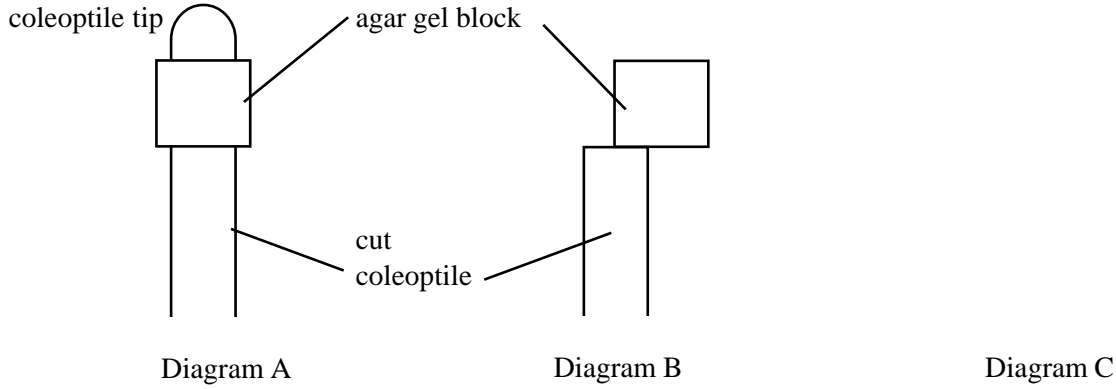


The statements in the table below refer to some effects of auxins and gibberellins in plants. If the statement is correct place a tick (✓) in the appropriate box and if it is incorrect place a cross (✗) in the appropriate box.

Effect	Auxins	Gibberellins
Promote cell enlargement		
Break bud dormancy		
Promote ripening of fruit		
Inhibit lateral growth		
Promote root formation in cuttings		
Promote fruit growth		
Stimulate stomatal opening		

A coleoptile grown in normal conditions had its tip cut off and replaced with an insert of agar as shown in diagram A. After a few hours the agar was removed and placed assymmetrically on another cut coleoptile as shown in diagram B. The shoots were kept in the dark during the experiment.



(a) (i) In the space above the heading Diagram C draw the coleoptile as you would expect it to appear 12 hours later.

[2]

(ii) Explain what is happening in the set up shown in diagram A.

.....  
.....

[2]

(iii) Explain what is happening in the set up shown in diagram B.

.....  
.....

[2]

(b) How does the plant growth substance involved in this experiment exert its effects?

.....  
.....  
.....

[2]

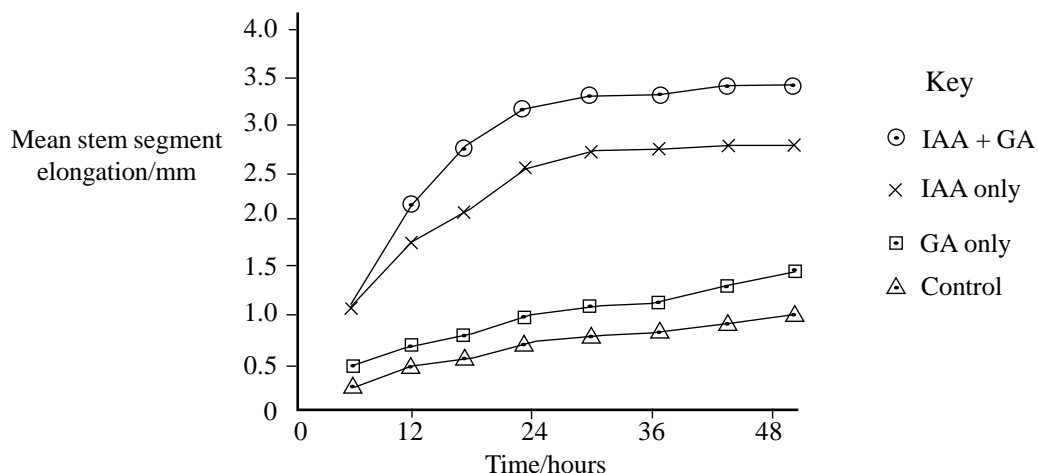
The table below indicates the sites of production and main effects of some plant growth substances. Complete the table by writing appropriate information in the empty boxes.

