wjec cbac GCSE

3445UC0-1

FRIDAY, 10 MAY 2024 – MORNING

APPLIED SCIENCE (Double Award)
UNIT 3: Food, Materials and Processes

HIGHER TIER

1 hour 30 minutes plus your additional time allowance

Surname _____

First name(s) _____

Centre Number _____

Candidate Number 0 _____

ADDITIONAL MATERIALS

In addition to this examination paper, you will require a calculator and a ruler.

ITEMS INCLUDED WITH QUESTION PAPER

A separate Diagram Booklet.

A separate Data 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 or your usual method.

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

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

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

Question 7(a) is a quality of extended response (QER) question where your writing skills will be assessed.

You are reminded to show all your workings. Credit is given for correct workings even when the final answer given is incorrect.

The Periodic Table is printed in the separate Data Booklet.

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**9**	
2.	**10**	
3.	**7**	
4.	**11**	
5.	**7**	
6.	**13**	
7.	**8**	
8.	**10**	
Total	**75**	

Answer ALL questions.

1 **Students are investigating how the stiffness of a wooden metre ruler depends on its length. They use the apparatus shown in DIAGRAM 1.1 in the separate diagram booklet. The weight, W, on the end of the ruler remains constant at 5 N.**

The length, L, is varied. For each length, L, the depression, D, of the end of the ruler is measured.

Their results are shown in TABLE 1.2 in the separate diagram booklet.

(a) **Plot the data in TABLE 1.2 on the grid in GRAPH 1.3 in the separate diagram booklet and draw a smooth curve. The point (0,0) has already been plotted for you. [4 marks]**

1 (b) It was expected that depression, D, would be directly proportional to length, L.
Explain whether the graph shows a proportional relationship. [2 marks]

1 (c) Use information in the table and the equation:

$$\text{stiffness} = \frac{\text{weight}}{\text{depression}}$$

to calculate the stiffness of the ruler at a length of 50 cm. [3 marks]

stiffness = _____ N / cm

9

2 **Photosynthesis is the process by which plants make food from water and carbon dioxide.**

(a) **Stomata are an important part of the leaf. In many plants, stomata remain open during the day and closed at night.**

(i) **Label DIAGRAM 2.1 in the separate diagram booklet. [2 marks]**

(ii) **State TWO functions of stomata. [2 marks]**

1. _____

_____

2. _____

_____

2 (b) Healthy plants require a supply of nutrients. Many farmers use artificial fertilisers to supply these nutrients to the soil.

GRAPH 2.2 in the separate diagram booklet shows the mass of different nutrients applied to agricultural land between 1983 and 2017.

Use the data from the graph to answer the following questions.

(i) It is claimed that the use of nitrate fertilisers halved between 1983 and 2017. Use the graph to explain whether you agree. [3 marks]

continue answer on next page

(Turn over)

2 (b)(ii)

The total land area of Wales is approximately 2 100 000 hectares. 60 % of this land is used for farming.

I. Calculate the area of land used for farming in Wales. [1 mark]

area = _____ hectares

2 (b)(ii) continued

II. Calculate the total mass of phosphates used in farming in Wales in 1983. [2 marks]

mass = _____ kg

10

3 Qualitative analysis is used to identify the ions present in a compound.

(a) TABLE 3.1 in the separate diagram booklet shows the observations from chemical tests carried out on solutions of two compounds.

COMPLETE the table. [3 marks]

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$$\text{number of moles} = \frac{\text{mass}}{M_r}$$

3 (b) Another compound was identified as calcium sulfate ($CaSO_4$).

Use the information in TABLE 3.2 in the separate diagram booklet and the equation on the opposite page to calculate the number of moles of calcium sulfate present in 34 g of powder. [4 marks]

number of moles = _____

4 Yeast is used in fermentation to make the ethanol in wine.

(a) Write down the word equation for fermentation. [1 mark]

4 (b) Genetically modified yeast can be used in wine making.

(i) State the meaning of the term ‘genetically modified’. [1 mark]

4 (b)(ii) One type of genetically modified yeast was used to make wine.

GRAPH 4.1 in the separate diagram booklet shows how sugar content (solid black line), ethanol concentration (dashed line) and number of living yeast cells (dotted line) change with time.

A home brewer thinks that when the number of living yeast cells is at a maximum, the sugar content will be at its minimum and the ethanol concentration would be at its maximum. Use data from GRAPH 4.1 to explain whether you agree. [3 marks]

continue answer on next page

(Turn over)

4 (c) Many countries have banned the use of genetically modified foods.

Suggest TWO reasons for their concern. [2 marks]

1. _____

_____

_____

_____

2. _____

_____

_____

_____

4 (d) The home brewer also uses this genetically modified yeast to produce beer. Complete the steps in the fermentation process. Three steps have been given. [4 marks]

Step 1: Barley is mixed with water. Starch in the barley is converted to glucose.

Step 2: Hops are added for flavour.

Step 3: _____

_____

_____

_____

continue answer on next page

Step 4: _____

_____

_____

Step 5: _____

_____

_____

continue answer on next page

Step 6: _____

_____

_____

Step 7: The beer may be pasteurised, then stored in bottles or casks.

11

(Turn over)

5 Ethanol is widely used in biofuels. When ethanol is burned in a car engine, carbon dioxide and water are formed.

The displayed formula equation for this reaction is shown in DIAGRAM 5.1 in the separate diagram booklet.

Some of the bond energies for this reaction are shown in TABLE 5.2 in the separate diagram booklet.

Use the information in DIAGRAM 5.1 and TABLE 5.2 to answer the following questions.

5 (a) The energy needed to break all the bonds in the reactants is 4706 kJ. Calculate the energy needed to break an O═O bond. [4 marks]

energy = _____ kJ

5 (b) The energy released to form new bonds in the products is 5712 kJ / mol.

Explain why a car engine using ethanol as a fuel needs a cooling system. [3 marks]

6 Carbon exists as a number of different allotropes. These allotropes have some important commercial uses. The uses of these allotropes depends upon the structure.

(a) Two allotropes of carbon are diamond and graphite, as shown in DIAGRAM 6.1 in the separate diagram booklet.

Use DIAGRAM 6.1 and your knowledge to answer the following questions.

