

OCR

Oxford Cambridge and RSA

Level 3 Cambridge Technical in Laboratory Skills

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Unit 1: Science fundamentals

Tuesday 9 January 2018 – Afternoon

Time allowed: 2 hours

You must have:

- a ruler

You may use:

- a scientific or graphical calculator

First Name						Last Name				
Centre Number						Candidate Number				
Date of Birth	D	D	M	M	Y	Y	Y	Y		

INSTRUCTIONS

- Use black ink.
- Complete the boxes above with your name, centre number, candidate number and date of birth.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- If additional answer space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- The Periodic Table is printed on the back page.

INFORMATION

- The total mark for this paper is **90**.
- The marks for each question are shown in brackets [].
- This document consists of **28** pages.

FOR EXAMINER USE ONLY	
Question No	Mark
1	/14
2	/14
3	/17
4	/17
5	/13
6	/6
7	/6
8	/3
Total	/90

Answer **all** the questions.

- 1 The nuclear notations for two of the isotopes of calcium are:



- (a) State the number of protons and electrons in one atom of calcium.

Protons

Electrons

[2]

- (b) Explain what is meant by the term **isotope**.

.....
.....
.....[1]

- (c) The nucleus of calcium-40 is stable.

The nucleus of calcium-51 disintegrates in 10 s.

Explain why the nucleus of calcium-40 does not disintegrate.

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

- (d) Fig. 1.1 shows the relationship between the atomic number and the atomic radius for some of the elements in the Periodic Table.

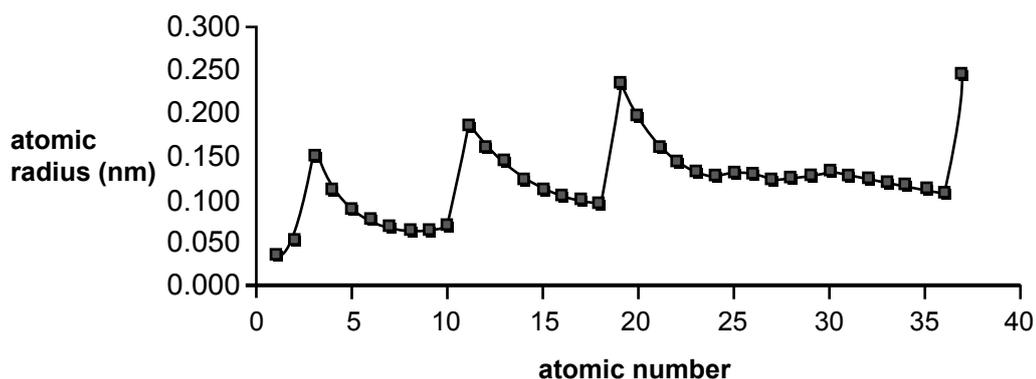


Fig. 1.1

Use Fig. 1.1 to determine the atomic radius of calcium.

Show your working by drawing suitable lines on Fig. 1.1.

Give your answer in **standard form** and include **units**.

atomic radius = units = [3]

- (e) (i) Calcium is in Group 2 of the Periodic Table.

Put a **ring** around the correct number of valence electrons in a calcium atom.

2 **4** **20** **40**

[1]

- (ii) The formula of calcium phosphate is $\text{Ca}_3(\text{PO}_4)_2$.

The calcium ion is Ca^{2+} .

Put a **ring** around the correct formula of the phosphate ion.

PO_4^{3+} PO_4^{4+} PO_4^{3-} PO_4^{4-}

[1]

(iii) Describe the type of bonding in a calcium phosphate molecule.

.....

.....

.....[2]

(b) A by-product of the biodiesel industry is glycerol.

The first stage of the process is the conversion of glycerol into dihydroxyacetone. This is shown in **Fig. 2.2**.

