No.	Mark Scheme	Score
1(a)	Able to record all four readings correctly. <table><tr><td>Temperature (°C)</td><td>Total surface area of Bacillus substilis (cm²)</td></tr><tr><td>0</td><td>2</td></tr><tr><td>28</td><td>11</td></tr><tr><td>37</td><td>26</td></tr><tr><td>60</td><td>1</td></tr></table>	3
	Able to list 3 reading correctly	2
	Able to list 1 - 2 correctly	1
	No response or incorrect response	0
1(b)(i)	Able to state two different observations correctly Sample answers: 1. In temperature 0 °C , the total surface area of *Bacillus substilis* is 2 cm² 2. In temperature 28 °C, the tota surface area of *Bacillus substilis* is 11 cm² 3. In temperature 37 °C, the total surface area of *Bacllus substilis* is 26 cm² 4. In temperature 60 °C, the total surface area of *Bacillus substilis* is 1 cm²	3
	Able to state one observation correctly and one-two inaccurate observation Sample answers: 1. In temperature 0 °C, the total surface area of *Bacillus substilis* is small 2. In temperature 37 °C, the total surface area of *Bacillus substilis* is large	2
	Able to state the observations at idea level Sampel answer: 1. In low / high temperature, the total surface area of *Bacillus substilis* is small	1
	No response or incorrect response	0
1(b)(ii)	Able to make two inferences correctly 1. At low / high temperature, the total surface area of *Bacillus substilis* is small because the growth rate is low 2. At optimum temperature (37°C), the total surface area of *Bacillus substilis* is large because the growth rate is maximum	3
	Able to make one inferences correctly and one-two inaccurate inference 1. At low / high temperature, the total surface area of *Bacillus substilis* is small 2. At optimum temperature, the total surface area of *Bacillus substilis* is large	2
	Able to make one correct inferences correctly and one-two inference at ide level. 1. Total surface area of *Bacillus substilis* is small / large	1
	No response or incorrect response	0
1(c)	Able to state all variables and the methods to handle the variables correctly (6 correct) Sample answer <table><tr><td>Variable</td><td>Method to handle the variable</td></tr><tr><td>Manipulated variable Temperature</td><td>Use different temperatures from 0°C , 28°C, 37°C and 60 °C.</td></tr><tr><td>Responding variable</td><td>Count and record the total surface</td></tr></table>	3

2

	The total of surface area of Bacillus substilis	area of *Bacillus substilis* by using grid	
	The growth rate of Bacillus substilis	Calculate the growth rate of Bacillus substilis by using formula = $\frac{\text{The total surface area (cm}^2\text{)}}{2(\text{ days })}$	
	Constant variable The volume of Bacillus substilis	Fix the volume of *Bacillus susbtilis* at 2 ml	

	Able to state 4-5 variables and the method to handle the variable correctly	2
	Able to state 1-3 variables and the method to handle the variable correctly	1
	No response or incorrect response	0
1(d)	Able to state hypothesis correctly following all criteria: P1: Manipulated variable P2: Responding variables H: Relationship Sample answer: The optimum temperature for the growth rate *of Bacillus substilis* is 37°C	3
	Able to make hypothesis relating the manipulated variable and the responding variable inaccurately Sample answer: The growth rate of *Bacillus substilis* is influenced by temperature	2
	Able to make a hypothesis at idea level Sample answer: The growth rate of Bacillus substilis is maximum	1
	No response or incorrect response	0
1(e)(i)	Able to construct a table and record all the data correctly Sample answer:	3

Temperatures ^{o}C	The total surface area of *Bacillus susbtilis* (cm^2)	Growth rate of *Bacillus substilis* =$\frac{\text{Total surface area}}{2 \text{ days}}$ (cm^2/day)
0	2	1
28	11	5.5
37	26	13
60	1	0.5

Note:
(T) : Able to state the titles and unit correctly
(D) : Able to record all the data correctly
(C) : Able to calculate and record the rate of growth correctly

