationwould show greatest drought resistance and should be used in selective breeding.

The rate of transpiration can be measured by using:

- a potometer with a shoot cut from the plant
- a whole plant growing in a pot, where water loss is calculated by measuring loss of mass.

Freeman investigated whether results obtained using a potometer were comparable with those obtained with whole plants. He measured the rate of transpiration in four types of plant by using either a potometer with cut shoots or whole plants growing in pots. The results are shown in Table 2.1.

Plant	Average rate of transpiration / mg cm^{-2} leaf hr^{-1}		Rate of transpiration in potometer as percentage of transpiration in pots (%)
	Pots	Potometer	
Daisy	7.21	1.44	20.0
Coleus	2.77	0.37	
Portulaca	1.72	0.47	
Geranium	0.65	0.65	100.0

Table 2.1

Complete Table 2.1 by calculating the missing percentages for Coleus and Portulaca.

Show your working. **[1]**

(b) (i) Temperature was controlled in this experiment. State **two** other variables that should be controlled to ensure valid results in this experiment.

[2]

(ii) Freeman made the following conclusions:

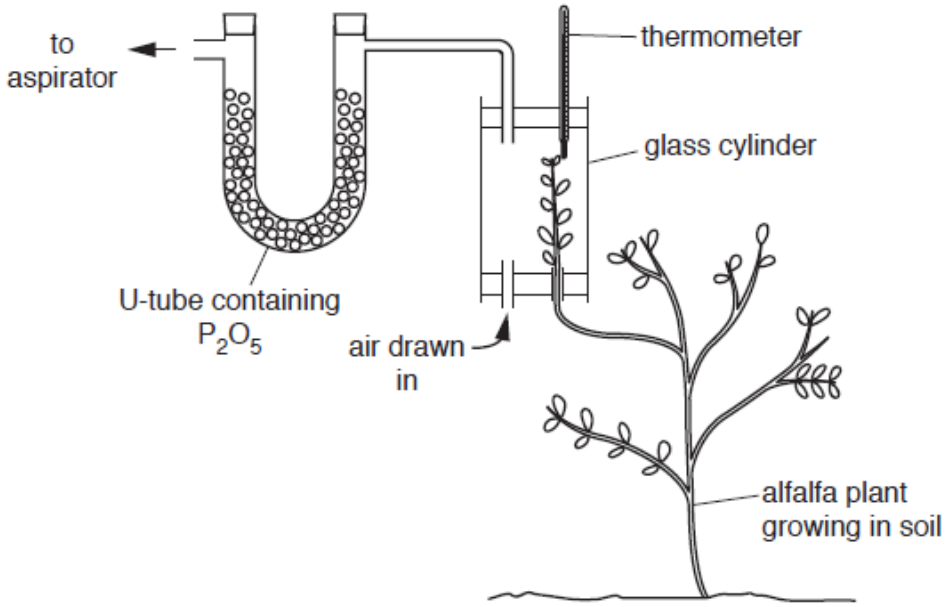
- There is a large difference between the rate of transpiration of a plant growing on its own roots ('normal' transpiration) and that of a cut shoot of the same plant placed in water.

- The difference is greatest in those plants having the highest rate of 'normal' transpiration.

Does the data in Table 2.1 support Freeman's conclusions? Give reasons for your answer.

[3]

(c) **(i)** Freeman then designed an experiment to allow him to measure the rate of transpiration in an alfalfa plant growing in soil in a greenhouse. Fig. 2 shows the apparatus he used.