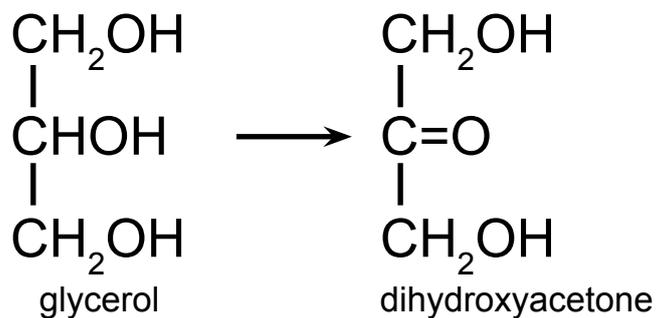


Fig. 2.2

(i) Describe the chemical reaction involved.

You can annotate the equation in **Fig. 2.2** to help with your answer.

.....

.....

.....[3]

- (ii) More complex reactions may lead to the formation of synthetic material such as plastic. One important biodegradable plastic, polylactic acid (PLA), is made by the condensation polymerisation of lactic acid.

The structure of lactic acid is shown in **Fig. 2.3**.

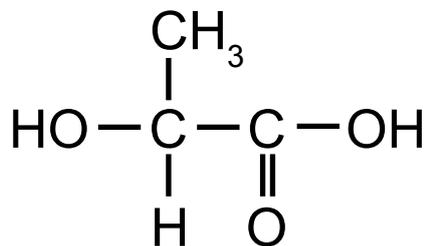


Fig. 2.3

Use the space below to show how this is polymerised to produce PLA.

Include two molecules of lactic acid in your diagram.

[3]

(b) Fig. 3.1 is an electron micrograph of an epithelial cell.

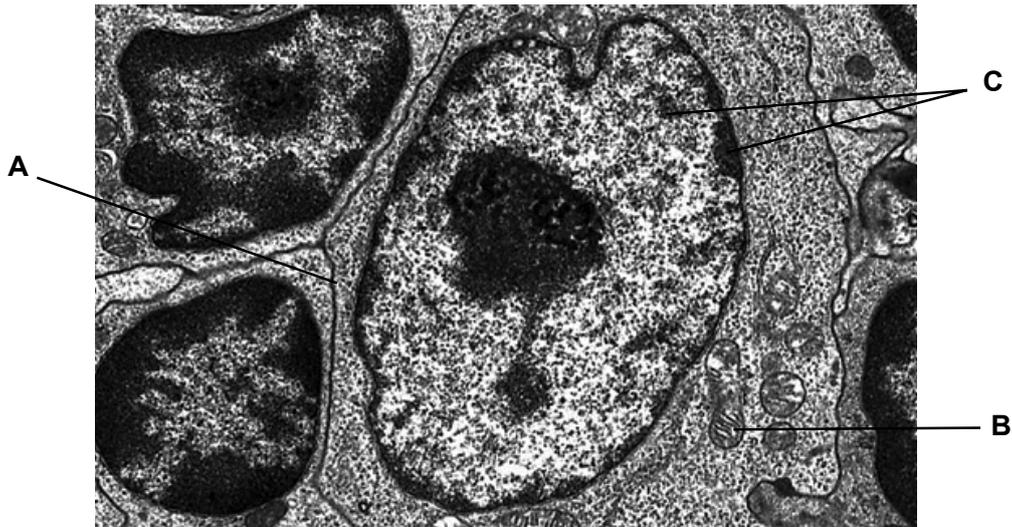


Fig. 3.1

(i) Identify the structures labelled **A** and **B** in Fig. 3.1.

Draw straight lines to join **A** and **B** to the correct name for the labelled parts.

	cell wall
A	plasma membrane
	cytoplasm
	mitochondrion
B	chloroplast
	Golgi apparatus

[2]

(ii) Identify the dense parts of the nucleus labelled **C**.

.....[1]

(iii) For each structure, summarise its role in the cell.

A

.....

.....

B

.....

.....