	Any two correct	2
	Any one correct	1
	No response or incorrect response	0

3

1(e)(ii)	Able to draw graph with all criteria correctly P- Uniform scales on both axes with unit T- Able to plot 4 points correctly B- Able to draw graph smoothly	3
	Any two criteria correct	2
	Any one criteria correct	1
	No response or incorrect response	0
1(f)	Able to explain the relationship between E1 : Relationship. E2 : Explain E3 : Reason Sample answer: The growth rate of the *Bacillus substilis* is maximum at optimum temperature / $37^{o}C$ (E2) because (at optimum temperature) the enzyme activity is maximum(E3) .At temperature more than $40^{o}C$ the enzyme becomes denatured(E3). The growth rate of *Bacillus substilis* is influenced by the temperature(E1)	3
	Able to interpret the relationship inaccurate (Any two E correct)	2
	Able to interpret the relationship at idea level (Any one E correct)	1
	No response or incorrect response	0
1(g)	Able to state the operational definition for growth rate P1:The growth rate is a process where the *Bacillus substilis* forms a colony on the medium agar in 2 days P2: The total surface area of the colony is measured by using the grid P3: The growth rate of *Bacillus substilis* is influenced by the temperature. Sample Answer : The growth rate is a process where the *Bacillus substilis* forms a colony on medium agar in 2 days which can be measured by the total surface area (of the colony) by using a grid. The growth rate is influenced by the temperature.	3
	Any two P correct	2
	Any one P correct	1
	No response or incorrect response	0
1(h)	Able to predict the growth rate of *Bacillus substilis* under acidic pH medium P1: Correct prediction P2: Reason P3: Effect Sample answer: P1: The growth rate of *Bacillus substilis* decreases/ less than $13cm^2$/day /total surface area is less than $26 cm^2$ P2: intolerate/ not suitable grow in acidic medium P3: grow maximum in neutral medium .	3
	Any two P correct	2
	Any one P correct	1
	No response or incorrect response	0

4

1(i)	Able to list all materials and apparatus in Table 3 correctly)	3

Material Bahan	Apparatus Alat
Nutrient agar *Bacillus substilis*	Petri dish Oven Measuring cylinder Specimen tube