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6 (a)(i) DESCRIBE the bonding between a carbon atom and its nearest neighbours in diamond.
On the opposite page, INCLUDE a dot and cross diagram of one carbon atom and its nearest neighbours in your answer. [3 marks]

6 (a)(ii) State the difference in the bonding between carbon atoms in diamond and graphite. [1 mark]

6 (a)(iii) Explain why graphite is a good conductor of electricity but diamond is a good insulator of electricity. [3 marks]

6 (a)(iv) Explain, in terms of structure and bonding, why graphite is soft and slippery but diamond is hard.
[3 marks]

6 (b) Graphene is a single layer of graphite. It can be rolled into the shape of a cylinder which is called a carbon nanotube.

TABLE 6.2 in the separate diagram booklet gives some data about carbon nanotubes, steel and aluminium.

Electricity power lines are currently made from a combination of steel and aluminium. Explain why carbon nanotubes would be better. [3 marks]

continue answer on next page

32

13

(Turn over)

7 (a) DESCRIBE a controlled nuclear fission reaction that takes place inside a nuclear reactor and COMPARE it to nuclear fusion reactions that occur in stars such as the Sun. You should include a comparison of the two types of reactions as a source of generating electricity. [6 marks QER]

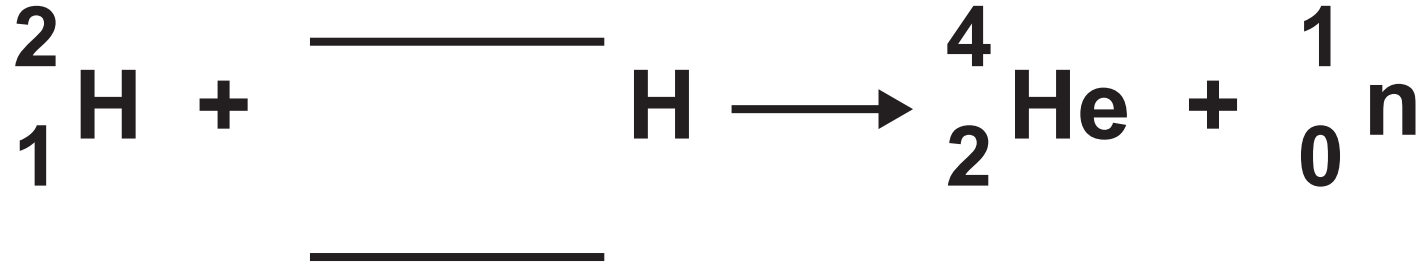
continue answer on next page

continue answer on next page

continue answer on next page

(Turn over)

7 (b) Complete the equation for the fusion reaction shown below. [2 marks]



8

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8 GRAPH 8.1 in the separate diagram booklet shows the confirmed cases of Campylobacter food poisoning per 100 000 of the population in Wales from 1990–2015.

In Wales, for every confirmed case of Campylobacter poisoning there are another two unconfirmed cases. The population of Wales is 3 million.

(a) Calculate the total number of Campylobacter cases in Wales in 1998. [3 marks]

Space for calculations on opposite page.

total number of cases = _____

8 (b) Turbidity can be used to calculate the number of bacteria present in a sample.
Alun used turbidity to study the growth rate of **Campylobacter** in water. He used the standard graph in GRAPH 8.2 in the separate diagram booklet.

(i) Alun analysed a water sample. The sample gave an absorbance of 0.01.

I. Use GRAPH 8.2 to find the cell number per cm^3 at an absorbance of 0.01. [1 mark]

cell number = _____ per cm^3

8 (b)(i) continued

II. **Campylobacter** reproduce every 20 mins The sample was left to stand for 1 hour. Alun thought that the absorbance would be 0.03 after 1 hour. Use your knowledge and data in GRAPH 8.2 to explain whether he is correct. [3 marks]

Space for calculations.

continue answer on next page

(Turn over)

8 (b)(ii) The threshold value for making a person sick is 120 000 bacteria. In (b)(i)I. Alun's sample was 7 cm^3. Use your answer above to determine whether this sample of water would make a person sick after standing for the hour. [3 marks]

10

END OF PAPER

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APPLIED SCIENCE (Double Award)

UNIT 3: Food, Materials and Processes

HIGHER TIER

1 hour 30 minutes plus your additional time allowance

DIAGRAM BOOKLET

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

Surname _____

First name(s) _____

Centre Number _____

Candidate Number 0 _____

DIAGRAM 1.1

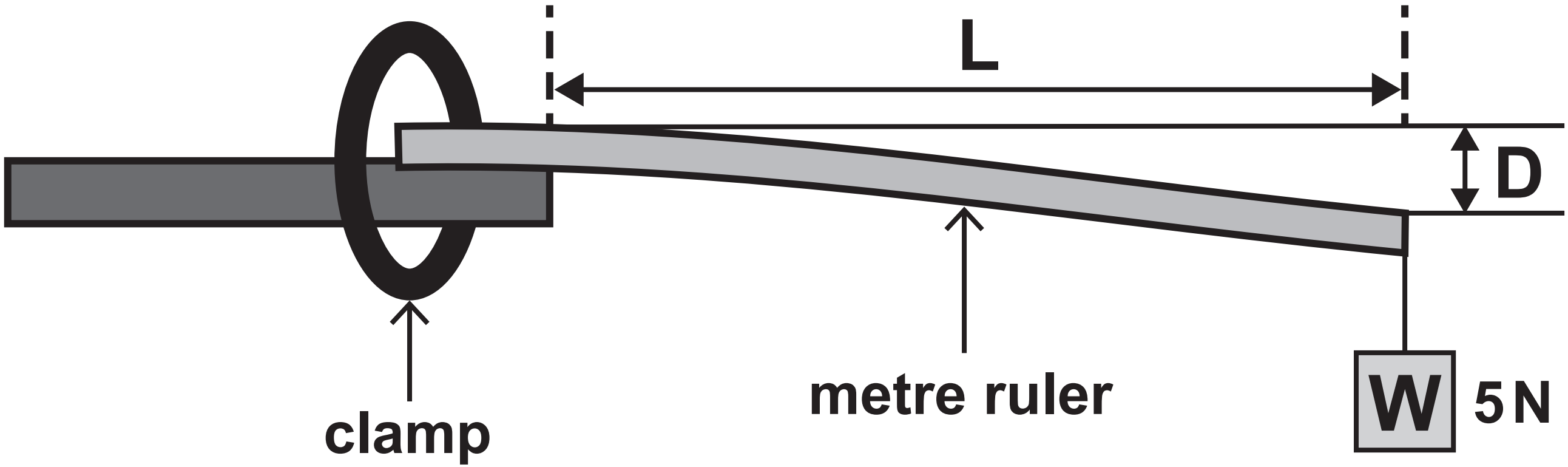

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TABLE 1.2

Length L (cm)	Depression D (cm)
0	0.0
30	1.0
40	3.0
50	6.0
60	10.0
70	15.0
80	22.0

