GCSE

3445U30-1

TUESDAY, 17 MAY 2022 – MORNING

APPLIED SCIENCE (DOUBLE AWARD)

UNIT 3: FOOD, MATERIALS AND PROCESSES

FOUNDATION TIER

1 hour 30 minutes plus your additional time allowance

Surname: _____

First name(s): _____

Centre Number: _____

Candidate Number: 0 _____

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**9**	
2.	**10**	
3.	**8**	
4.	**6**	
5.	**9**	
6.	**14**	
7.	**19**	
Total	**75**	

ADDITIONAL MATERIALS

A calculator.

ITEMS INCLUDED WITH QUESTION PAPER

Periodic Table (provided separately)

A separate Diagram Booklet.

The Diagram Booklet MUST be handed in to the invigilators and sent for marking.

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball – point pen, black felt tip or your usual method.

Write your name, centre number and candidate number in the spaces on the front cover.

Answer ALL questions.

Write your answers in the spaces provided.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part – question.

Question 4 is a quality of extended response (QER) question where your writing skills will be assessed.

The Periodic Table is provided separately.

ANSWER ALL QUESTIONS.

1. The production and processing of dairy products requires a number of processes.

(a) Look at the information for Question 1 (a) in the separate Diagram Booklet.
The information shows statements A – E which show the main stages of making yoghurt. However the stages are not in the correct order.

(i) Use the letters B, C, D, to arrange the stages in the correct order in the boxes below.

A				E

[2 marks]

continued on the next page . . .

Question 1 (a) continued

1. (a) (ii) CIRCLE the type of microorganism used in this process.

fungus	bacterium	virus

[1 mark]

(iii) State ONE reason why the equipment should be sterilised before use.

_____

_____

[1 mark]

(iv) State why the milk is pasteurised during the process.

_____

_____

[1 mark]

continued on the next page . . .

Question 1 continued

1. (b) (i) Whole milk, semi – skimmed milk and skimmed milk are available in supermarkets.
Complete the following sentence.

Semi – skimmed milk is made by skimming

_____ from _____ milk.

[2 marks]

continued on the next page . . .

Question 1 (b) continued

1. (b) (ii) Complete the following sentences about homogenisation of milk by CIRCLING the correct word in the brackets.

The milk is pumped at high

(PRESSURE / TEMPERATURE / VOLUME) through

very narrow tubes breaking up the fat globules.

This prevents a layer of

(BUTTER / CHEESE / CREAM) forming on the milk.

[2 marks]

(Total for Question 1 = 9 marks)

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2. Aluminium, copper and iron are metals.

Brass is a metal alloy.

These materials have many uses.

Look at the diagram for Question 2 in the separate Diagram Booklet.

The diagram represents the apparatus used to investigate the thermal conductivity of metals.

The time taken for a drawing pin to fall from each metal rod is measured.

(a) (i) State the independent variable in this experiment.

_____

_____

[1 mark]

continued on the next page . . .

Question 2 (a) continued

2. (a) (ii) State TWO variables that are controlled in this experiment.

_____

_____

_____

[2 marks]

(iii) Describe how the thermal conductivity is related to the dependent variable.

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 2 continued

2. (b) Two students obtained the results shown in the table below.

Metal	Time taken for pin to drop (s)
iron	17
copper	7
brass	12
aluminium	5

(i) Use the results shown in the table above to place iron, copper, brass and aluminium in order of conductivity.

Best conductor _____

_____

_____

Poorest conductor _____

[1 mark]

Question 2 (b) continued

2. (b) (ii) The following table shows the theoretical values of the thermal conductivity of the metals.

Metal	Thermal conductivity (units)
iron	80•4
copper	401
brass	109
aluminium	210

Use the information above to explain whether the theoretical data agrees with experimental data.

Best conductor _____

_____

_____

Poorest conductor _____

_____

_____

[3 marks]

2. (c) Mercury is a metal which has a melting point of $-39^{\circ}C$.

Suggest why the students could not use mercury in this investigation.

[1 mark]

(Total for Question 2 = 10 marks)

3. Look at the diagram for Question 3 (a) in the separate Diagram Booklet.

The diagram shows the structure of three substances; A, which is a solid, B, which is a gas and C, which is a solid.

(a) State which of the structures (A, B or C) is an ionic compound.

Give ONE reason for your answer.

Letter: _____

Reason: _____

_____

_____

_____

_____

[2 marks]

Question 3 continued

3. (b) Sodium chloride is an ionic compound which consists of sodium and chloride ions.

Explain why sodium chloride will not conduct electricity when it is a solid but will conduct electricity when it is dissolved in water.

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 3 continued

3. (c) Look at the table for Question 3 (c) in the separate Diagram Booklet.

Some of the materials used in sporting equipment are shown in the table.

Use the data in the table to answer the following questions.

(i) Carbon fibre is an example of a composite material used to make bicycle frames for use in cycle races.

State TWO reasons why modern bicycle frames are made of carbon fibre rather than aluminium.

Reason 1.

_____

_____

Reason 2.

_____

_____

[2 marks]

Question 3 (c) continued

3. (c) (ii) A shot put contains lead.

Use the equation

$$\text{mass} = \text{density} \times \text{volume}$$

to find the mass of lead in a shot put that has a volume of $700\ \text{cm}^3$

SPACE FOR WORKING:

Mass = _____ g

[2 marks]

(Total for Question 3 = 8 marks)

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4. Look at the diagram for Question 4 in the separate Diagram Booklet.
The diagram shows three graphs.

Students carried out an experiment to investigate the factors that affect photosynthesis.

Their results are shown in the graphs.

Use the graphs to describe how the rate of photosynthesis is affected by each of these factors.

[6 marks QER]

(Total for Question 4 = 6 marks)

5. Look at the diagram for Question 5 in the separate Diagram Booklet.
The diagram shows a bar chart.

A farmer wanted to grow soybean crops on three fields. She analysed soil samples for nitrate, phosphate and potassium.
The results are shown on the bar chart.

Soybeans will show healthy growth if the nutrient levels in the soil are above a threshold value.
The plants will show signs of mineral deficiency if the nutrient levels in the soil are below these values.

continued on the next page . . .

Question 5 continued

The nitrate, phosphate and potassium threshold values for soybeans are shown in the table below.

Nutrient	Threshold value (units)
nitrate	2
phosphate	16
potassium	28

(a) Use the information above to answer the following questions.

(i) State which field would be the most suitable to grow soybean crops. Give a reason for your answer.

Field: _____

Reason: _____

_____

_____

[2 marks]

Question 5 (a) continued

5. (a) (ii) State which field would result in soybeans with yellow leaves and stunted growth.
Give a reason for your answer.

Field: _____

Reason: _____

_____

_____

[2 marks]

(iii) State how the farmer ensures that her soybean plants do not suffer from mineral deficiencies in any field used to grow them.

_____

_____

[1 mark]

continued on the next page . . .

Question 5 continued

5. (b) Some counties have banned the growing of genetically modified (GM) crops.