	Able to list 4-5 correct	2
	Able to list 2-3 correct	1

5

The Growth Rate of *Bacillus substilis* (cm/day)
Kadar Pertumbuhan *Bacillus substilis* (cm/hari)
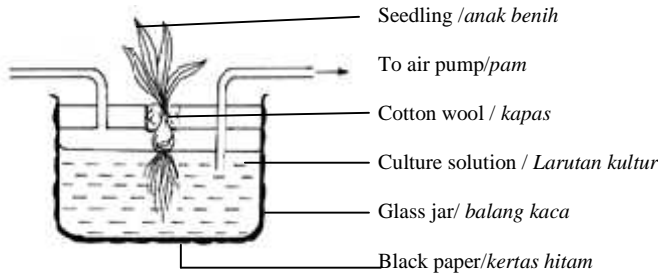
Temperature
Suhu (oC)
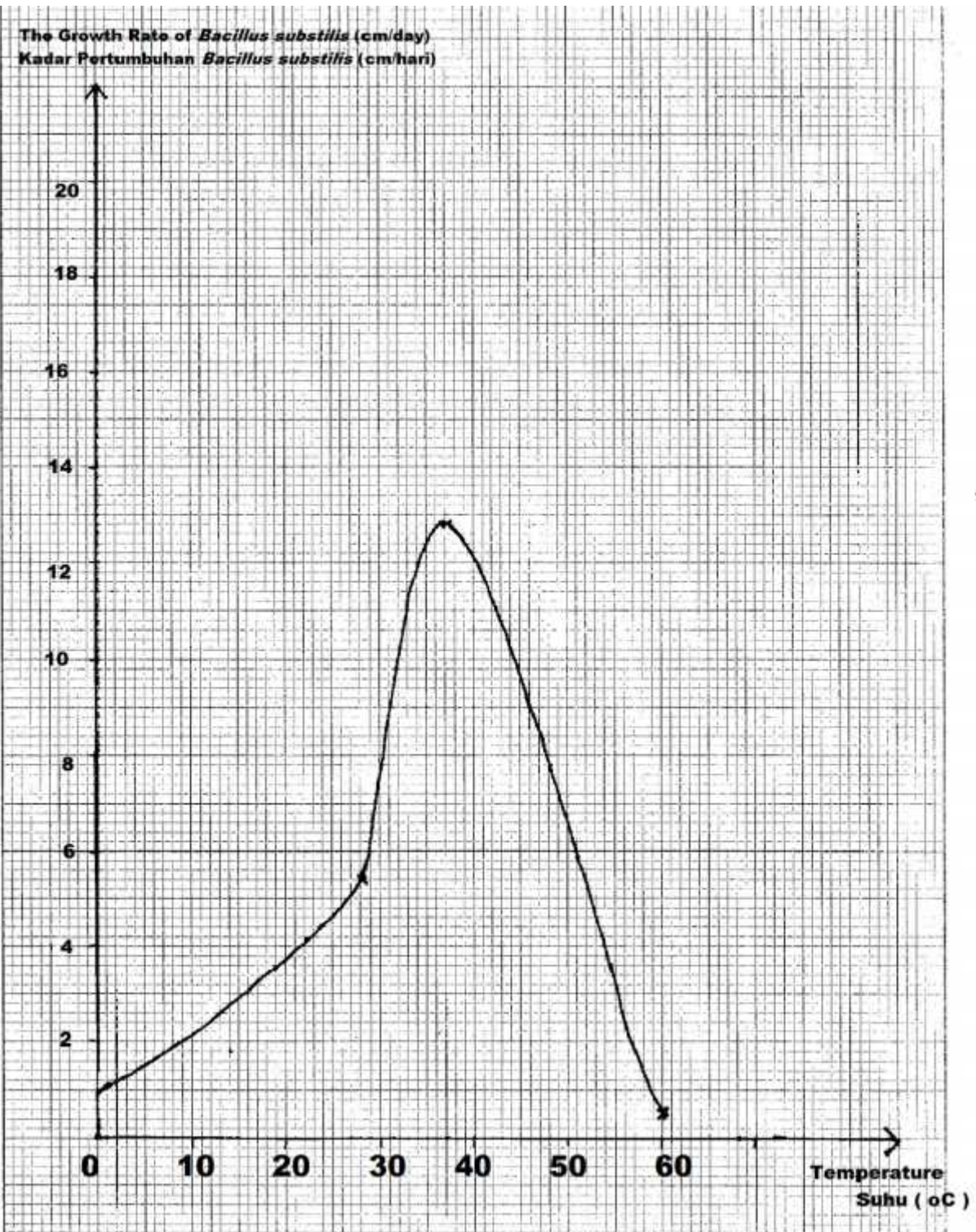
Question 2

	Explanation	Score
01	**Able to state problem statement by relating P1, P2 and P3 in a question form correctly.**	3
	P1- manipulated variable	P1+P2+P3
	The deficiencies of nitrogen in culture solution/types of culture solution	
	P2-responding variable	
	The height of seedling/growth rate of seedling	
	P3-question form (What …?)	
	Sample answer:	
	1. What is the effect of nitrogen deficiencies in culture solution (P1) on the height / the growth rate of seedling (P2)? (P3)	
	2. How does the deficiencies of nitrogen in culture solution (P1) affects the height / the growth rate of seedling (P2) **?** (P3)	
	Able to state problem statement inaccurately	2
	Sample answer:	P1+P2/
	1. What is the effect of deficiencies of nitrogen in culture solution on plants ? (P1+P3)	P1+P3/ P2+P3
	2. The height / growth rate of seedling is affected by the deficiencies of nitrogen in culture solution (no P3)	
	Able to state the idea	1
	Sample answer :	P1/P2/P3
	1. The deficiencies of nitrogen in culture solution affects the plants (no P2 + P3)	
	No response or wrong response	0

	Explanation	Score
02	**Able to state the hypothesis by relating two variables correctly (P1+P2+H)**	3 P1+P2+H
	P1- manipulated variable	
	The deficiencies of nitrogen in culture solution/ the types of culture solution	
	P2-responding variable	
	The height of seedling/ the growth rate of seedling	
	H-relationship	
	Sample answer:	
	1. The height / growth rate of seedling (P2) is lower / slower (H) in nitrogen deficiencies of culture solution.(P1)	
	2. In complete culture solution (P1), the higher/ slower (H) , the height / the growth rate of seedling (P2)	
	3. The height / the growth rate of seedling (P2) is higher (H) in complete Knop's solution (P1)	
	4. In complete Knop's solution (P1), the height of seedling / the growth rate (P2) is higher (H)	
	Able to state any two criteria correctly or inaccurate hypothesis	2
	Sample answer:	P1+P2/
	1. The deficiencies of culture solution (P1) affect the height /growth	P1+H/

rate of seedling (P2). (no H) 2. The height of seedling is higher (no P1)	P2+H
Able to draw the idea of hypothesis *Sample answer*: 1. The deficiencies of nitrogen in culture solution affect the plants (noP2+H)	1 P1/P2/H
No response or wrong response	0