GRAPH 1.3

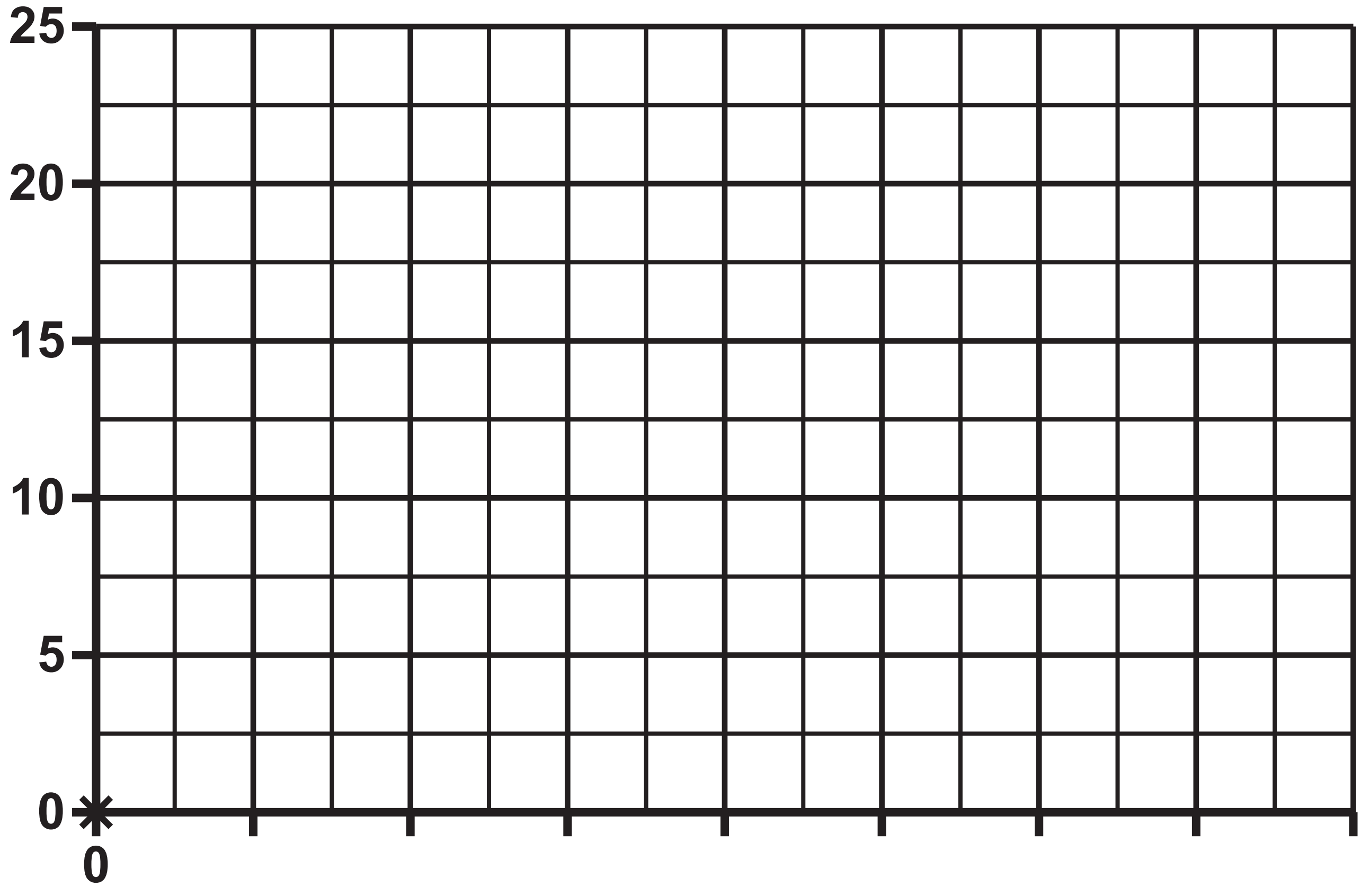
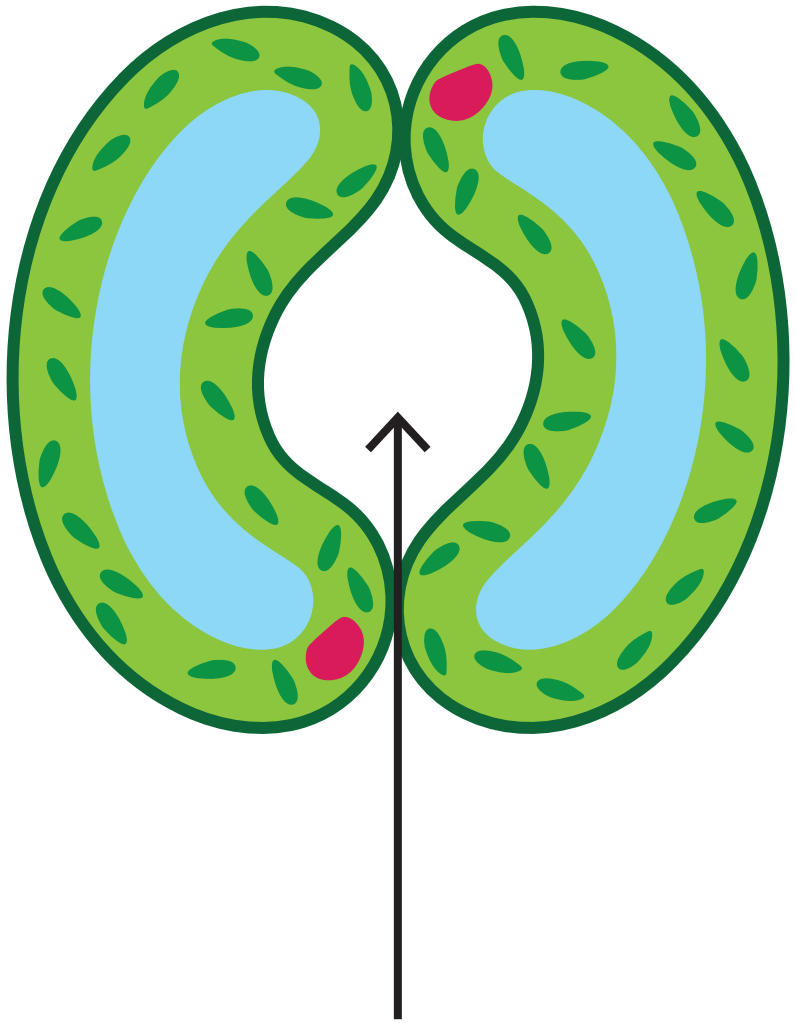
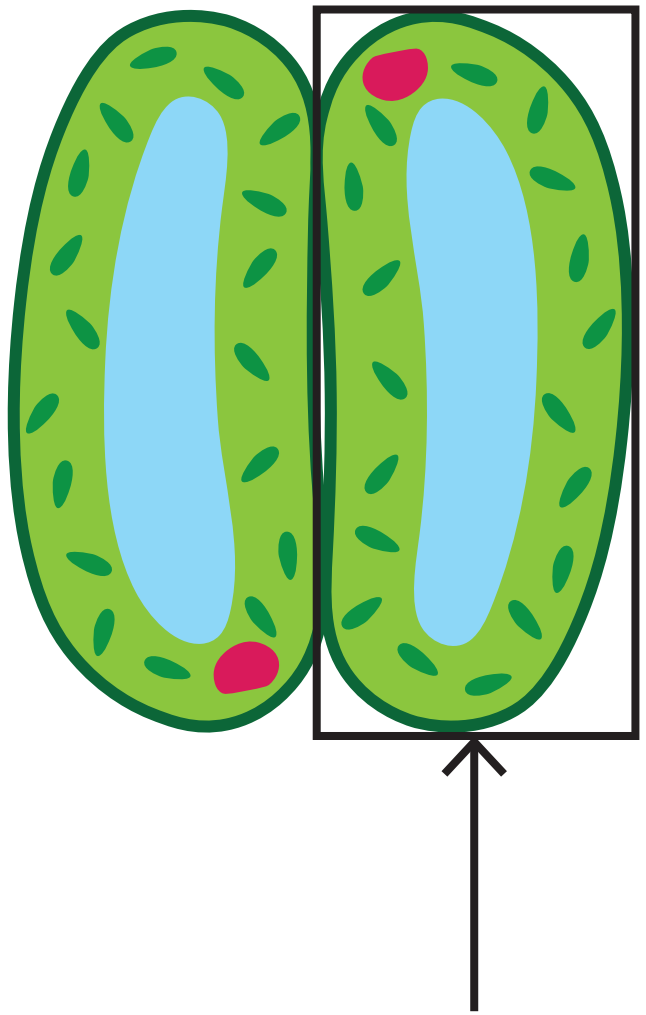