The table below gives some arguments for and against the use of GM crops.

Place a tick (✓) next to TWO arguments AGAINST growing GM crops.

Argument	Against (✓)
cheaper food	
increased crop yield	
could cross – pollinate with weeds	
long – term effects unknown	

[2 marks]

continued on the next page . . .

Question 5 continued

5. (c) Selective breeding is used by large companies to increase the yield of soybeans.

State TWO disadvantages of using crops developed by a selective breeding process.

Disadvantage 1.

_____

_____

_____

Disadvantage 2.

_____

_____

_____

[2 marks]

(Total for Question 5 = 9 marks)

6. Despite safety precautions, industrial accidents occur.

(a) Methyl isocyanate (MIC) was involved in the Bhopal disaster that led to the deaths of thousands of people.
A highly toxic cloud of MIC was released from chimneys at the chemical plant.
On the night of the disaster it reacted with water that leaked into a storage tank, causing a valve to blow.
The structural formula of MIC is

$$H_3C - N = C = O$$

continued on the next page . . .

Question 6 (a) continued

6. (a) (i) Complete the table provided for Question 6 (a) (i) in the separate Diagram Booklet to calculate the total energy required to break all the bonds in 1 mole of the reactants, MIC and water.

SPACE FOR WORKING:

total energy to break ALL bonds

= _____ kJ/mol [5 marks]

continued on the next page . . .

Question 6 (a) continued

6. (a) (ii) A similar calculation shows the energy released when bonds are formed in the products is greater than your answer given in Part (i).

Complete the paragraph below by CIRCLING the correct word(s) in the brackets.

When a chemical reaction happens, energy is transferred to or from the surroundings. Energy is transferred to the surroundings if the energy released is (LESS THAN / EQUAL TO / GREATER THAN) the energy absorbed. This is called (AN ENDOTHERMIC / A COMBUSTION / AN EXOTHERMIC) reaction. The temperature of the surroundings (DECREASES / STAYS THE SAME / INCREASES).

[3 marks]

continued on the next page . . .

Question 6 (a) continued

6. (a) (iii) The Bhopal disaster was caused because of thermal runaway.

Explain what is meant by the term 'thermal runaway'.

_____

_____

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 6 continued

6. (b) Spinach grown in north – eastern Japan was contaminated by radioactivity from the Fukushima nuclear power station accident in March 2011.

Radioactive dust deposited iodine – 131 atoms on spinach leaves.
Its activity was 8200 units.

No spinach was allowed to be used for 96 days.

Iodine – 131 has a half – life of 8 days.

continued on the next page . . .

Question 6 (b) continued

6. (b) (i) The initial activity of the iodine – 131 was 8200 units.

Calculate the activity after 8 days.

SPACE FOR WORKING:

activity _____ units

[1 mark]

(ii) Calculate the number of half – lives in 96 days.

SPACE FOR WORKING:

number = _____

[1 mark]

continued on the next page . . .

Question 6 (b) continued

6. (b) (iii) Calculate the activity after 96 days.

SPACE FOR WORKING:

activity _____ units

[2 marks]

(Total for Question 6 = 14 marks)

7. Criminals will try to hide their activities but forensic scientists, using biological and chemical testing, are able to find evidence that reveals what happened.

(a) DNA profiling is commonly used to identify criminals.

(i) State where DNA is found in the cell.

_____

[1 mark]

continued on the next page . . .

Question 7 (a) continued

7. (a) (ii) There were three suspects in a crime. Suspect 1 did not have an alibi but suspects 2 and 3 did. Initially it was thought that suspect 1 was the criminal. DNA samples were collected from the crime scene.

Look at the diagram for Question 7 (a) (ii) in the separate Diagram Booklet.
The diagram shows the DNA samples that were collected at the crime scene.

Compare the DNA samples shown to explain whether having an alibi or not is sufficient to decide on guilt.

_____

_____

[2 marks]

7. (a) (iii) State ONE OTHER use of DNA profiling.

_____

_____

[1 mark]

continued on the next page . . .

Question 7 continued

7. (b) It is suspected that supplies of vinegar have been tampered with by adding a strong acid. White vinegar usually contains ethanoic acid at a concentration of $0{\cdot}01\ mol/dm^3$

Samples of the vinegar are taken and tested by titrating against $0{\cdot}5\ mol/dm^3$ sodium hydroxide solution.

Look at the diagram for Question 7 (b) in the separate Diagram Booklet.
The diagram shows the equipment used for the titration.

continued on the next page . . .

Question 7 (b) continued

A pH meter is used to monitor the pH of the solution in the flask.

The results are shown in the table below.

Volume of sodium hydroxide solution (cm^3)	pH
0	1•5
5	1•6
10	1•7
15	1•9
20	2•2
25	3•0
30	13•7
35	14•0
40	14•0

continued on the next page . . .

Question 7 (b) continued

7. (b) (i) Use the data in the table to complete the graph on the grid provided for Question 7 (b) (i) in the separate Diagram Booklet.

[3 marks]

(ii) Use the graph to find the volume of sodium hydroxide solution required to neutralise the white vinegar.

volume = _____ cm^3

[1 mark]

continued on the next page . . .

Question 7 (b) continued

7. (b) (iii) Look at the equation for Question 7 (b) (iii) in the separate Diagram Booklet.

Use the information given in this question and the equation given to determine whether or not the samples had been tampered with.

SPACE FOR WORKING:

_____

_____

_____

[3 marks]

continued on the next page . . .

Question 7 (b) continued

7. (b) (iv) Complete the word equation for the reaction between an acid and a base.

acid + base → _____

[2 marks]

(v) Explain why taking repeat readings will increase the accuracy of the result.

_____

_____

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 7 continued

7. (c) Powders A and B are collected at a crime scene.

The tests used to identify them are shown in the table below.

Test	Action
1	Flame test
2	Add silver nitrate solution
3	Add sodium hydroxide solution
4	Add dilute hydrochloric acid and bubble gas through limewater

Look at the diagram for Question 7 (c) in the separate Diagram Booklet.

The diagram shows the results of the tests.

continued on the next page . . .

Question 7 (c) continued

Identify powders A and B.