KB061204	Explanation	Score
04	**Able to state K1, K2, K3, K4 and K5 (5K) correctly** **K1**: The set up of apparatus (S1/ S2/S3/S4/S5/S6/S7/S8) (any 3) **K2**: How to manipulate the variable (S2/S3/S4 /S11) **K3**: How to operate the responding variable (S10/S12) (any 1) **K4**: How to fix the constant variable(S5/S6/S10) (any 1) **K5**: Precautions (S5/S6/S7/S8/S9) S1- Three glass jars labelled A, B and C are prepared S2- In glass jar A, distilled water is fulfilled which serves as a control experiment. S3- In glass jar B, a complete culture solution is prepared using the composition of the Knop's solution as a guide. S4- In glass jar C , a culture solution deficient in nitrogen is prepared by replacing calcium nitrate with calcium chloride and potassium nitrate is replaced by potassium chloride. . S5- Each jar is wrapped with black paper to prevent light from penetrating into the culture solution which will cause the growth of green algae. S6-Three maize seedlings of the same height are chosen and put into each jars. S7- Keep the roots of seedlings are fully immersed in each solutions. The culture solution is aerated using an air pump to ensure the root of the seedling obtain enough oxygen for respiration. S8- All set of apparatus are exposed to light so the seedling are able to carry put photosynthesis S9- The culture solution in each jar is replaced every week to ensure that the nutrients which are supposed to be available are not depleted. S10- After one month , seedling in jar A is taken out and the height of seedling is measured by using a ruler . The growth rate of the seedling is calculated and is recorded in a table . (Any abnormal	3 **K1+K2+ K3+ K4+K5 (5K)**

	characteristics are not to be observed.) S11- Step S10 is repeated with seedling in glass jar B and glass jar C are observed . S12- Record the result in a table and plot a bar chart showing the growth rate of seedlings (cm/day) against the types of solution.	
	Able to state any 3K – 4K correctly	2
	Able to state any 1K – 2K correctly	1
	Wrong response or no response	0

KB061205	Explanation	Score

05	**Able to list all materials and apparatus correctly to make a functional experiment and able to get the data**
	MATERIALS (M)
	    Tomato seedling/ maize seedling,
	    Calcium nitrate
	    Potasium nitrate
	    Potassium dihydrogen phosphate
	    Magnesium sulphate
	    Iron (III) phosphate(trace)
	    Calcium chloride
	    Potasium chloride
	    Distilled water
	    Cotton wool
	    Black paper
	
	Notes:
	Accept if written as Knop's Solution ( ) only.
	If solutions are listed, reject if list out are incomplete
	
	APPARATUS (A)
	    Glass jar
	    Glass tubing
	    L – shaped delivery tubes
	    Air pump
	    Rubber bung
	    Ruler
	
	Notes :
	
		Score	Material (M)	Apparatus (A)

3	7M	6A
2	5M	3A
	3M	2A
1	2M	1A
	1M	1A		3
	Able to list any 5 materials and any 3 apparatus related to the experiment (5M + 3A / 3M + 2A)	2
	Able to list any 2 material and any 1 apparatus related to the experiment (2M + 1A / 1M + 1A)	1
	Wrong response or no response	0

	Explanation	Score
	Able to construct a table to record data with the following aspects - Titles - Data is not required <table><tr><td>Glass Jar</td><td>Types of solution</td><td colspan="2">The height of seedling /(cm)</td><td>The growth rate of seedling / (cm/day)</td></tr><tr><td></td><td></td><td>Initial height</td><td>Final height</td><td></td></tr><tr><td>A</td><td>Distilled water</td><td></td><td></td><td></td></tr><tr><td>B</td><td>Complete Knop's Solution</td><td></td><td></td><td></td></tr><tr><td>C</td><td>Nitrogen Deficient in culture solution</td><td></td><td></td><td></td></tr></table>	**B2 = 1 mark**