DIAGRAM 2.1

Open by day



Closed by night



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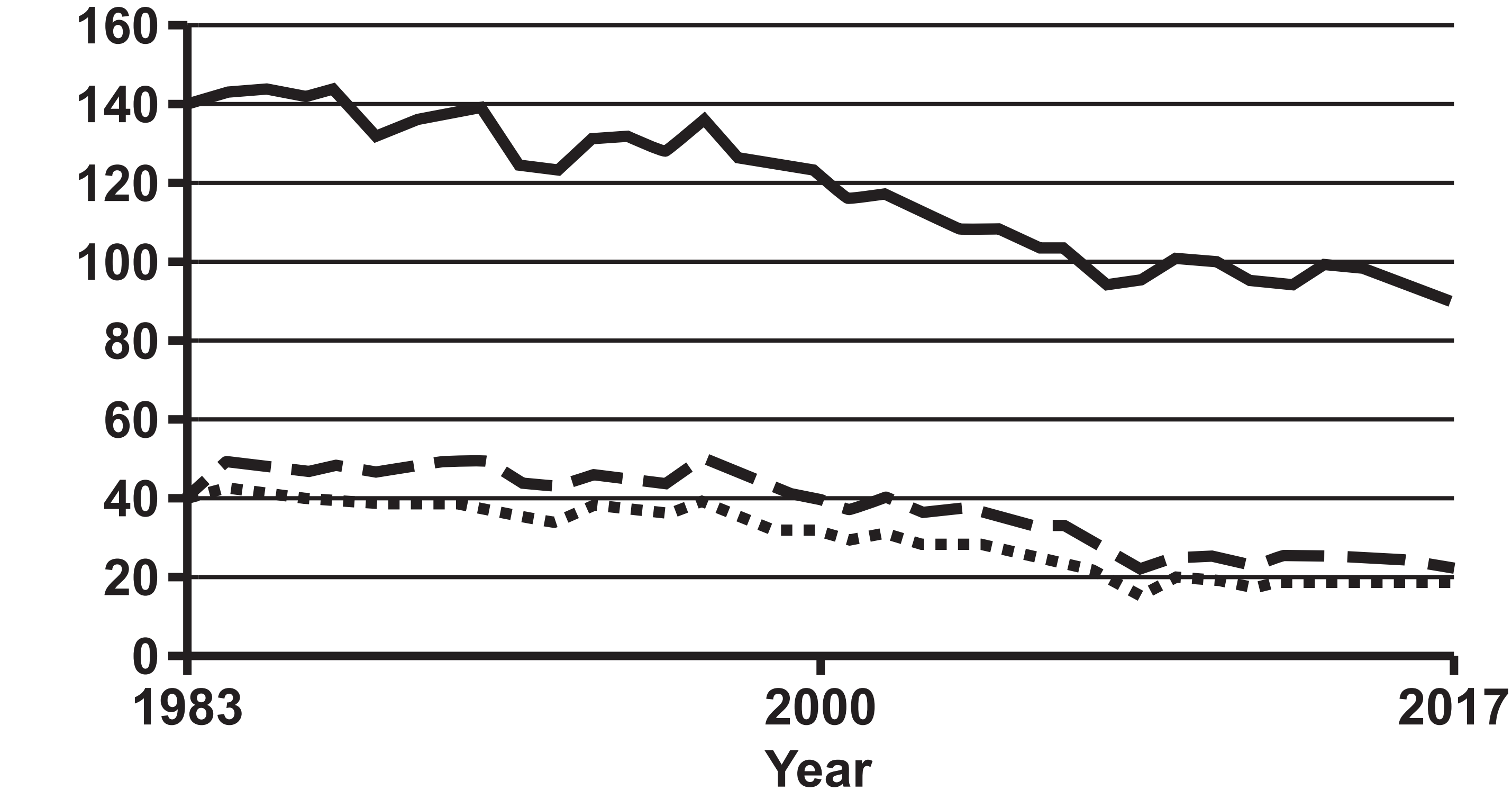
GRAPH 2.2