Powder A: _____

_____

Powder B: _____

_____

[4 marks]

(Total for Question 7 = 19 marks)

END OF PAPER

TOTAL 75 MARKS

GCSE

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APPLIED SCIENCE (DOUBLE AWARD)

UNIT 3: FOOD, MATERIALS AND PROCESSES

FOUNDATION TIER

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Diagram Booklet

Surname: _____

First name(s): _____

Centre Number: _____

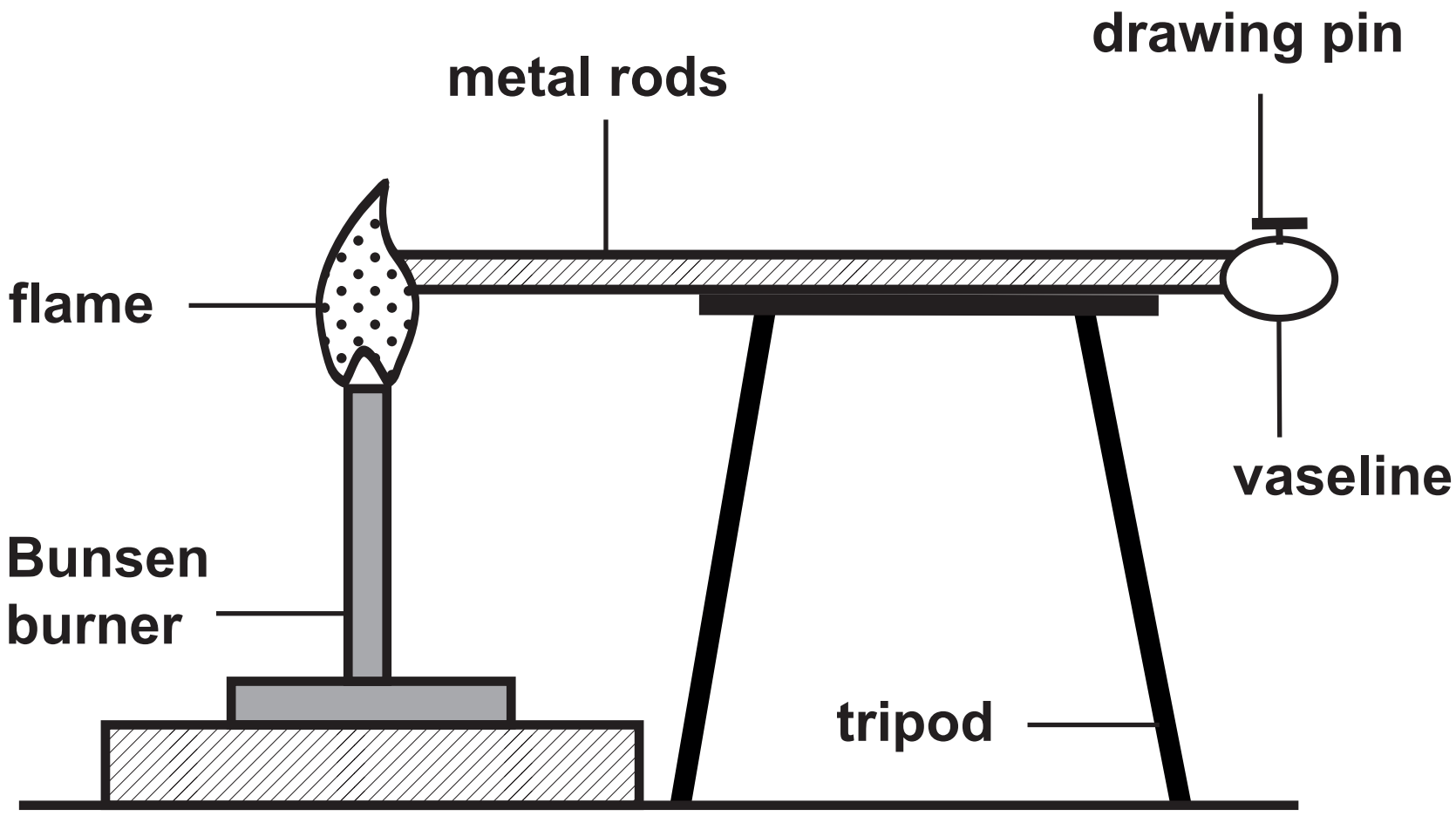
Candidate Number: 0 _____

Question 1 (a)

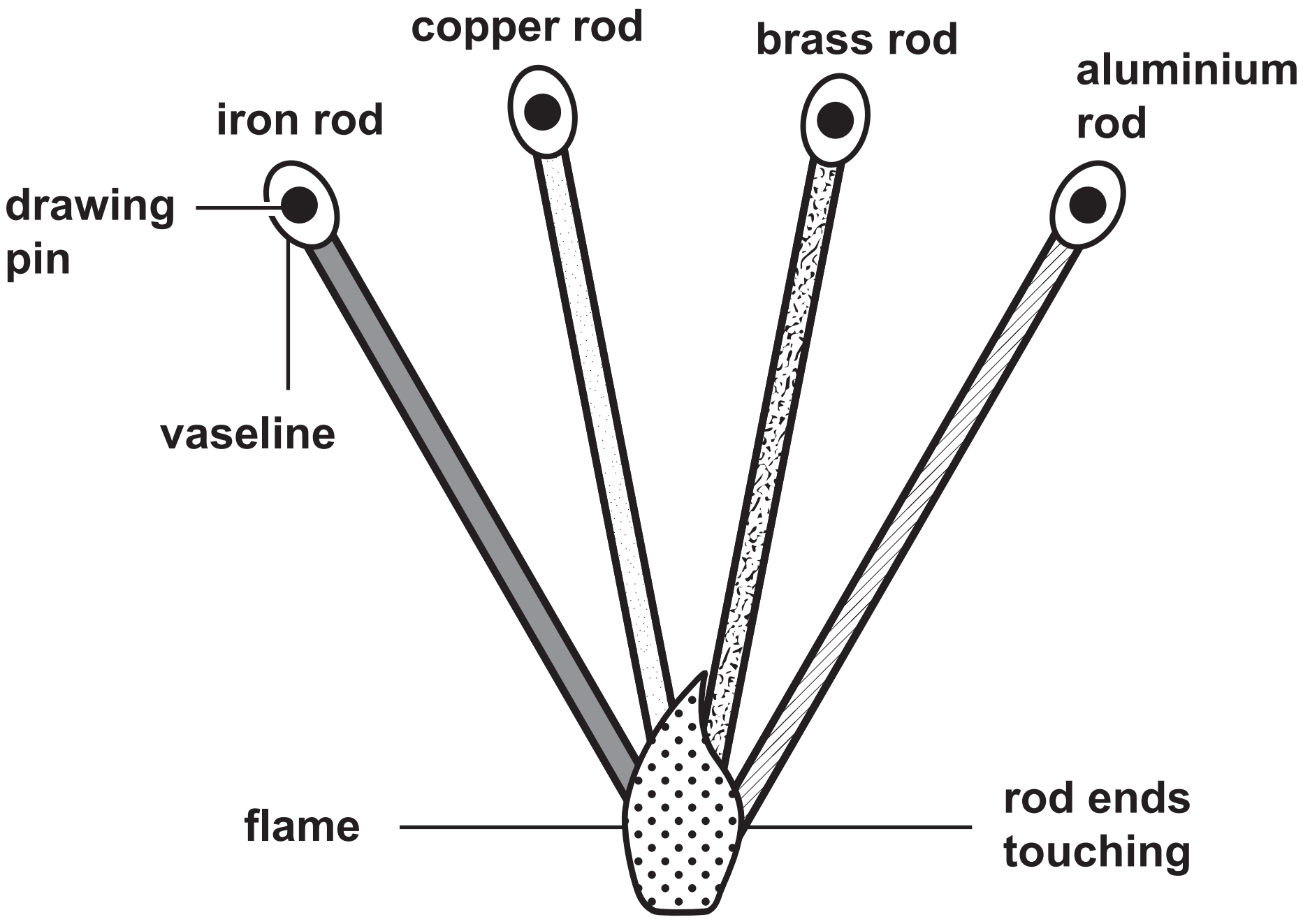
Statements

A	**The equipment is sterilised**
B	**Samples are taken to see if the yoghurt is ready**
C	**The milk is pasteurised by heating**
D	**The bacterial culture is added to the pasteurised milk and left at 46°C for about four hours**
E	**Flavours and colours are added, then the yoghurt is packaged**