Name of growth substance	Site of production	One main effect
		Promotes leaf fall
Ethene		
		Promotes positive phototropic response
		Stimulates amylase synthesis in germinating seeds
		Stimulates rapid mitosis particularly in embryo

An experiment was performed to investigate the effects of auxin (IAA) and gibberellic acid (GA) on elongation of bean seedlings. Internode sections of the plant/stems were used and kept in identical conditions apart from the following treatments.

- The control batch received no growth substance
- One batch received IAA only
- One batch received GA only
- One batch received both IAA and GA

The graph below indicates the results that were obtained



(a) (i) Compare the effects of the three treatments on the elongation of the bean segments.

.....  
 .....  
 ..... [3]

(ii) With reference to the results of this investigation explain the meaning of the term 'synergism'.

.....  
 ..... [2]

(iii) Suggest a possible source of error in the experiment.

..... [1]

(b) Distinguish between the effects of auxins and cytokinins in regulating stem growth.

.....  
 ..... [2]

(c) State two commercial applications of gibberellins.

1: .....

2: .....

[2]

The table below lists some functions and commercial applications of plant growth substances. Complete the table by inserting the names of the relevant plant growth substances in the empty boxes.

You should select your answers from the following list:

auxins, gibberellins, cytokinins, abscisic acid, ethene

Function or application	Growth substance
Promotes fruit ripening	1.
Promotes cell division in apical meristem and cambium	2.
Promotes cell division in cambium only	3.
Promotes bud dormancy	4.
Promotes leaf fall	5.
Can induce parthenocarpy (seedless fruit production)	6.
Promotes growth of lateral buds	7.
Promotes apical dominance	8.
Promotes 'bolting' of rosette plants	9.
Acts synergistically with auxin	10.

The table below shows the effects of auxin at different concentrations on the growth of shoots and roots of oat seedlings. The elongation of the test seedlings was compared to the elongation of a group of control seedlings which did not receive auxin treatment. A positive value indicates that the test seedlings grew more than the controls and a negative value indicates that the test seedlings grew less than the controls.

Auxin concentration /parts per million	Elongation relative to control/mm	
	Shoot	Root
10 <sup>-6</sup>	0	+3
10 <sup>-5</sup>	0	+5
10 <sup>-4</sup>	+2	+11
10 <sup>-3</sup>	+6	+10
10 <sup>-2</sup>	+9	-3
10 <sup>-1</sup>	+34	-23
1	+60	-38
10	+33	-40
100	-22	-40

a) Plot these results in a suitable graphical form.

[5]

b) Compare the response of the shoots to auxin with the response of the roots.

.....

.....

.....

.....

.....

[4]

c) Synthetic auxins are used as weedkillers. Suggest how they operate selectively to kill broadleaved weeds such as plantains in a lawn.

.....

.....

.....

[3]

Synthetic auxins, such as 2,4-dichlorophenoxy acetic acid (2,4-D) have been used as weedkillers. This is useful because it is a selective herbicide which kills broad-leaved plants but not grasses.

Natural auxin (IAA) is actively transported into cells by a carrier protein molecule in the cell membrane and leaves the cells by facilitated diffusion through a different channel protein molecule. The importing protein will also work for 2,4-D. However the exporting protein cannot transfer 2,4-D back out of the cell.

(a) What are the effects of auxins on root and shoot growth?

.....  
.....  
.....  
.....

[3]

(b)(i) Suggest how application of 2,4-D could kill a plant.

.....  
.....  
.....  
.....

[3]

(ii) Suggest an explanation for the selective action of 2,4-D.

.....  
.....  
.....  
.....

[3]

(c) Explain how the structures of protein molecules enable channel proteins to be specific in the molecules which they allow through the membrane.

.....  
.....  
.....