C

.....

.....

[6]

(c) Fig. 3.2 shows two light micrographs:

- one with normal cervical epithelial cells
- one with cells showing the first signs of transformation into cancer cells.



Cervical smear with normal cells only



Cervical smear that includes cancerous cells

Fig. 3.2

Describe the differences, other than size, between the normal and cancerous cells.

.....

.....

.....

.....[2]

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- 4 Carbohydrates, including starches and sugars, are important biochemicals in biological systems.

(a) The molecule in **Fig. 4.1** is a hexose, or six-carbon sugar.

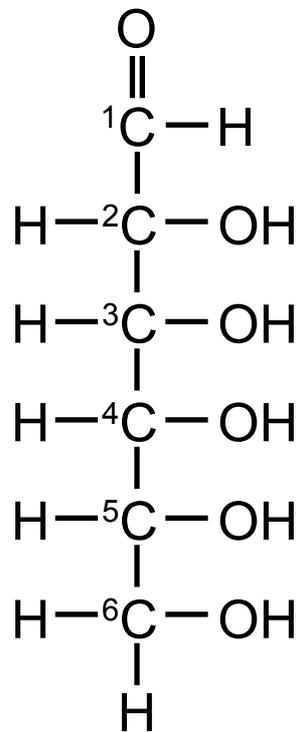


Fig. 4.1

- (i) Name the functional group on carbon atom 1.

.....[1]

- (ii) How many optical isomers will this molecule have? Explain your answer.

.....

[2]

- (iii) Draw **two** of these isomers.

- (iv) When dissolved in water, this type of hexose forms an oxygen bridge between carbon atoms 1 and 5 (**Fig. 4.2**).

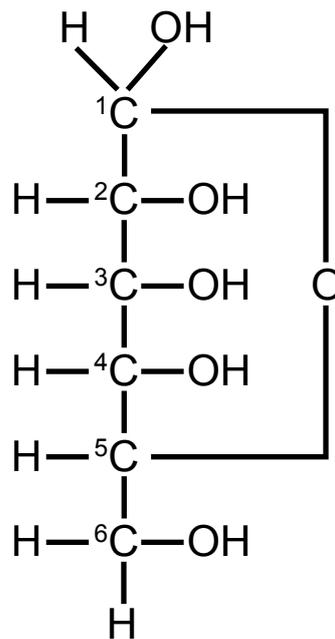


Fig. 4.2

How many isomers will this new hexose have? Explain your answer.

.....

.....

.....[2]

- (b) Waxy maize starch is one of the most recent 'sports carbohydrates' to be sold to athletes. The product claims to help fuel training and sporting events carried out by endurance athletes.

Waxy maize starch consists of a polymer of α -glucose. The structure of α -glucose is shown in **Fig. 4.3**.

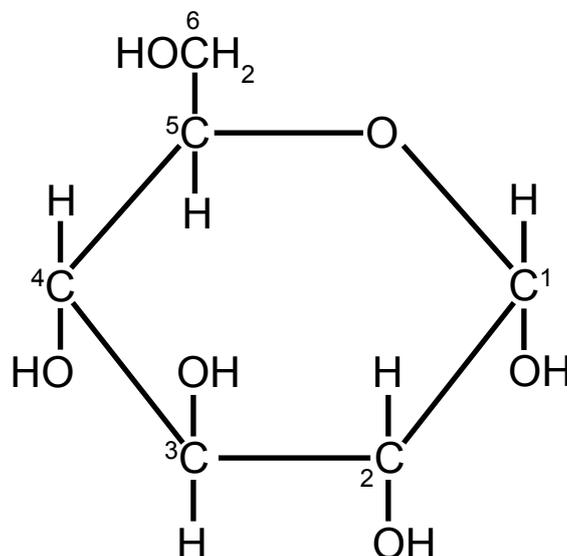


Fig. 4.3

- (i) In waxy maize starch, the glucose molecules are linked with $\alpha 1 \rightarrow 4$ and $\alpha 1 \rightarrow 6$ linkages (bonds).