Question 2

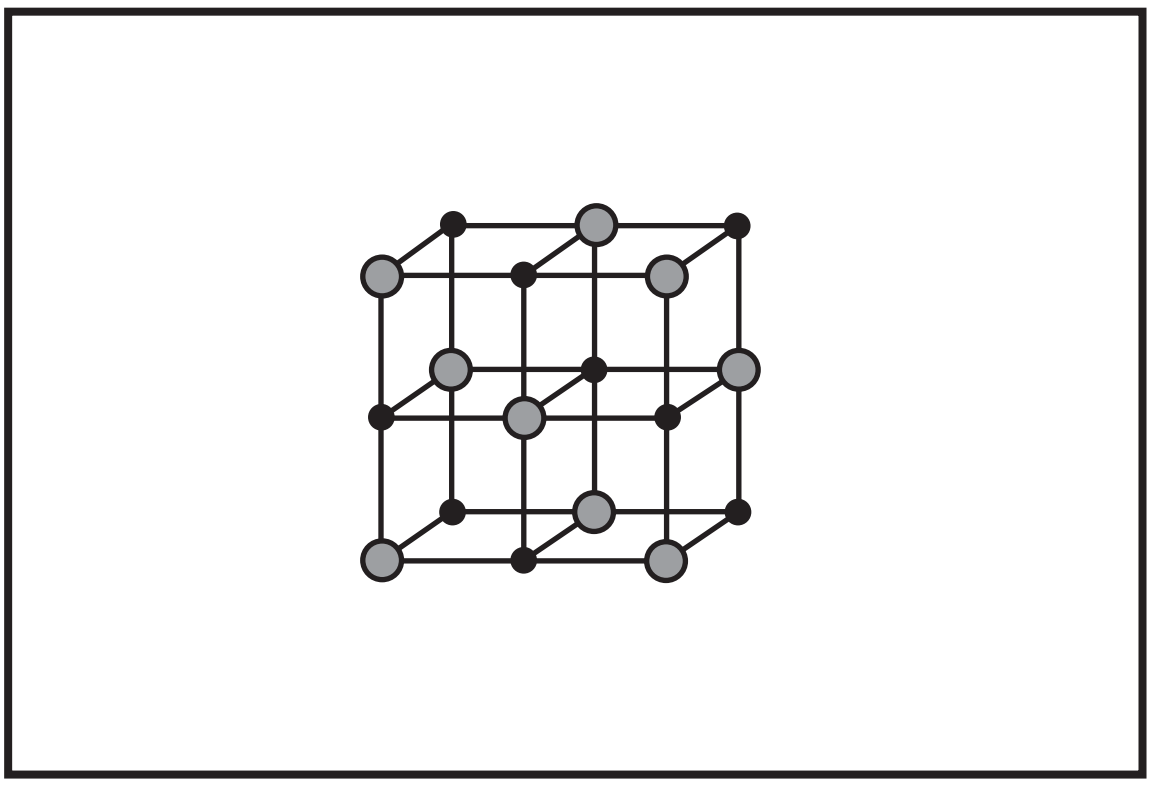


Metal rods arrangement on the tripod

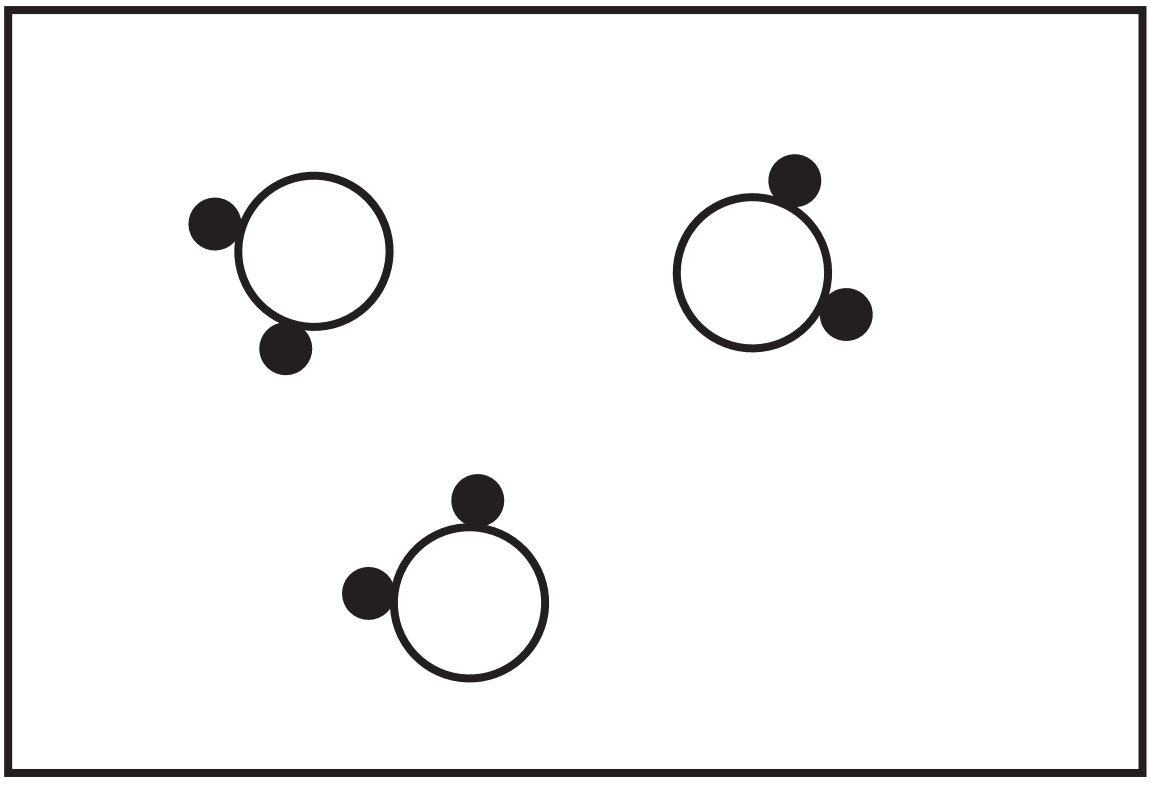


Question 3 (a)