[2]

QUESTIONSHEET 8

One of the pairs of characters that Mendel investigated as he worked out the rules of inheritance in pea plants was tall and short. It is now known that tall plants contain an allele, **Le**, which codes for an enzyme which stimulates the synthesis of gibberellic acid. This allele is dominant to the recessive allele, **le**, which does not enable the plant to make the enzyme which stimulates the synthesis of gibberellic acid. Plants with the genotypes **LeLe** and **Lele** have tall phenotypes, while plants with the genotype **lele** have short phenotypes. Other growth substances, such as auxin and cytokinin may be involved in plant growth.

(a) (i) With reference to the plant growth substances involved explain how growth is controlled in the short plants.

.....  
.....  
.....  
.....

[3]

(ii) Explain the greater growth found in the tall plants.

.....  
.....

[2]

(b) Even though tallness and shortness in pea plants are regulated by a single pair of alleles, considerable variation in height can occur. Why is this so?

.....  
.....

[2]

(c) (i) If synthetic gibberellic acid is applied to short plants they will grow into tall plants, but the number of side branches will not increase. Why is this so?

.....  
.....

[2]

(ii) How could you induce the pea plants to produce more lateral branches and so become more bushy?

.....  
.....

[1]



(a) (i) State three differences between plant growth substances and animal hormones.

1: .....

2: .....

3: ..... [3]

(ii) Explain why unripe tomatoes ripen more quickly if placed around ripe bananas?

.....

..... [2]

(b) Plant growth substances may interact together in a synergistic way or an antagonistic way.

(i) Explain the meaning of synergistic and give an example.

Explanation: .....

.....

Example: ..... [2]

(ii) Explain the meaning of antagonistic and give an example.

Explanation: .....

.....

Example: ..... [2]

(c) (i) What is 'apical dominance'?

..... [1]

(ii) What are the effects of plant growth substances on apical dominance?

.....

..... [2]

QUESTIONSHEET 10

Distinguish between each of the following pairs, giving examples if relevant.

(a) Positive phototropism and positive phototaxis.

.....  
.....  
.....  
.....

[4]

(b) Etiolation and abscission.

.....  
.....  
.....  
.....

[4]

(c) Long day plants and short day plants.

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.....  
.....  
.....

[4]

(d) Phytochrome and parthenocarpy.

.....  
.....  
.....  
.....

[4]

QUESTIONSHEET 11

Read through the following passage about auxins and then complete it by filling in the spaces with the most appropriate word or words.

Auxins, such as ....., are the most abundant plant growth substances. They are concerned with ..... growth due to cell ..... and differentiation. They also cause ..... to external stimuli, such as ..... and ..... . They also promote the growth of ..... roots from stems, suppress the development of ..... buds and initiate ..... development, even if pollination has not occurred ( a process known as .....). Auxin is produced in the ..... of stems and ..... down to the target region.

QUESTIONSHEET 12

Flowering in flowering plants is regulated by photoperiodism, which is the relative lengths of daylight to darkness. Plants may be long day plants, short day plants or neutral to the effects of the daylength. There is a plant pigment that exists in two forms, P<sub>660</sub> and P<sub>730</sub>. P<sub>660</sub> has a maximum light absorption around 660 nm (red light) and P<sub>730</sub> has a maximum light absorption around 730nm (far red light).

- Red light is absorbed by P<sub>660</sub> which converts it to P<sub>730</sub>.
- Far red light is absorbed by P<sub>730</sub> which converts it to P<sub>660</sub>.
- P<sub>730</sub> in the dark slowly converts to P<sub>660</sub> and it is this slow conversion that is the 'clock' by which the plant measures night length.

Flowering in long day plants is stimulated only if the level of P<sub>730</sub> stays above a critical value. Flowering in short day plants is stimulated only if the level of P<sub>730</sub> drops below a critical value.

