

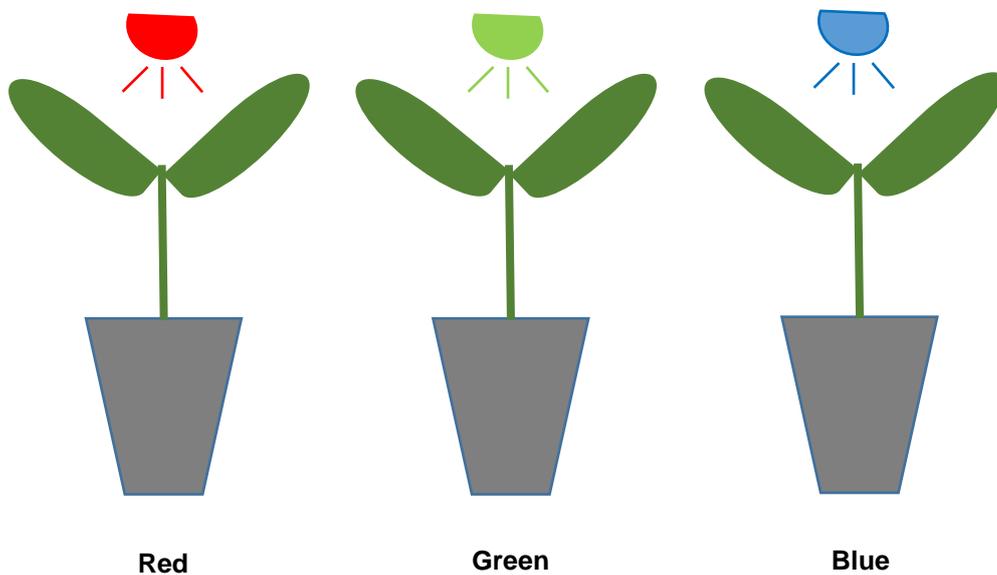
## UNIT 3 BIOLOGY

### SAMPLE QUESTION ON THE SCIENTIFIC PRINCIPLES OF PRACTICAL DESIGN

#### THE EFFECT OF LIGHT WAVELENGTH ON PLANT GROWTH

Beatrice and Bruce designed an experiment to test the effect of red, green and blue wavelengths of light on plant growth.

Three plants (*Macdonnellia majestica*) were grown in three separate containers; one under red, another under green, and the final plant under blue light.



- (a) Write a hypothesis for the above experiment. (1 mark)

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- (b) (i) What was the independent variable in this experiment? (1 mark)

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- (ii) What was the dependent variable? (1 mark)

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- (c) Name three variables that should have been held constant (controlled) in this experiment. Explain. (2 marks)

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- (d) Does this activity contain a control group? If not, explain what the ideal control group should be. (3 marks)

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Days After Planting	Plant Growth (mm)		
	Red	Green	Blue
4	4.7	4.0	4.9
8	8.2	6.2	9.3
12	12.4	6.7	14.0
16	16.9	7.0	20.1
20	23.7	7.1	30.5

- (e) (i) Is the data depicted above continuous or discontinuous in nature? (1 mark)

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- (ii) What type of graph(s) should be used to display this data? (1 mark)

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- (f) In graphing the outcome of this activity, what label would form the “y” axis? Explain. (2 marks)

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- (g) Assuming all relevant variables are controlled, apart from the lack of a control group, describe another clear fault in the design of the above experiment. (2 marks)

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The mass of soil used in each pot was determined prior to planting each *Macdonnellia* seed. Bruce weighed each soil sample simply after turning the electronic scale on. Beatrice, however, recalibrated the scales each time before reweighing the same soil samples. She observed that her values were consistently 0.45 grams higher than the readings obtained by Bruce.

- (h) (i) What type of experimental error was in evidence between Bruce and Beatrice’s results when soil mass was determined? (1 mark)

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- (ii) If Bruce and Beatrice reweighed each of their samples 10 times, would that reduce the effect of this error? Explain. (1 mark)

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Even when Beatrice recalibrated the scales and reweighed the same soil sample on 10 occasions, she discovered minor discrepancies in her values (+/- 0.015 grams)

- (i) (i) What type of error appears to be responsible for the fluctuation in the mass of her soil sample? (1 mark)

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- (ii) How could Beatrice reduce the effect of this type of error on her results? (1 mark)

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(j) How could the accuracy of Beatrice's soil mass measurements be improved? (1 mark)

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With insufficient care in his procedure, Bruce introduced personal error into his results creating a higher degree of fluctuation in his figures when compared with those of Beatrice.

(k) Outline two ways in which Bruce may have mishandled his procedure. (1 mark)

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## SOLUTIONS

- (a) If the plant is exposed to green light wavelengths, the rate of photosynthesis will be the slowest and hence there will be the least amount of plant growth.

**Note:**

There are multiple correct hypotheses for the experiment.

'If – then –' structure is preferable for hypothesis questions.

Green light is reflected, not absorbed by the chlorophyll, therefore, it will have the lowest rate of photosynthesis and therefore plant growth.

- (b) (i) Light wavelengths (red, green, blue light).  
(ii) Rate of photosynthesis and hence, plant growth.
- (c) **Temperature:** Impacts enzyme activity and the rate of reactions in photosynthesis.

**Soil type:** Different nutrients in the soil could have different impacts on plant growth.

**Amount of water:** Different amounts of water could impact plant growth independently of the light wavelength.

- (d) There is no control group. The ideal control group would be the same *Macdonellia majestica* plant grown in the absence of light (thus not exposed to the IV). This allows us to compare the effect of no light on plant growth and ensure that plant growth does not happen without exposure to light.

**Note:** Another possible control group could be a plant exposed to white light (all wavelengths).

- (e) (i) Continuous  
(ii) X-Y scatterplot (you could also add a line of best fit).
- (f) Plant growth in mm.

**Note:**

The dependent variable always forms the y-axis.  
Ensure you include units in your axis labels.

- (g) A different dependent variable should be chosen to better measure the effect of light wavelengths. Plant growth can be impacted by uncontrollable factors such as age. Plants may also grow laterally (sideways) rather than vertically, therefore plant growth is difficult to reliably measure.

- (h) (i) Systematic error
- (ii) No. Since Beatrice's values were consistently 0.45 g higher, re-weighing 10 times and averaging results would not make Bruce's value closer to Beatrice's.

**Note:** This would only work in the case of random error, where averaging results can reduce the effect of outliers.

- (i) (i) Random error
- (ii) Beatrice could take multiple measurements and then average her results. This would reduce the effect of outliers, so that Beatrice's measurement is closer to the true value.

- (j) There are multiple correct answers for this question such as:

Take more measurements and average out the results.

Ensure that no environmental factors are affecting the measurements (scales are clean, same environment).

- (k) There are multiple correct answers for this question such as:

Bruce may have put each soil sample in different containers which had different weights.

Bruce may have spilled some soil when transferring the samples into the pots, therefore decreasing the soil mass.