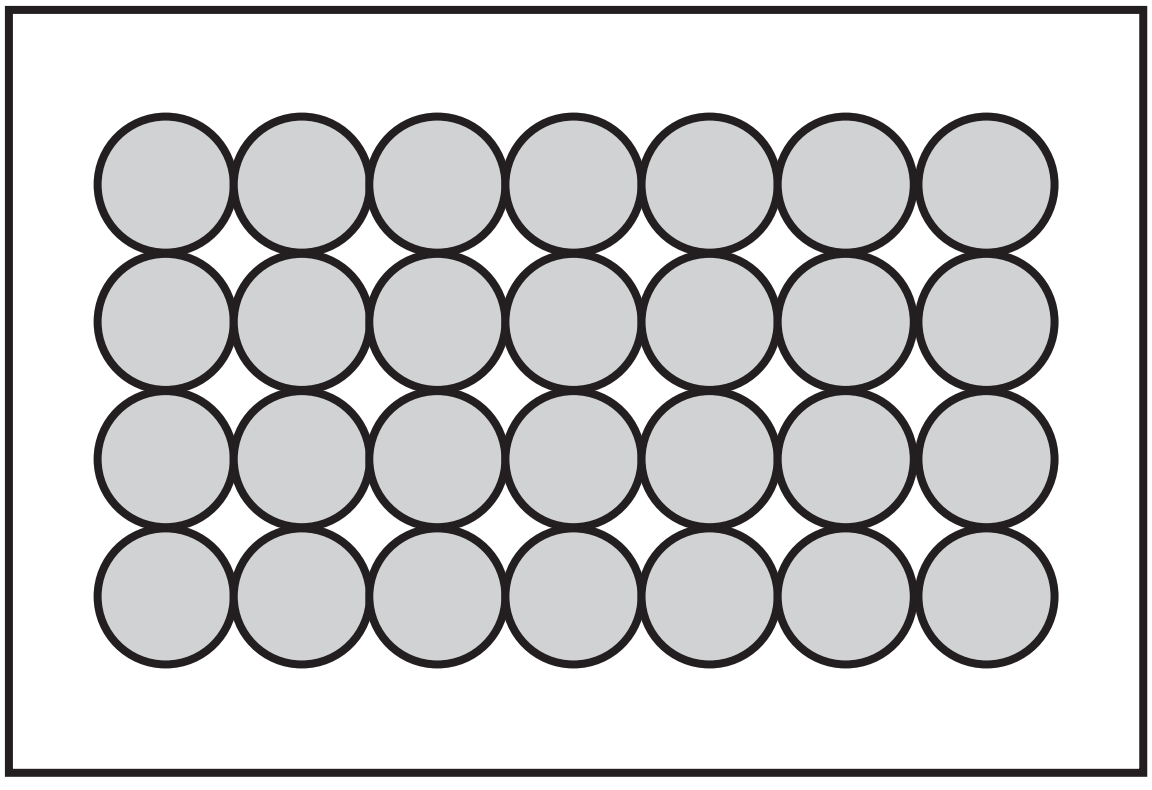
Substance A (solid)



Substance B (gas)



Substance C (solid)

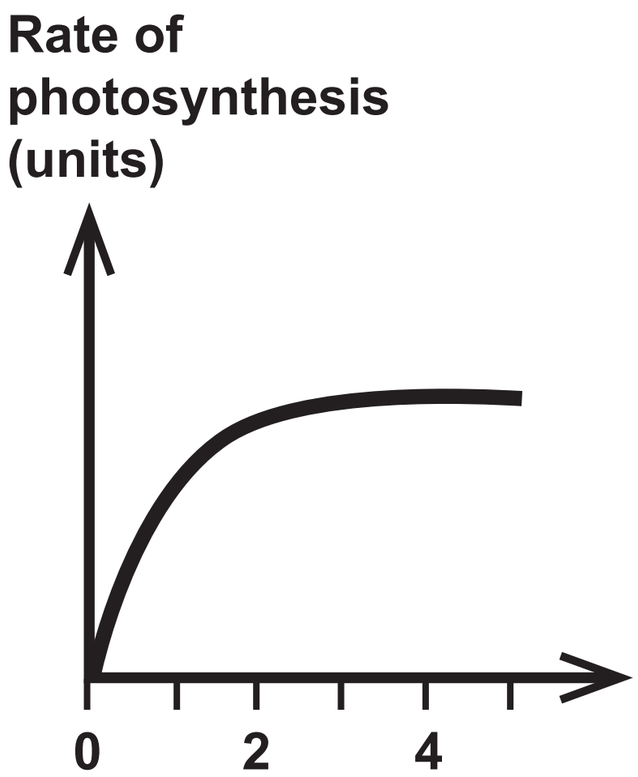


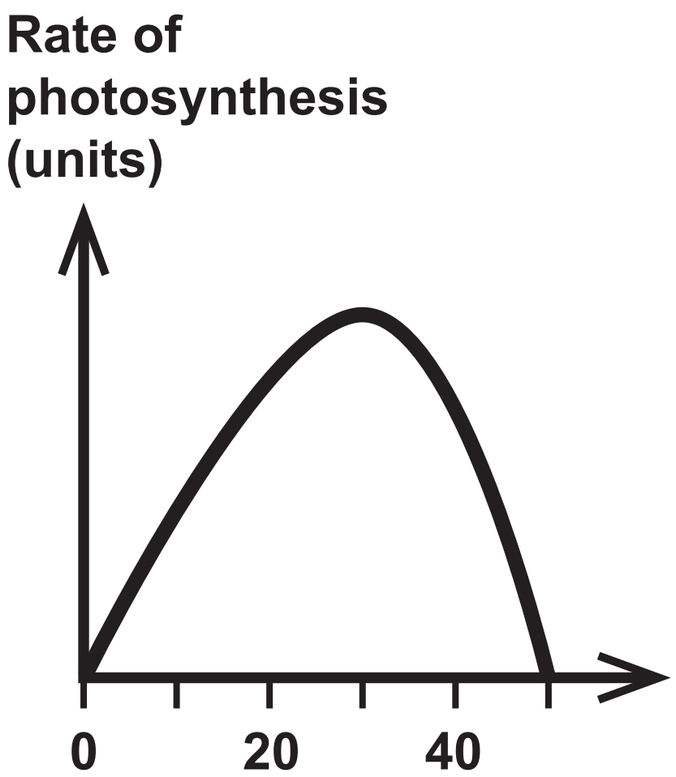
Question 3 (c)