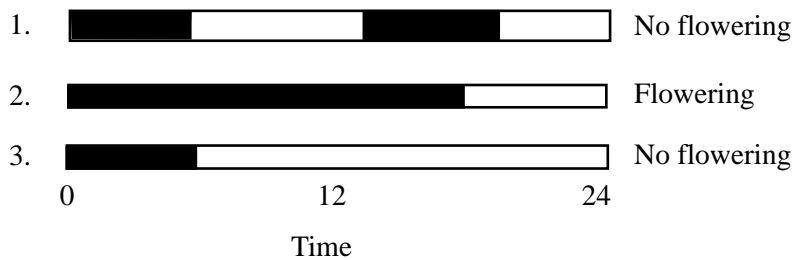
(a) (i) Name the plant pigment which occurs in the forms P<sub>660</sub> and P<sub>730</sub>.

..... [1]

(ii) Draw a simple flow chart to illustrate the interconversion between P<sub>660</sub> and P<sub>730</sub>.

[2]

(b) A number of Poinsettia plants were subjected to three different patterns of illumination (blank spaces) and darkness (black spaces). The following results were obtained.



Using the information above, deduce whether Poinsettias are long day plants, short day plants or day neutral plants. Explain your answer.

..... [2]

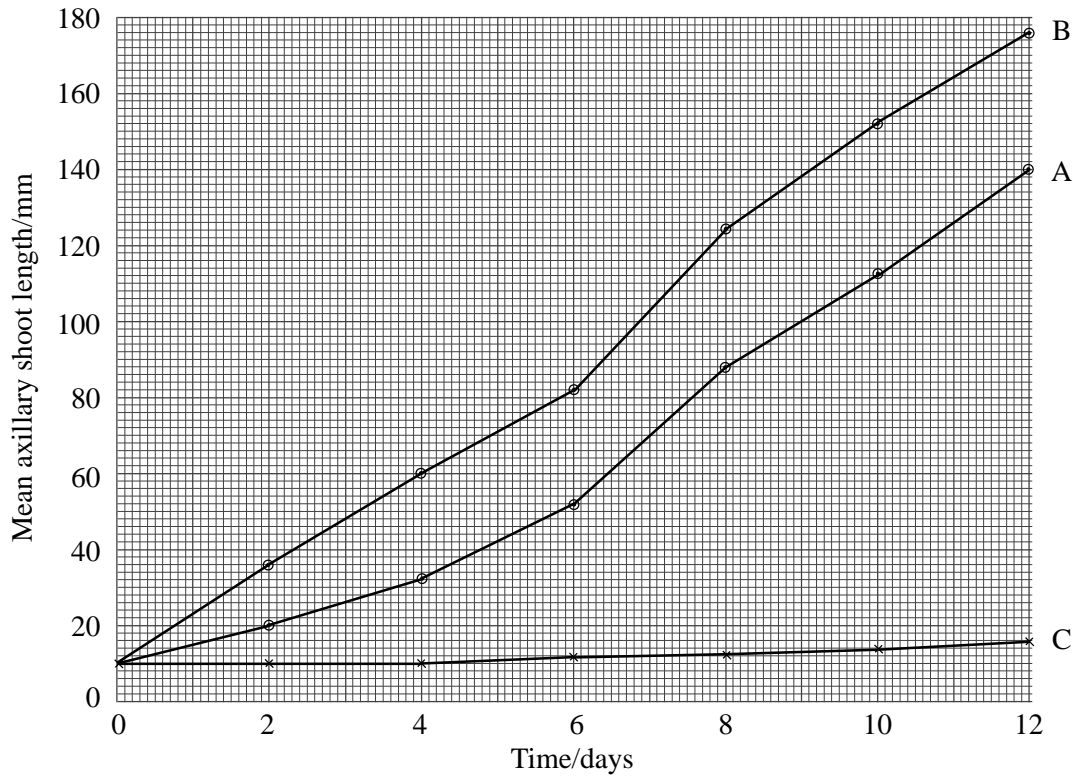
(c) Cucumber plants show no relationship between daylength and flowering. Suggest two factors which could trigger flowering in cucumbers.