Mass of nutrient (kg / hectare)
160
140
120
100
80
60
40
20
0
1983
2000
2017
Year

Key for GRAPH 2.2 opposite

nitrate

phosphate

potassium

TABLE 3.1

Sample	Test	Observation	Name of compound tested
1	add dilute acid	colourless gas evolved which turns limewater milky	_____
	flame test	lilac	_____
2	flame test	lilac	_____
	add nitric acid then silver nitrate	white precipitate	_____

TABLE 3.2

Element	A_r
Calcium	40
Sulfur	32
Oxygen	16

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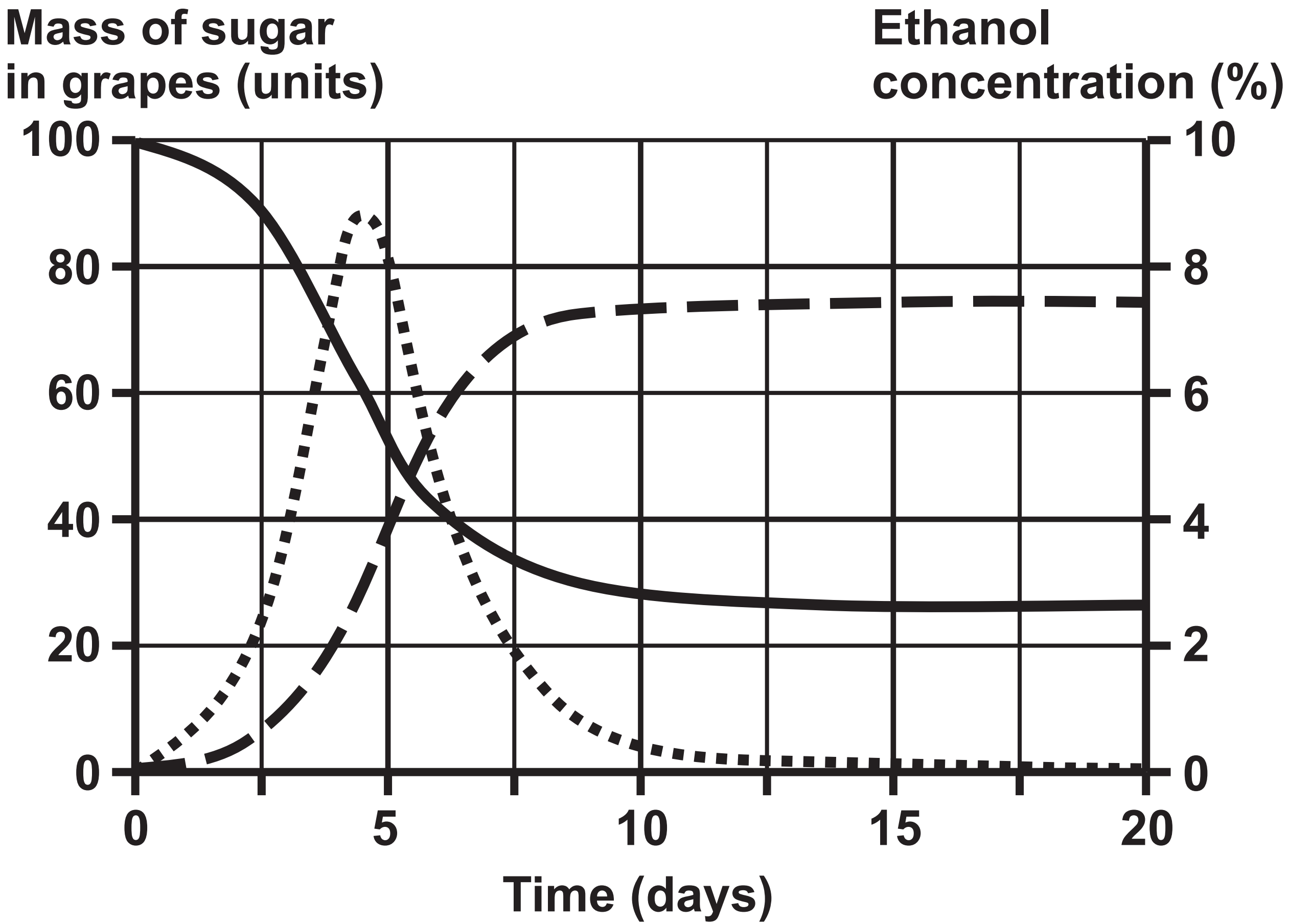
GRAPH 4.1


Mass of sugar in grapes (units)
Ethanol concentration (%)
100
80
60
40
20
0
10
8
6
4
2
0
0
5
10
15
20
Time (days)