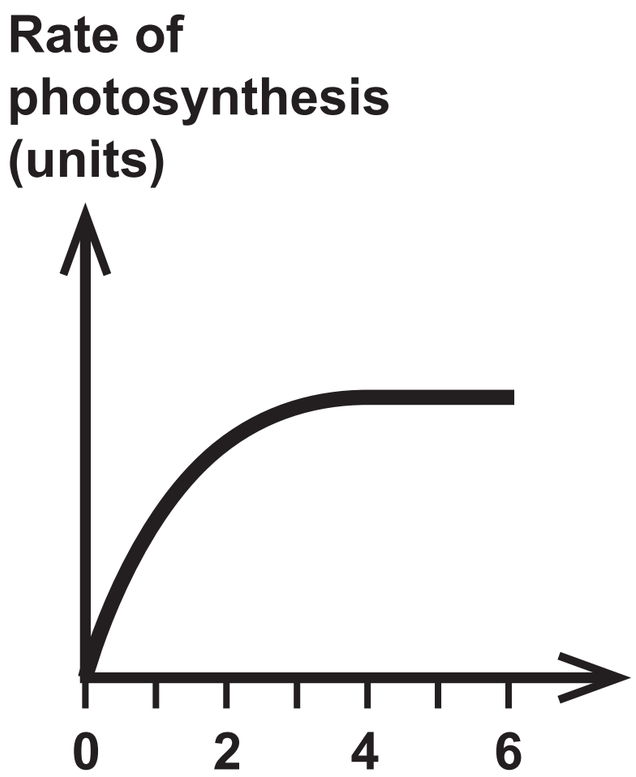
Table

Material	Thermal conductivity (units)	Melting point (°C)	Density (g/cm^3)	Tensile strength (MPa)
carbon fibre	21	3650	1•78	4137
aluminium	210	660	2•71	276
lead	35	327	11•3	12

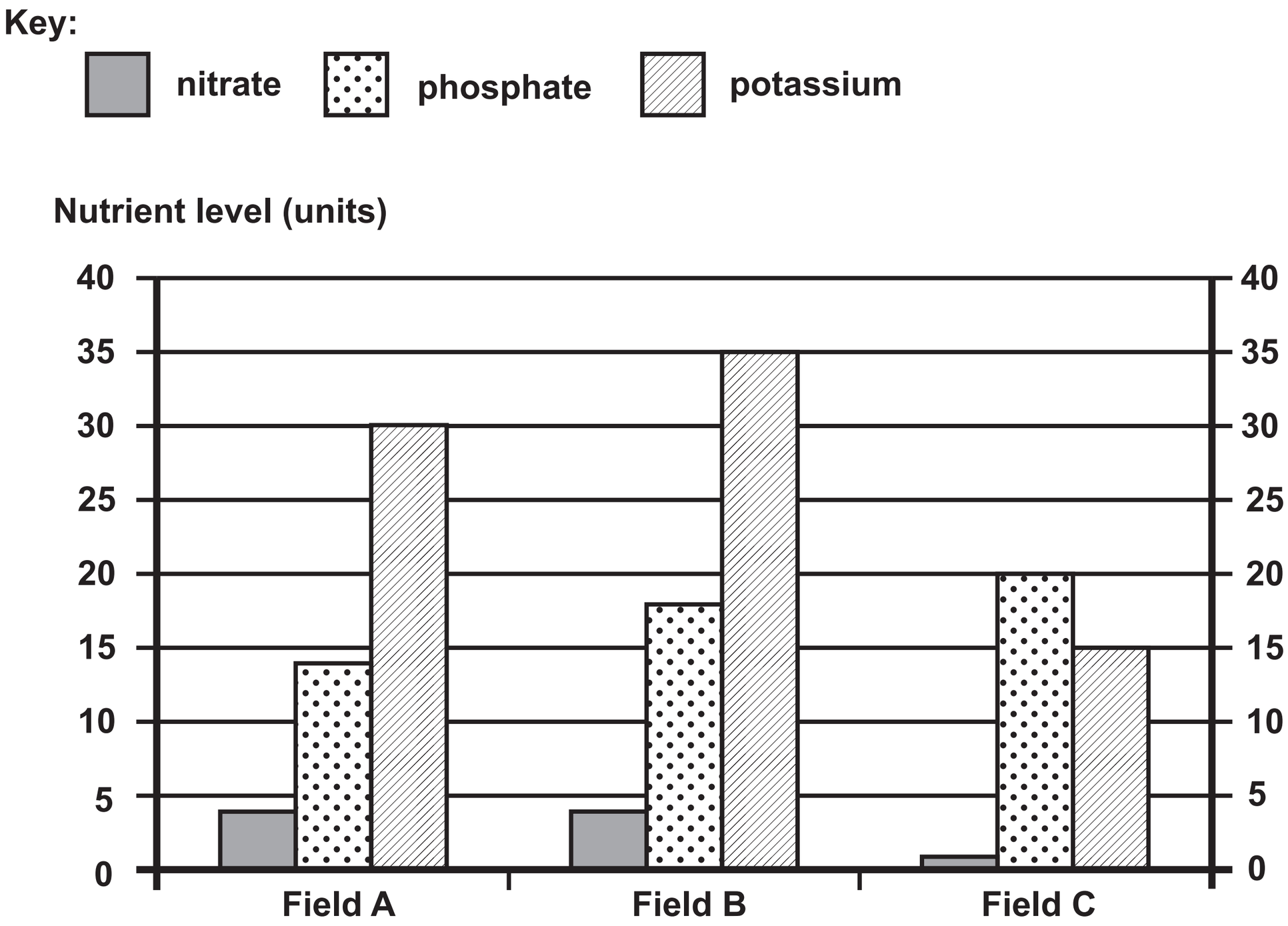
Question 4


Rate of photosynthesis (units)
0
2
4
Light intensity (units)


Rate of photosynthesis (units)
0
20
40
Temperature (°C)


Rate of photosynthesis (units)
0
2
4
6
Carbon dioxide concentration (units)

Question 5


Key:
nitrate
phosphate
potassium
Nutrient level (units)
40
35
30
25
20
15
10
5
0
Field A
Field B
Field C

Question 6 (a) (i)