1: ..... 2: ..... [2]

QUESTIONSHEET 13

An experiment was performed to investigate the growth of lateral (axillary) shoots in bean plants. Three sets of bean plants were treated in three different ways.  
 A - apical buds removed.  
 B - apical buds removed and cytokinin placed on the cut stumps.  
 C - plants left intact.

The total length of the lateral shoots of all the plants in each group was measured and the mean lengths calculated. The results are shown in the graph below.



(a) (i) Explain the results seen in group C.

.....

.....

.....

[3]

(ii) Explain the results seen in group A.

.....

.....

.....

[3]

(iii) Explain the results seen in group B.

.....

.....

.....

[3]

(b) A fourth group of seedlings had their apical buds removed and auxin placed on the cut stumps.

(i) What do you think the response of the bean plants would be?

..... [1]

(ii) What does this indicate about the role of the apical bud in controlling lateral growth?

.....  
..... [2]

(c) Suggest two precautions that should be taken when carrying out this experiment.

1: .....

2: ..... [2]

(d) How would you prune a plant to obtain,

(i) growth in height?

..... [1]

(ii) bushy growth?

..... [1]

The plant growth substance abscisic acid is involved in the overwintering of plants and the survival of plants during unfavourable conditions.

State five actions of abscisic acid which help plants to survive unfavourable conditions. In each case say how the plant is helped in its struggle for survival.

1: .....  
..... [2]

2: .....  
..... [2]

3: .....  
..... [2]

4: .....  
..... [2]

5: .....  
..... [2]

Describe the roles of plant growth substances in regulating the following processes:

(a) germination.

.....  
.....  
.....  
.....  
.....

[5]

(b) fruit growth.

.....  
.....  
.....  
.....  
.....

[5]

(c) leaf fall.

.....  
.....  
.....  
.....  
.....

[5]



Suggest explanations for the following observations:

- (i) Fruit growers apply small amounts of synthetic growth substances to apple orchards.

.....  
.....  
[2]

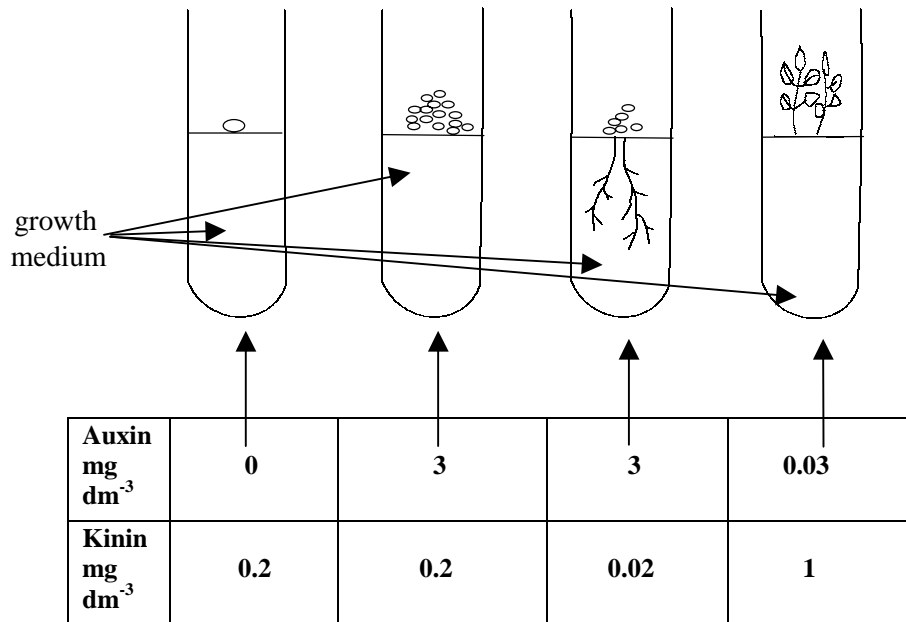
- (ii) The addition of gibberellic acid to embryo-less barley seeds stimulates amylase production.