Using the formula of glucose in **Fig. 4.3**, show how two glucose molecules form an $\alpha 1 \rightarrow 4$ linkage.

[4]

- (ii) Using the formula of glucose in **Fig. 4.3**, show how two glucose molecules form an $\alpha 1 \rightarrow 6$ linkage.

[4]

(iii) Which polymer of glucose is similar in structure to waxy maize starch and is found in animals?

.....[1]

(c) In the past ten years, esters of glucose have become increasingly important chemicals.

They are used widely in the cosmetics industry, and in the food industry as surfactants and foam producers.

One ester bond is formed between the –OH group on carbon atom 6 of a glucose molecule, and the fatty acid, stearic (octadecanoic) acid.

Fig. 4.4 shows stearic acid and a glucose molecule.

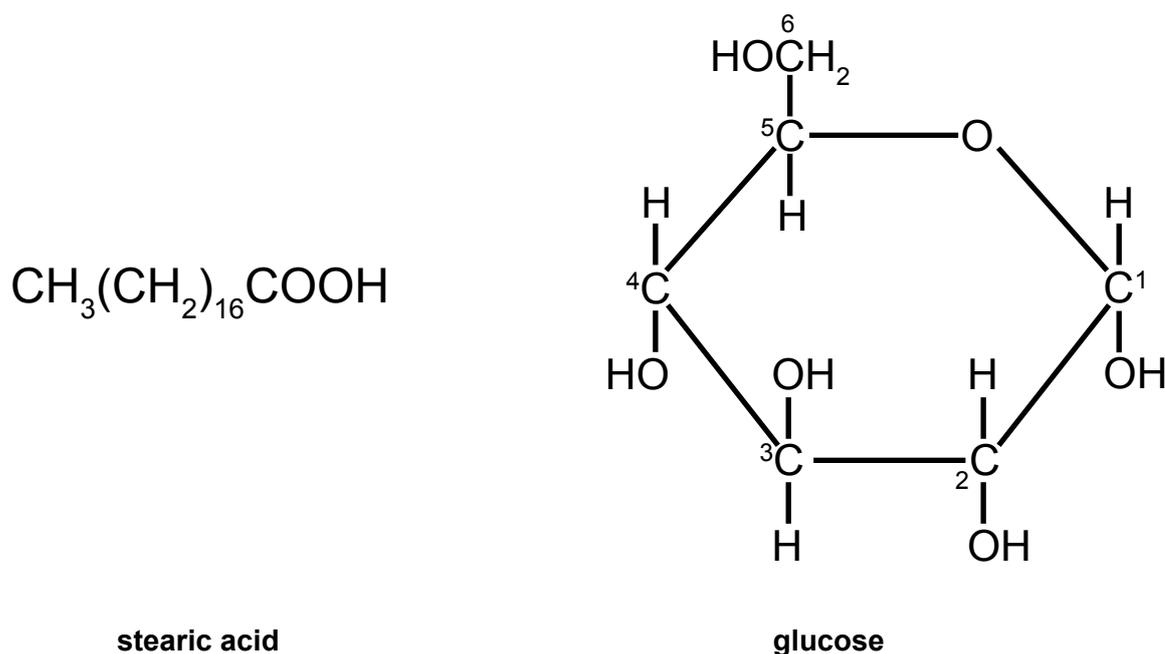


Fig. 4.4

Using the formulae in Fig. 4.4, draw the structure of the ester formed.

[1]

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Turn over for the next question

5 Hydroponics is a method of cultivating plants. It uses a liquid growing medium instead of soil. The use of hydroponics makes it easier to:

- control levels of nutrients given to plants
- vary these levels to meet the requirements of different plant species, and at various times during their development.

(a) The nutrient requirements for tomato plants at two different stages of development are shown in **Table 5.1**.