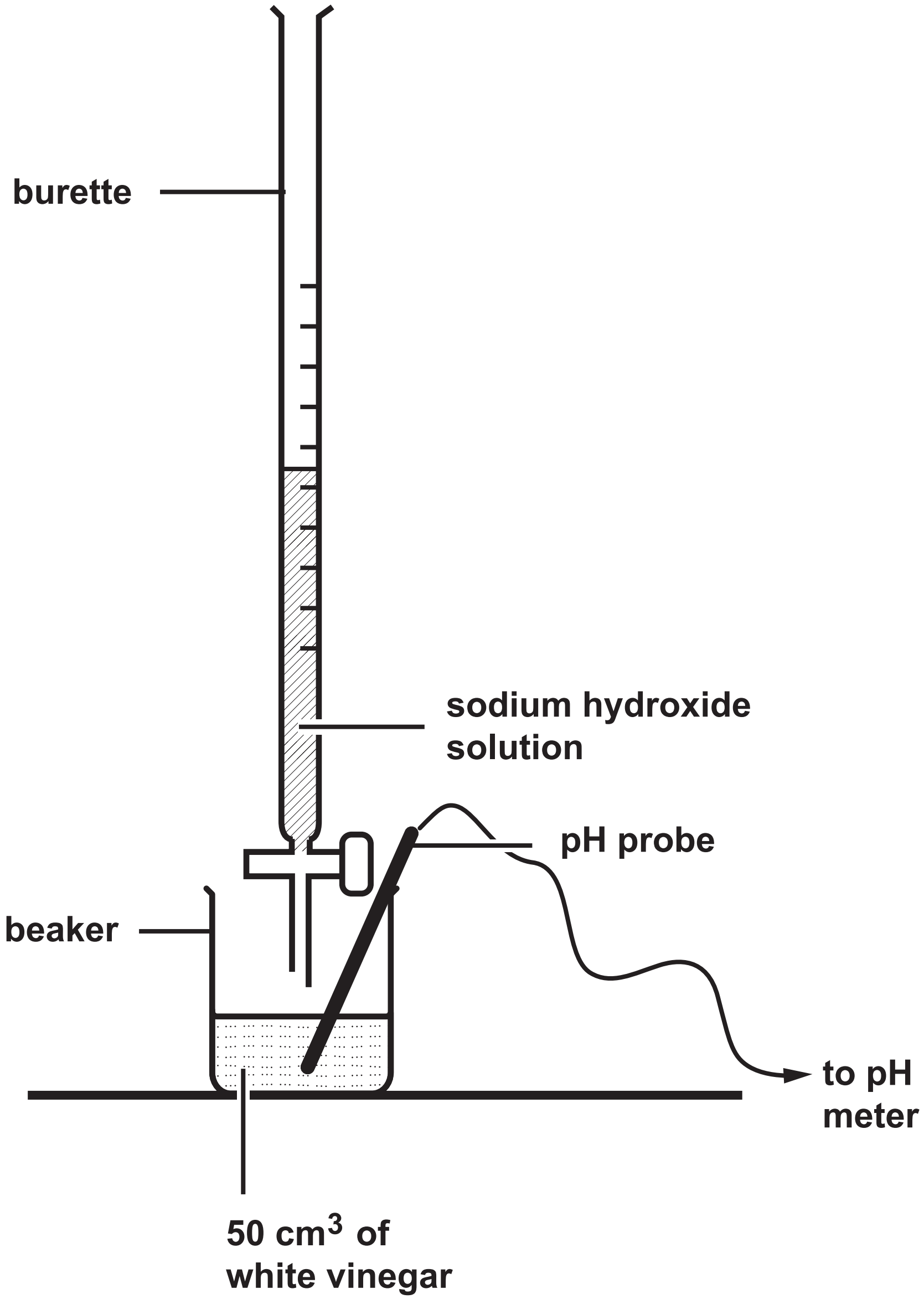
Table

$H_3C - N = C = O$			
Bond type	**Number of bonds**	**Energy to break one bond (kJ/mol)**	**Energy to break all of each bond type (kJ/mol)**
H — C	3	413	
C — N	1	305	305
N = C	1	615	
C = O	1		745

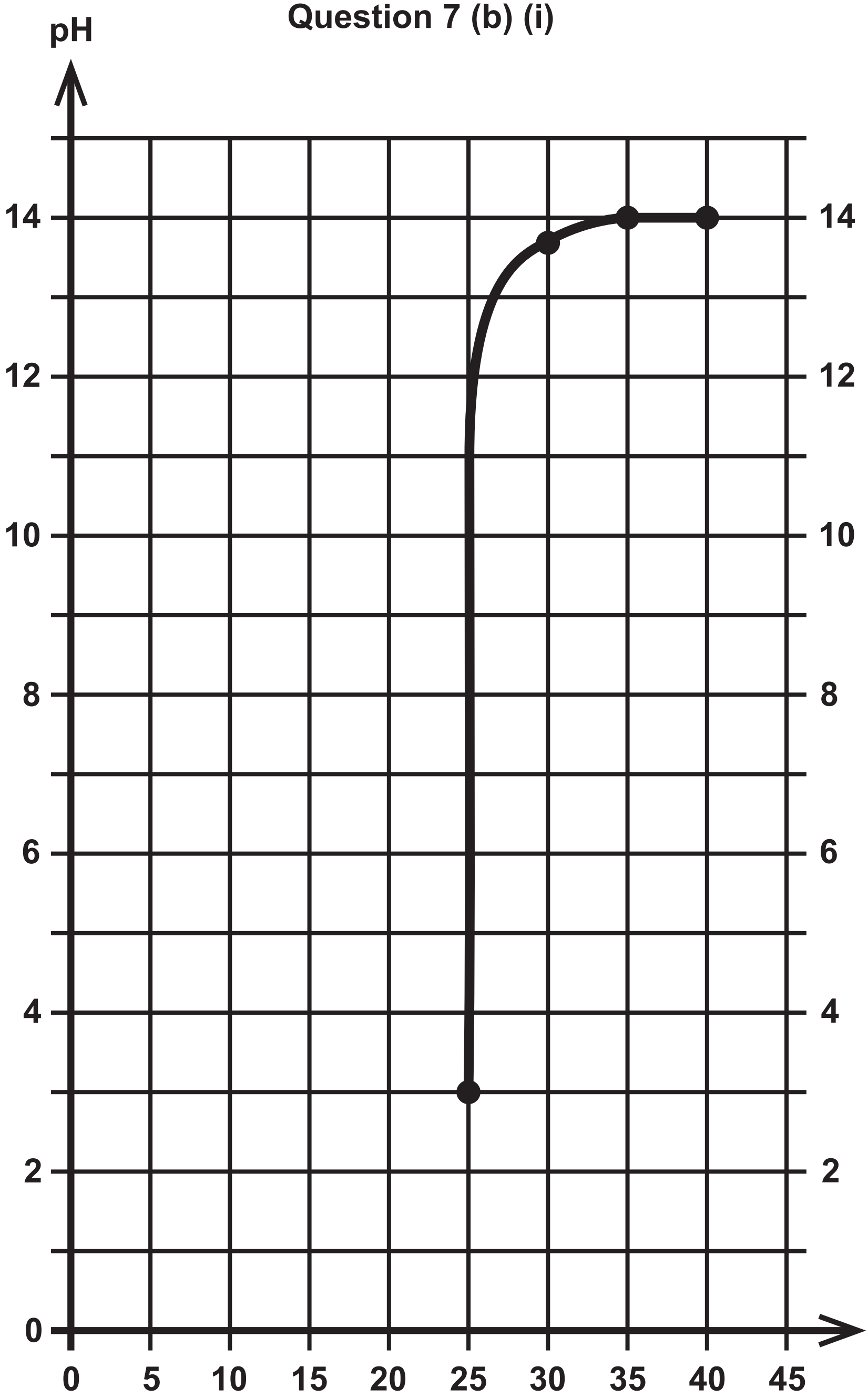
H_2O			
Bond type	**Number of bonds**	**Energy to break one bond (kJ/mol)**	**Energy to break all of each bond type (kJ/mol)**
H — O	2	467	

Question 7 (a) (ii)

Question 7 (b)


burette
sodium hydroxide solution
pH probe
beaker
to pH meter
50 cm3 of white vinegar