Key for GRAPH 4.1 opposite

——— sugar content

– — – ethanol concentration

..... living yeast cells

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TURN OVER

DIAGRAM 5.1

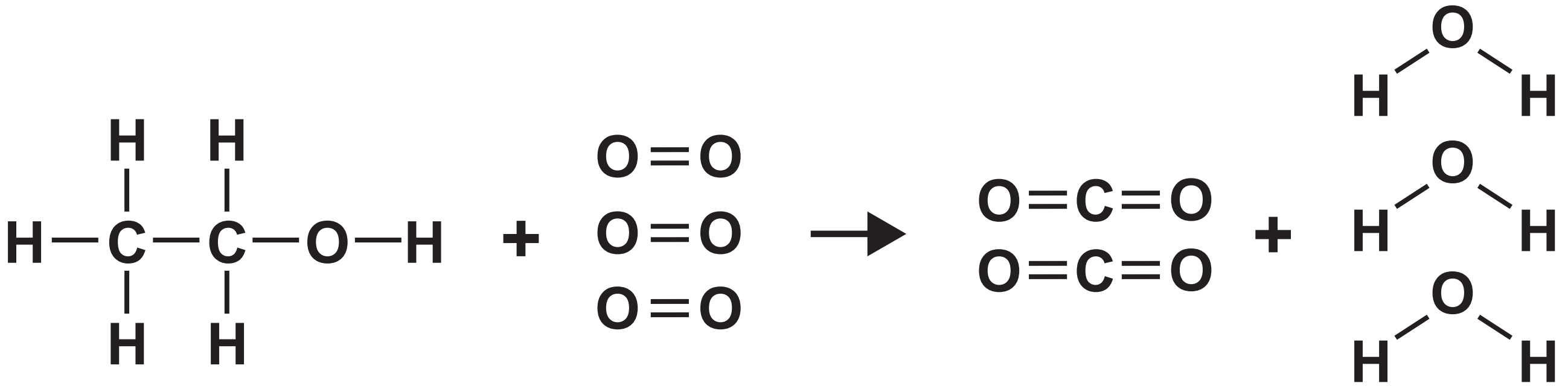
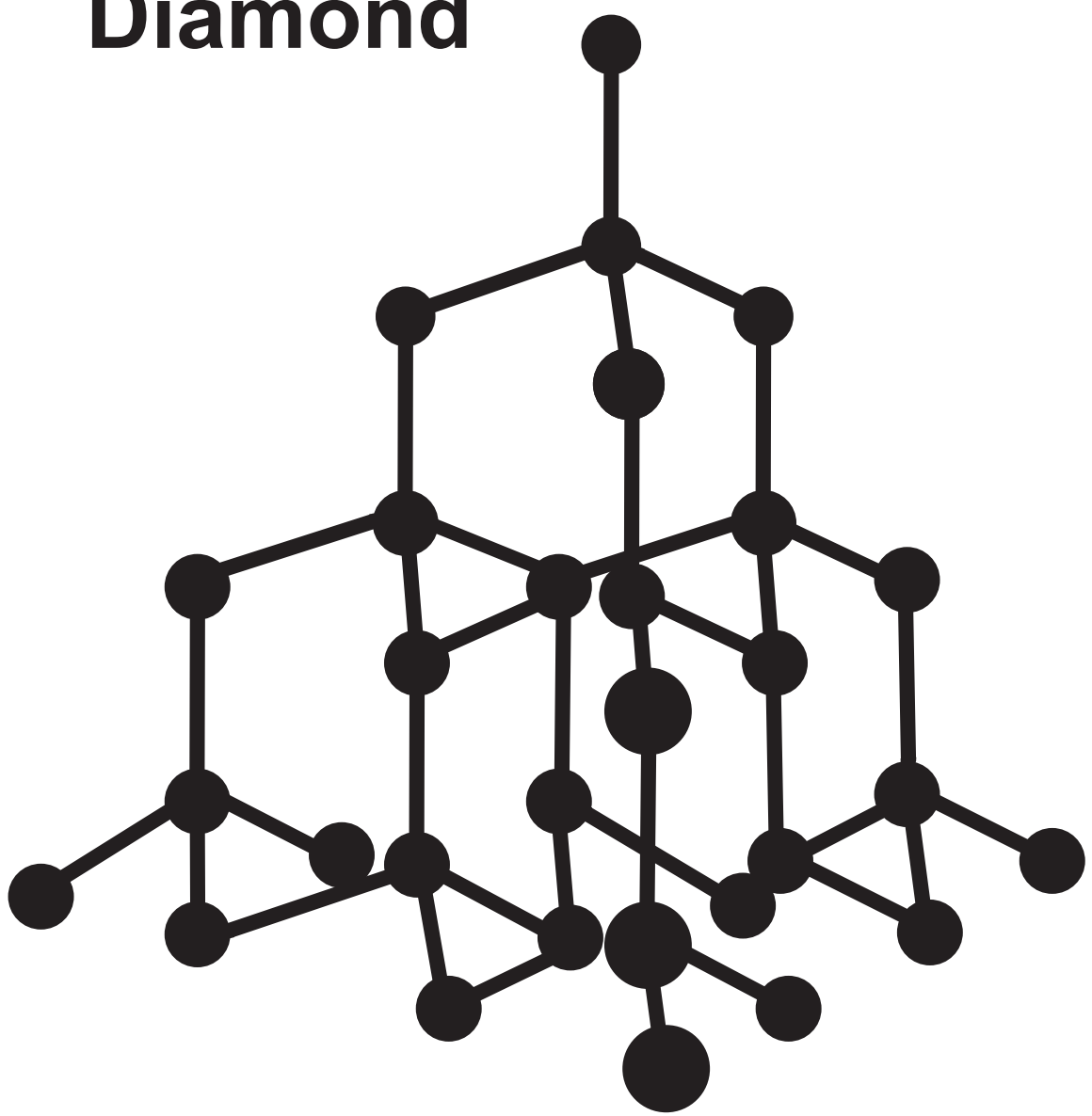