Element	Recommended concentration in hydroponic medium (parts per million)	
	Newly-transplanted tomato plant seedlings	Older tomato plants (forming their fifth cluster of fruit)
Nitrogen	70.00	150.00
Phosphorus	50.00	50.00
Potassium	120.00	200.00
Calcium	150.00	150.00
Magnesium	40.00	50.00
Iron	2.80	2.80
Copper	0.20	0.20
Manganese	0.80	0.80

Table 5.1

(i) In what form is nitrogen available to plants?

.....[1]

(ii) Give **two** uses of nitrogen in plants.

Put a tick (✓) next to the **two** correct answers.

component of glucose

component of DNA

component of cellulose cell wall

helps the transport of glucose

helps the transport of water

used in protein synthesis

[2]

(iii) Compare the requirements for the different elements of newly-transplanted seedlings and plants forming their fifth cluster of tomatoes.

Use the information in **Table 5.1** in your answer.

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

(iv) Suggest which **two** elements are most important for the development of fruit clusters. Justify your answer.

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

(v) Give **two** reasons why the element manganese is essential for plant growth.

1

.....

2

.....

[2]

(b) A different method, aquaponics, involves the growth of plants in a liquid medium.

This technique utilises the waste water and organic matter from a fish farm.

The waste water provides an excellent source of nitrogen, and other elements, for growing plants.

Fig. 5.1 shows a typical aquaponics system.

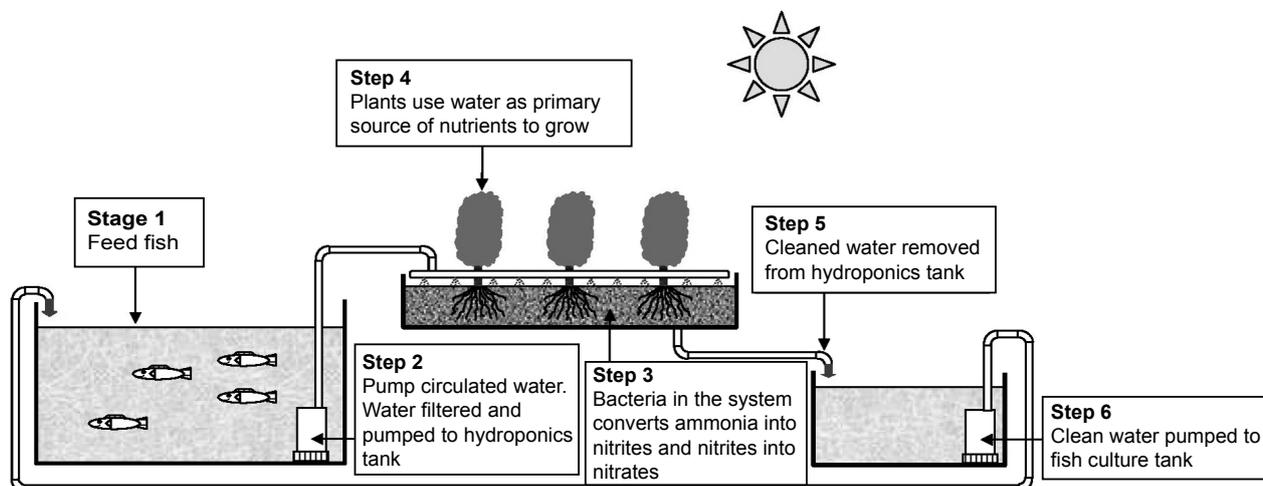
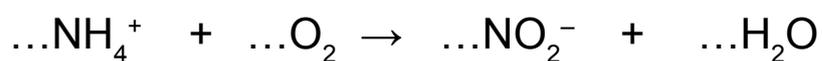


Fig. 5.1

(i) Ammonia produced by the fish is converted to nitrite, then nitrate, by bacteria in the aquaponics system.