Question 7 (b) (i)

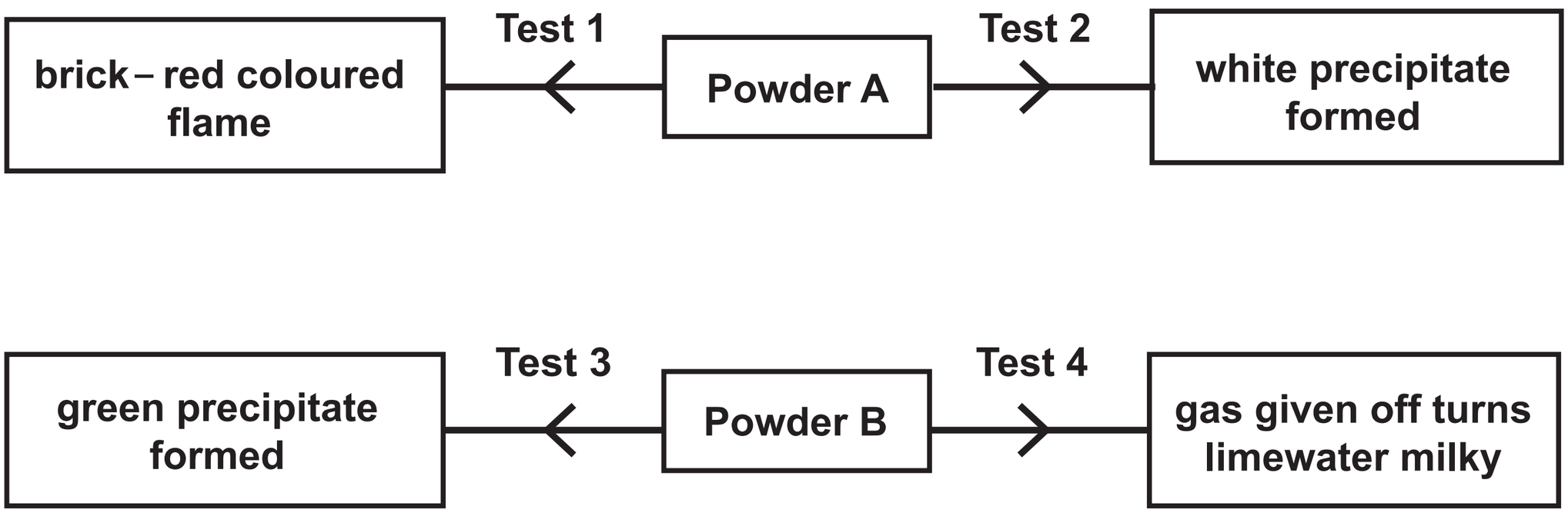


Question 7 (b) (iii)

Equation

$$\text{concentration of white vinegar} = \frac{\text{concentration of sodium hydroxide} \times \text{volume of sodium hydroxide}}{\text{volume of white vinegar}}$$

Question 7 (c)


brick – red coloured flame
Test 1
Powder A
Test 2
white precipitate formed
green precipitate formed
Test 3
Powder B
Test 4
gas given off turns limewater milky

Periodic Table

1 H 1

Key:

A_r Symbol Z

A_r : Relative atomic mass
Symbol : Chemical symbol
Z : Atomic number

	represents where elements 58-71 (lanthanides) are omitted

1	2											
7 Li 3	9 Be 4											
23 Na 11	24 Mg 12											
39 K 19	40 Ca 20	45 Sc 21	48 Ti 22	51 V 23	52 Cr 24	55 Mn 25	56 Fe 26	59 Co 27	59 Ni 28	63.5 Cu 29	65 Zn 30
86 Rb 37	88 Sr 38	89 Y 39	91 Zr 40	93 Nb 41	96 Mo 42	99 Tc 43	101 Ru 44	103 Rh 45	106 Pd 46	108 Ag 47	112 Cd 48
133 Cs 55	137 Ba 56	139 La 57	179 Hf 72	181 Ta 73	184 W 74	186 Re 75	190 Os 76	192 Ir 77	195 Pt 78	197 Au 79	201 Hg 80
223 Fr 87	226 Ra 88	227 Ac 89									

3	4	5	6	7	0
					4 He 2
11 B 5	12 C 6	14 N 7	16 O 8	19 F 9	20 Ne 10
27 Al 13	28 Si 14	31 P 15	32 S 16	35.5 Cl 17	40 Ar 18
70 Ga 31	73 Ge 32	75 As 33	79 Se 34	80 Br 35	84 Kr 36
115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
204 Tl 81	207 Pb 82	209 Bi 83	210 Po 84	210 At 85	222 Rn 86

List of elements in the Periodic table in order of atomic number

KEY: atomic number – chemical symbol – element

1 – Hydrogen – H

2 – Helium – He

3 – Lithium – Li

4 – Beryllium – Be

5 – Boron – B

6 – Carbon – C

7 – Nitrogen – N

8 – Oxygen – O

9 – Fluorine – F

10 – Neon – Ne

11 – Sodium – Na

12 – Magnesium – Mg

13 – Aluminium – Al

14 – Silicon – Si

15 – Phosphorous – P

16 – Sulphur – S

17 – Chlorine – Cl

18 – Argon – Ar

19 – Potassium – K

20 – Calcium – Ca

21 – Scandium – Sc

22 – Titanium – Ti

23 – Vanadium – V

24 – Chromium – Cr

25 – Manganese – Mn

26 – Iron – Fe

27 – Cobalt – Co

28 – Nickel – Ni

29 – Copper – Cu

30 – Zinc – Zn

31 – Gallium – Ga

32 – Germanium – Ge

33 – Arsenic – As

34 – Selenium – Se

35 – Bromine – Br

36 – Krypton – Kr

37 – Rubidium – Rb

38 – Strontium – Sr

39 – Yttrium – Y

40 – Zirconium – Zr

41 – Niobium – Nb

42 – Molybdenum – Mo

43 – Technetium – Tc

44 – Ruthenium – Ru

45 – Rhodium – Rh

46 – Palladium – Pd

47 – Silver – Ag

48 – Cadmium – Cd

49 – Indium – In

50 – Tin – Sn

51 – Antimony – Sb

52 – Tellurium – Te

53 – Iodine – I

54 – Xenon – Xe

55 – Caesium – Cs

56 – Barium – Ba

57 – Lanthanum – La

(The lanthanides, elements 58-71, are omitted)

72 – Hafnium – Hf

73 – Tantalum – Ta

74 – Tungsten – W

75 – Rhenium – Re

76 – Osmium – Os

77 – Iridium – Ir

78 – Platinum – Pt

79 – Gold – Au

80 – Mercury – Hg

81 – Thallium – Tl

82 – Lead – Pb

83 – Bismuth – Bi

84 – Polonium – Po

85 – Astatine – At

86 – Radon – Rn

87 – Francium – Fr

88 – Radium – Ra

89 – Actinium – Ac