TABLE 5.2

Bond	Bond energy (kJ/mol)
C–C	347
C–H	413
C=O	732
C–O	336
O–H	464

DIAGRAM 6.1

Diamond



Graphite

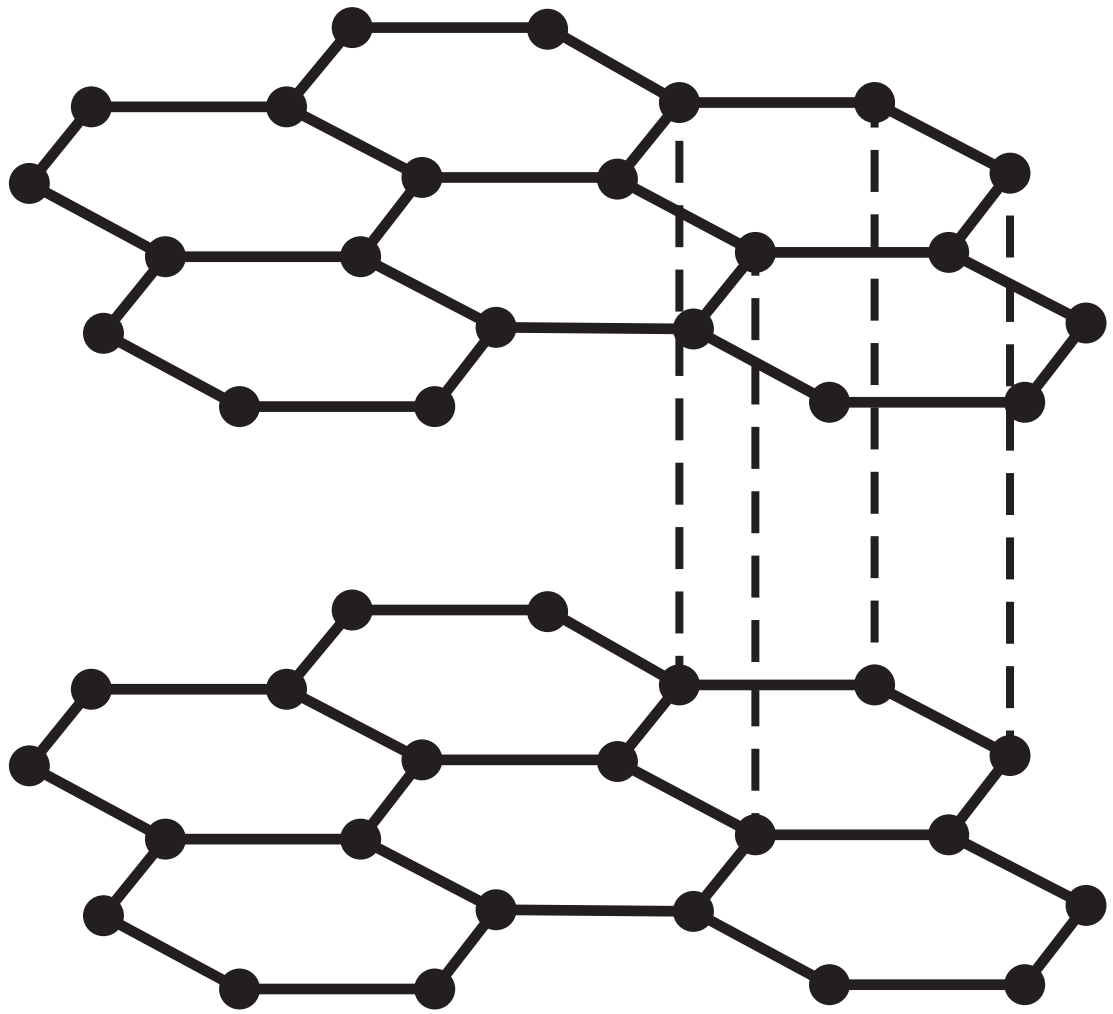
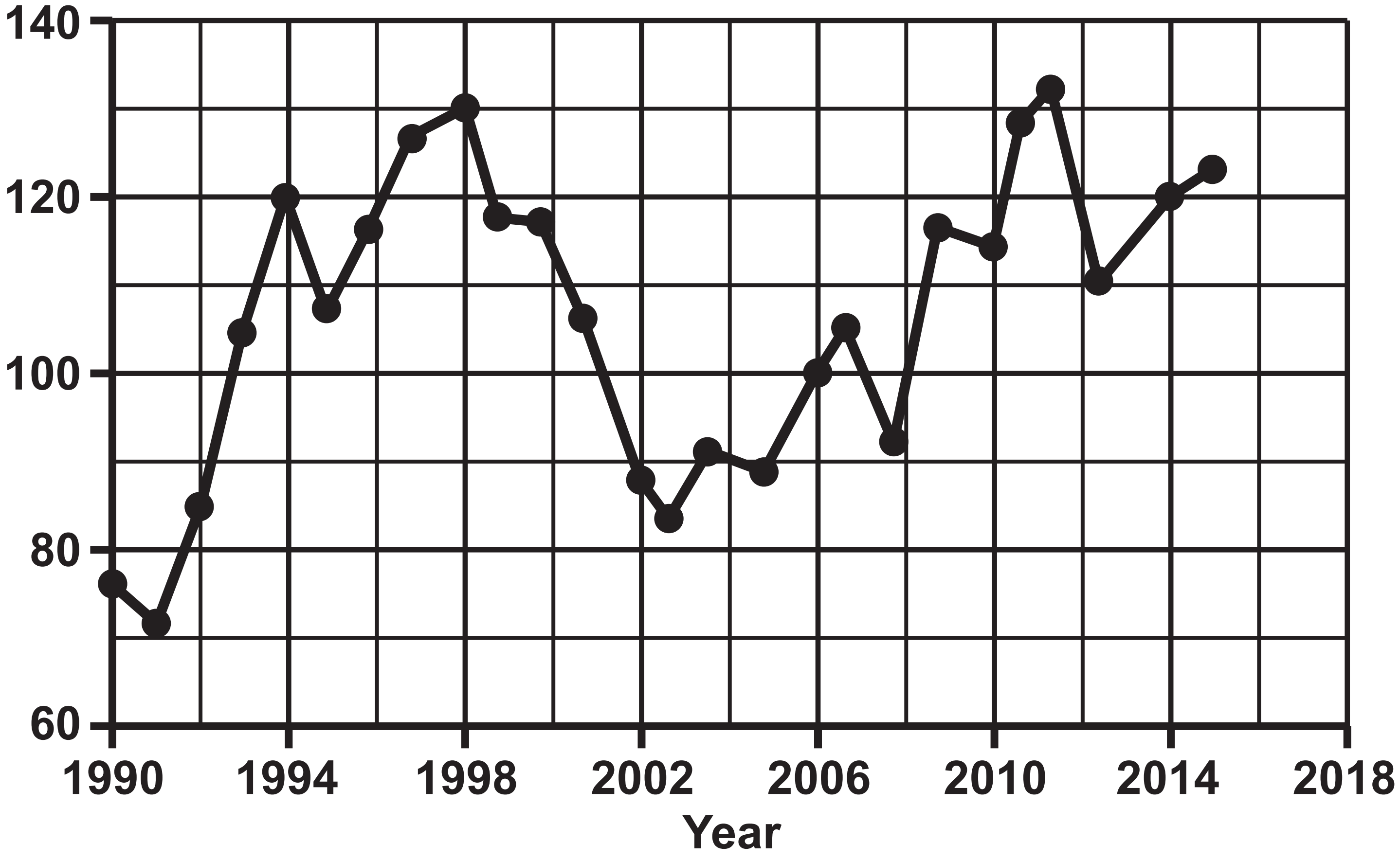