The two reactions are shown below. The equations are unbalanced.

Balance the chemical equations.



[2]

(b) How can the arrangement of molecules in a polymer be changed to alter its mechanical properties?

Put a tick (✓) next to the **two** correct answers.

addition of metals

addition of plasticizers

cross-linking

polymerisation

ionic bonding

covalent bonding

[2]

- 7 (a) A charge of 0.04 C moves from point **A** to point **B** in a time of 0.02 s.
10 J of work is done in transferring this charge.

- (i) Calculate the potential difference between point **A** and point **B**.
Show your working.

potential difference =V
[2]

- (ii) Calculate the current between point **A** and point **B**.
Show your working.

current = A
[2]

- (iii) Calculate the power produced in moving the charge.
Show your working.

power = W
[2]

- 8 Three resistors, $R_1 = 5.00 \Omega$, $R_2 = 10.00 \Omega$ and $R_3 = 15.06 \Omega$ are joined together in series and parallel arrangements to produce different combined resistances.

The combined resistances they produce are 11.00Ω , 13.75Ω and 18.30Ω , respectively.

Describe the series and parallel arrangements of R_1 , R_2 and R_3 that produce 11.0Ω , 13.75Ω and 18.3Ω

11.0Ω

13.75Ω

18.3Ω

[3]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s) – for example 1(a) or 2(b).

A large rectangular area containing horizontal dotted lines for writing answers. The lines are evenly spaced and extend across the width of the page, leaving a narrow margin on the left side.

A vertical solid line runs down the left side of the page. To its right, there are 25 horizontal dotted lines spaced evenly down the page, providing a guide for handwriting practice.

The Periodic Table of the Elements

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(0)		
1 H hydrogen 1.0	2 He helium 4.0	3 Li lithium 6.9	4 Be beryllium 9.0	5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
11 Na sodium 23.0	12 Mg magnesium 24.3	13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulphur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9	19 K potassium 39.1	20 Ca calcium 40.1
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium 101.1	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4
55 Cs caesium 132.9	56 Ba barium 137.3	57-71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1
87 Fr francium	88 Ra radium	89-103 actinoids	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium
111 Ag silver	112 Cd cadmium	113 In indium	114 Sn tin	115 Sb antimony	116 Te tellurium	117 I iodine	118 Xe xenon	119 Au gold	120 Hg mercury
121 Tl thallium	122 Pb lead	123 Bi bismuth	124 Po polonium	125 At astatine	126 Rn radon	127 Fr francium	128 Ra radium	129 Ac actinium	130 Th thorium
131 Sb antimony	132 Te tellurium	133 I iodine	134 Xe xenon	135 Ba barium	136 La lanthanum	137 Ce cerium	138 Pr praseodymium	139 Nd neodymium	140 Pm promethium
141 Tl thallium	142 Pb lead	143 Bi bismuth	144 Po polonium	145 At astatine	146 Rn radon	147 Fr francium	148 Ra radium	149 Ac actinium	150 Th thorium
151 Tl thallium	152 Pb lead	153 Bi bismuth	154 Po polonium	155 At astatine	156 Rn radon	157 Fr francium	158 Ra radium	159 Ac actinium	160 Th thorium
161 Tl thallium	162 Pb lead	163 Bi bismuth	164 Po polonium	165 At astatine	166 Rn radon	167 Fr francium	168 Ra radium	169 Ac actinium	170 Th thorium
171 Tl thallium	172 Pb lead	173 Bi bismuth	174 Po polonium	175 At astatine	176 Rn radon	177 Fr francium	178 Ra radium	179 Ac actinium	180 Th thorium
181 Tl thallium	182 Pb lead	183 Bi bismuth	184 Po polonium	185 At astatine	186 Rn radon	187 Fr francium	188 Ra radium	189 Ac actinium	190 Th thorium

Key
atomic number
Symbol
name
relative atomic mass



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