Construct	Explanation	Score
	Able to state the correct technique with the following aspects Sample answer **Measure t**he height of seedling from the tip of the shoot to the root by using ruler **OR** **Calculate** the growth rate of seedling by using formula : The growth rate of seedlings= $\dfrac{\text{The height of seedling (cm)}}{\text{Time taken (days)}}$	**B1 = 1 mark**

		Explanation	Score

03		**Able to state 7-9 aspects of experimental planning correctly** :
		     Statement of problem
		     Objective
		     Hypothesis
		     Variables (The three variables are correct)
		     List of materials and apparatus
		     Technique used
		     Procedure
		     Presentation of data
		     Conclusion
		
		 Note:
		 7-9 - 3 marks
		 4-6 - 2 marks
		 1-3 - 1 mark
			3

		Able to state any 4 - 6 items/aspects in the experimental planning correctly	2

Able to state any 1 - 3 items correctly	1
Wrong response or no response Example: The report is in the form of explanation without planning item	0

Sample Answer :

Problem Statement

01=3

What is the effect of nitrogen deficiencies in culture solution on the height /growth rate of seedling ?

Aim of experiment

To study the effect of nitrogen deficiencies in culture solution on the height/ growth rate of seedling

Hypothesis

02=3

The height / growth rate of seedling is lower / slower   in nitrogen deficiencies of culture solution.

Variables

Manipulated variable : The types of culture solution
Responding variable : The height of seedling/ growth rate of seedling
Constant variable : The initial height of seedling / the type of seedling

Materials
Tomato seedling/ maize seedling, **calcium nitrate*, potassium nitrate*, potassium dihydrogen phosphate*, magnesium sulphate*, iron (III) phosphate***, calcium chloride, potassium chloride,distilled water, cotton wool, black paper

Notes: accept 5 * if it is written as Knop's solution .

Apparatus
Glass jar , Glass tubing , L – shaped delivery tubes, Air pump, Rubber bung , Ruler

Techniques

B1=1

Measure the height of seedling from the tip of the shoot to the root by using ruler
OR
Calculate the growth rate of seedling by using formula :
    The growth rate of seedlings=   The height of seedling (cm)
                                                      Time taken   (days)

Procedure
 1. Three glass jars labelled A, B and C are prepared
 2. In glass jar A, distilled water is fulfilled which serves as a control experiment.
 3. In glass jar B, a complete culture solution is prepared using the composition of the Knop's

solution as a guide.
4. In glass jar C , a culture solution deficient in nitrogen is prepared by replacing calcium nitrate with calcium chloride and potassium nitrate is replaced by potassium chloride. .
5. Each jar is wrapped with black paper to prevent light from penetrating into the culture solution which will cause the growth of green algae.
6. Three maize seedlings of the same height are chosen and put into each jars.
7. Keep the roots of seedlings are fully immersed in each solutions. The culture solution is aerated using an air pump to ensure the root of the seedling obtain enough oxygen for respiration.
8. All set of apparatus are exposed to light so the seedling are able to carry put photosynthesis
9. The culture solution in each jar is replaced every week to ensure that the nutrients which are supposed to be available are not depleted.
10. After one month , seedling in jar A is taken out and the height of seedling is measured by using a ruler . The growth rate of the seedling is calculated and then is recorded in a table . (Any abnormal characteristics on the leaves are not to be observed.)
11. Step S10 is repeated with seedling in glass jar B and glass jar C are observed .
12. Record the result in a table and plot a bar chart showing the growth rate of seedlings (cm/day) against the types of solution.

Results

B2= 1

Glass Jar	Types of solution	The height of seedling /(cm)		The growth rate of seedling / (cm/day)
		Initial height	Final height	
A	Distilled water			
B	Complete Knop's Solution			
C	Nitrogen Deficient in culture solution			

Conclusion

 The height/ the growth rate of seedling is lower/slower   in nitrogen deficiencies of culture solution. The hypothesis is accepted.

 Note:
   7-9 - 3 marks
   4-6 - 2 marks
   1-3 - 1 mark

03=3
_____

17