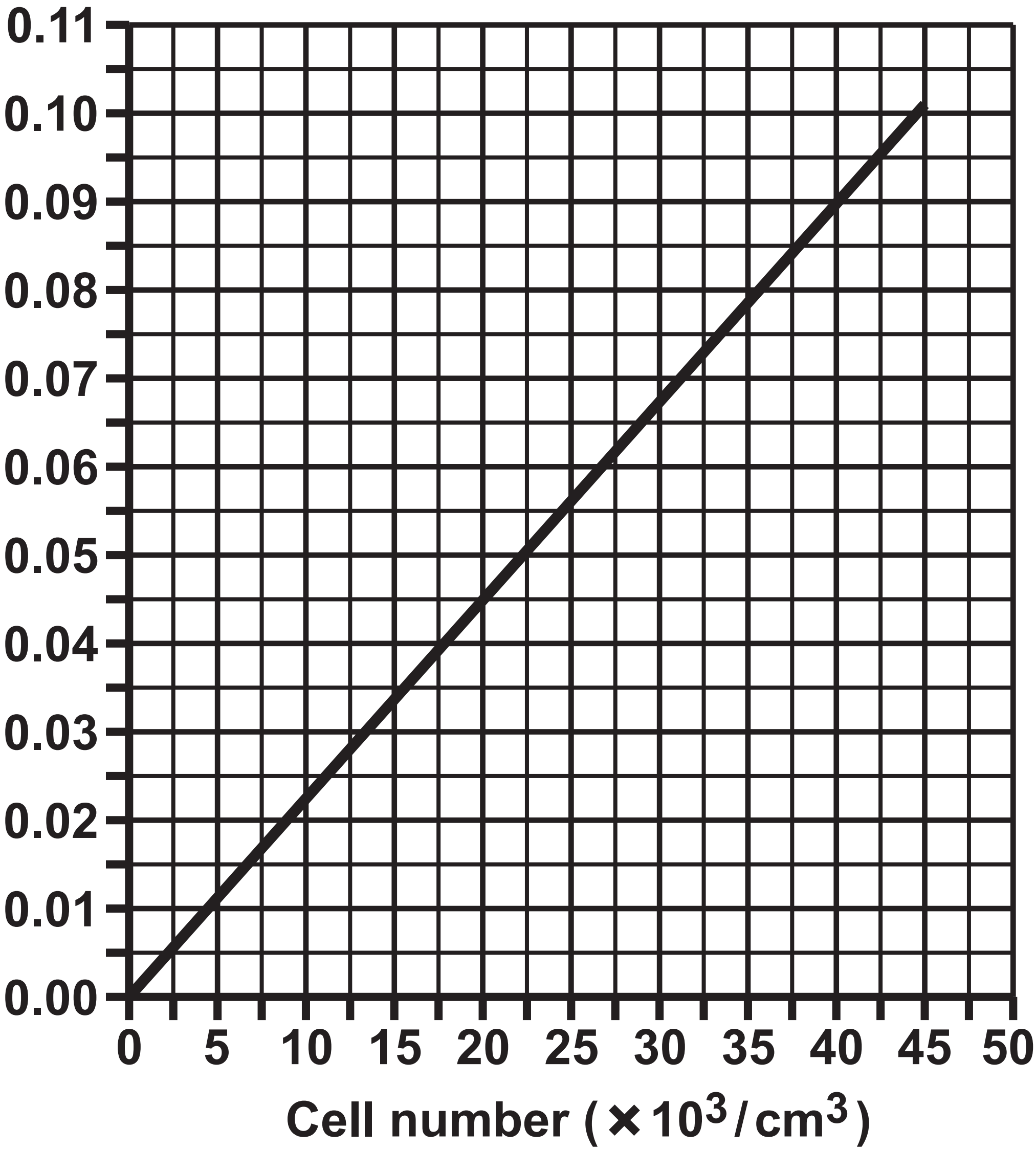
TABLE 6.2

Material	Strength (MPa)	Density (g/cm^3)	Maximum length of power line before it breaks (km)	Electrical conductivity ($\times 10^6$ units)
carbon nanotube	62 000	1.3	4700	>> 1000
steel	500	8.0	6.4	7
aluminium	80	2.7	1.0	40

GRAPH 8.1


Rate per 100 000 of population
140
120
100
80
60
1990
1994
1998
2002
2006
2010
2014
2018
Year

GRAPH 8.2


Absorbance
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0
5
10
15
20
25
30
35
40
45
50
Cell number (×10³/cm³)

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FRIDAY, 10 MAY 2024 – MORNING

APPLIED SCIENCE (Double Award)
UNIT 3: Food, Materials and Processes

HIGHER TIER

Data Booklet

THE PERIODIC TABLE

1	2	GROUP						
								1 H 1
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
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
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
223 Fr 87	226 Ra 88	227 Ac 89						

KEY

A_r	relative atomic mass
Sym	symbol
Z	atomic number

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
59 Ni 28	63.5 Cu 29	65 Zn 30	70 Ga 31	73 Ge 32	75 As 33	79 Se 34	80 Br 35	84 Kr 36
106 Pd 46	108 Ag 47	112 Cd 48	115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
195 Pt 78	197 Au 79	201 Hg 80	204 Tl 81	207 Pb 82	209 Bi 83	210 Po 84	210 At 85	222 Rn 86

THE PERIODIC TABLE

PERIODIC TABLE – KEY
ATOMIC NUMBER – SYMBOL – NAME

1	H – Hydrogen	19	K – Potassium
2	He – Helium	20	Ca – Calcium
3	Li – Lithium	21	Sc – Scandium
4	Be – Beryllium	22	Ti – Titanium
5	B – Boron	23	V – Vanadium
6	C – Carbon	24	Cr – Chromium
7	N – Nitrogen	25	Mn – Manganese
8	O – Oxygen	26	Fe – Iron
9	F – Fluorine	27	Co – Cobalt
10	Ne – Neon	28	Ni – Nickel
11	Na – Sodium	29	Cu – Copper
12	Mg – Magnesium	30	Zn – Zinc
13	Al – Aluminium	31	Ga – Gallium
14	Si – Silicon	32	Ge – Germanium
15	P – Phosphorus	33	As – Arsenic
16	S – Sulfur	34	Se – Selenium
17	Cl – Chlorine	35	Br – Bromine
18	Ar – Argon	36	Kr – Krypton

37	Rb – Rubidium	57	La – Lanthanum
38	Sr – Strontium	72	Hf – Hafnium
39	Y – Yttrium	73	Ta – Tantalum
40	Zr – Zirconium	74	W – Tungsten
41	Nb – Niobium	75	Re – Rhenium
42	Mo – Molybdenum	76	Os – Osmium
43	Tc – Technetium	77	Ir – Iridium
44	Ru – Ruthenium	78	Pt – Platinum
45	Rh – Rhodium	79	Au – Gold
46	Pd – Palladium	80	Hg – Mercury
47	Ag – Silver	81	Tl – Thallium
48	Cd – Cadmium	82	Pb – Lead
49	In – Indium	83	Bi – Bismuth
50	Sn – Tin	84	Po – Polonium
51	Sb – Antimony	85	At – Astatine
52	Te – Tellurium	86	Rn – Radon
53	I – Iodine	87	Fr – Francium
54	Xe – Xenon	88	Ra – Radium
55	Cs – Caesium	89	Ac – Actinium
56	Ba – Barium		