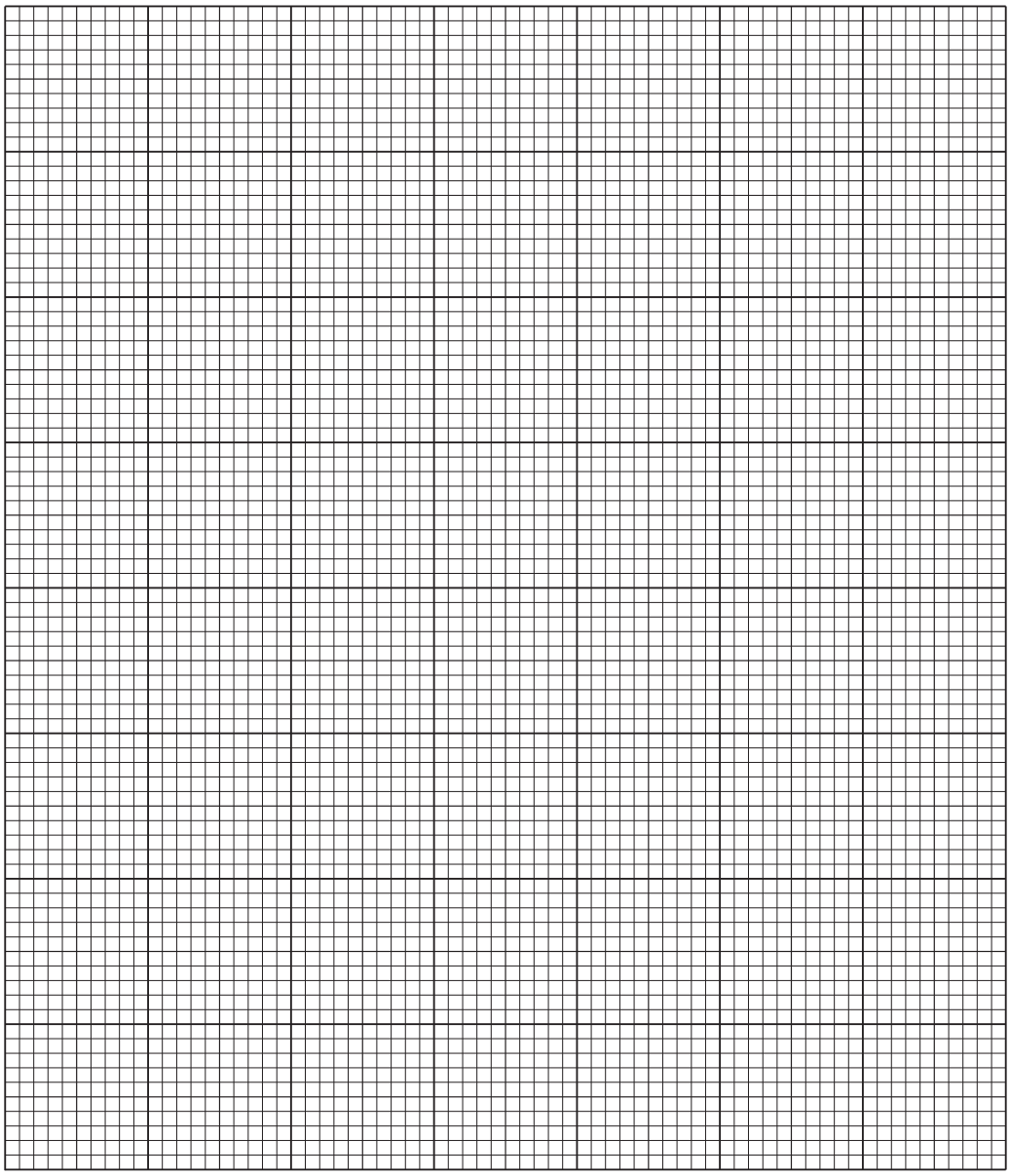
The aspirator created a steady flow of air into the cylinder past the stem of the alfalfa and through the U-tube. Phosphorous pentoxide (P_2O_5) absorbed any water in the air flowing through the U-tube. The mass of the U-tube was measured at ten minute intervals for one hour in order to calculate the rate of transpiration.

The results of one experiment are shown in Table 2.2.

Time (min)	Increase in mass of U-tube (mg)
0	0
10	65
20	120
30	184
40	255
50	309
60	379

Table 2.2

Plot a graph of the results in Table 2.2 on 2mm graph paper.



[3]

(ii) The total area of leaves inside the cylinder was 22.28 cm^2. Use this value and your graph to calculate the rate of transpiration.

Give your answer in standard form to **two** decimal places.

[3]

(d) (i) Freeman was working on developing drought-resistant varieties of alfalfa using selective breeding, but this has proved difficult.

Drought resistance depends on the ability to withstand several abiotic factors, such as high temperatures and high light intensity.

Use your knowledge of inheritance to suggest why it is difficult to study the genetic basis of drought resistance.

[2]

(ii) Alleles of the *miRNA 156* gene regulate a group of transcription factors in alfalfa. These transcription factors activate or inhibit promoters that control genes related to drought resistance.

Explain how the *miRNA 156* gene could be used to investigate the genetic basis of drought resistance.

[2]

(iii) Scientists have made a plasmid that produces more of the *miRNA 156* gene product than normal and want to use this to develop a drought-resistant alfalfa plant.

Explain how they could incorporate the plasmid into alfalfa cells.

[2]

Total Marks for Question Set 9: 18