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.....  
[3]

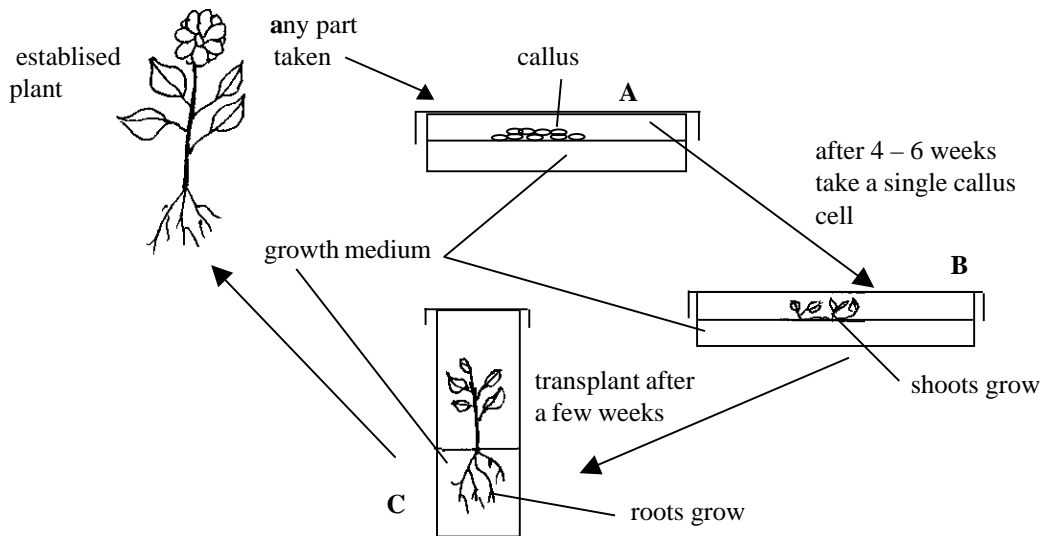
- (iii) If the leading shoot of a Christmas tree (Norway spruce) is removed, within eight hours previously dormant axillary buds just below the tip begin growing.

.....  
.....  
.....  
[3]

The data below indicates the effects of different levels of auxins and kinins on the morphogenesis of unidentified plant tissue into callus, shoots or roots;



The diagram below shows the steps involved in culturing a new plant from an explant of an established plant.



(a) (i) What do you understand by the term ‘explant’?

.....  
 ..... [2]

(ii) What is a callus?

.....  
 ..... [2]

(iii) When culturing plants in this way it is important to operate an aseptic technique throughout. Suggest why.

.....  
..... [2]

(iv) The growth medium contains agar as a setting agent. Suggest four other sorts of substance which it must contain.

1: ..... 2: .....  
3: ..... 4: ..... [4]

(v) Suggest two abiotic factors which should be provided during this technique.

1: ..... 2: ..... [2]

(b) (i) The composition of the growth medium in A, B and C must be modified to initiate the stage of development required. State the modifications in the three media.

A. ....  
.....  
B. ....  
.....  
C. ....  
..... [6]

(ii) Suggest why more than one plant growth substance is used in this method.

.....  
.....  
..... [2]

Describe experiments which you could perform to demonstrate that:

(a) it is the tip of a stem that senses the unidirectional light in a positive phototropic response.

.....  
.....  
.....  
.....  
..... [4]

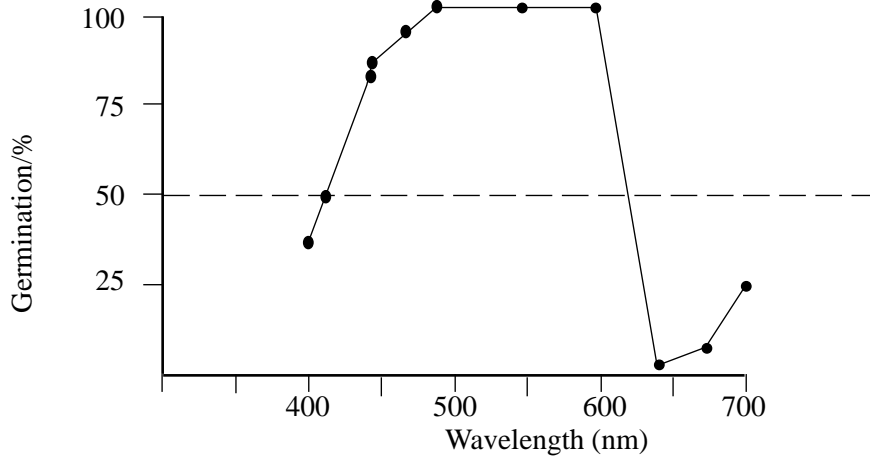
(b) auxin travels down from the stem tip on the dark side of the stem when illuminated with unilateral light.

.....  
.....  
.....  
.....  
..... [4]

(c) exposure to some dilute salicylate(asprin) concentrations will increase the time cut flowers will last. (salicylates have recently been recognised as growth regulators in plants).

.....  
.....  
.....  
.....  
..... [4]

Grand Rapids lettuce seeds are photoblastic i.e. they will not germinate unless they are exposed to light (irradiated). Scientists investigated which parts of the electromagnetic spectrum had greatest effect on germination. Trays of seeds were exposed to different wavelengths of light for an equal length of time and the resulting seed germination was recorded. Germination of 50% was regarded as a control figure. The results of the investigation are shown on the graph below.



(a) From the graph identify the range of wavelengths which appeared to have:

(i) a greater than average stimulatory effect.

..... [1]

(ii) an inhibitory effect

..... [2]

The scientists then investigated the effect of supplying a new batch of seeds with stimulatory red light (R) and then inhibitory far red (FR) wavelengths in succession. The results of the investigation are shown in the table.

Exposure	Germination (%)
R	98
R + FR	46
R + FR + R	100
R + FR + R + FR	51
R + FR + R + FR + R	98

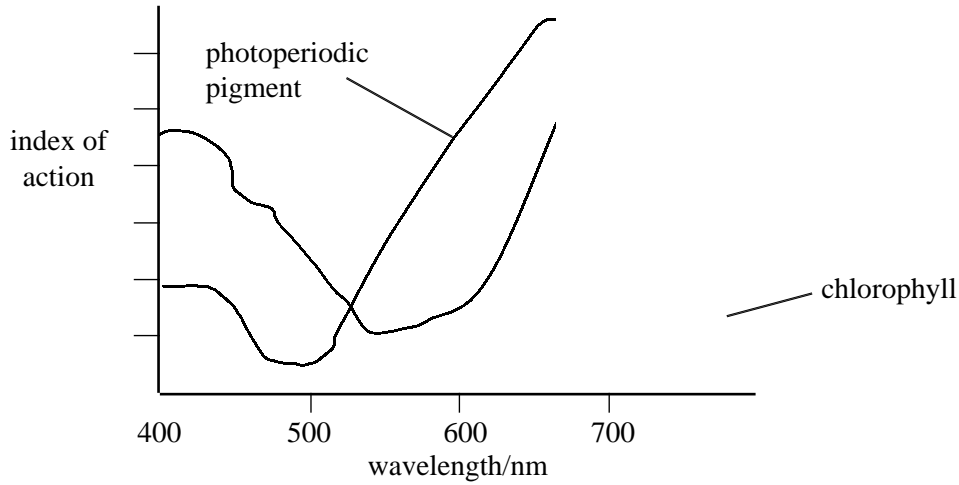
(b) What can you conclude from this investigation?

..... [1]

(c) Outline the significance of the observation that, in some plants the photoperiodic stimulus cannot be detected until the plant has been exposed to a period of very low temperature.

.....  
 .....  
 ..... [2]

The graph shows the action spectra for chlorophyll and for the pigment which is thought to be responsible for the photoperiodic control of flowering.



(a) Define the term action spectrum.

.....  
.....  
.....

[2]

(b) What can be deduced from the data about the nature of the photoperiod pigment.

.....  
.....  
.....

[2]

(c) Investigations have shown that the same photoperiodic action spectrum is obtained for both short - day and long - day plants. What can be deduced from this observation?

.....  
.....

[2]