Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3445UC0-1

Z22-3445UC0-1

TUESDAY, 17 MAY 2022 – MORNING

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

HIGHER TIER

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**19**	
2.	**8**	
3.	**8**	
4.	**16**	
5.	**13**	
6.	**11**	
Total	**75**	

3445UC01
01

ADDITIONAL MATERIALS

A calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.
You may use a pencil for graphs and diagrams only.
Write your name, centre number and candidate number in the spaces at the top of this page.
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 **5**(c) is a quality of extended response (QER) question where your writing skills will be assessed.
The Periodic Table is printed on the back cover of the examination paper.

JUN223445UC0101

© WJEC CBAC Ltd.

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© WJEC CBAC Ltd.

Examiner only

Answer **all** questions in the spaces provided.

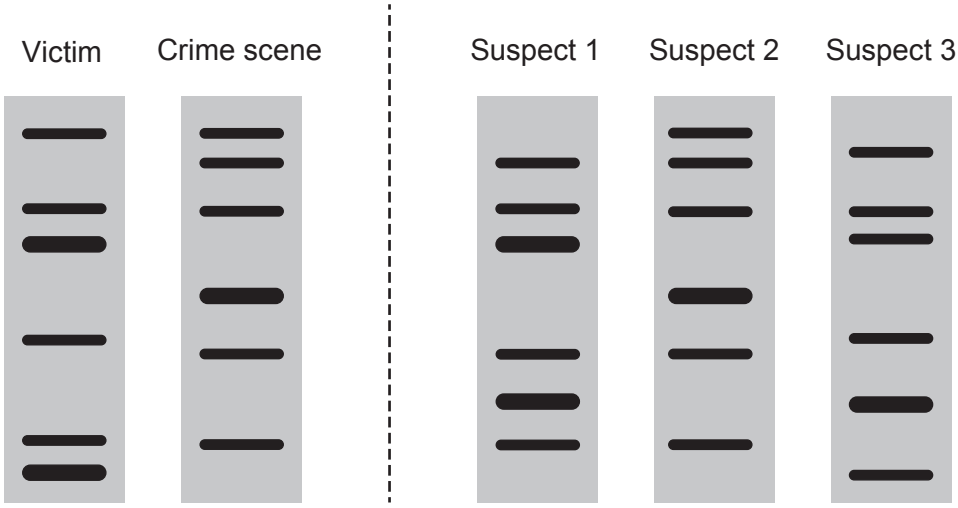
1. Criminals will try to hide their activities but forensic scientists, using biological and chemical testing, are able to find evidence that reveals what happened.

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

(i) State where DNA is found in the cell. [1]

.....

(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.



Compare the DNA samples above to explain whether having an alibi or not is sufficient to decide on guilt. [2]

.....

.....

.....

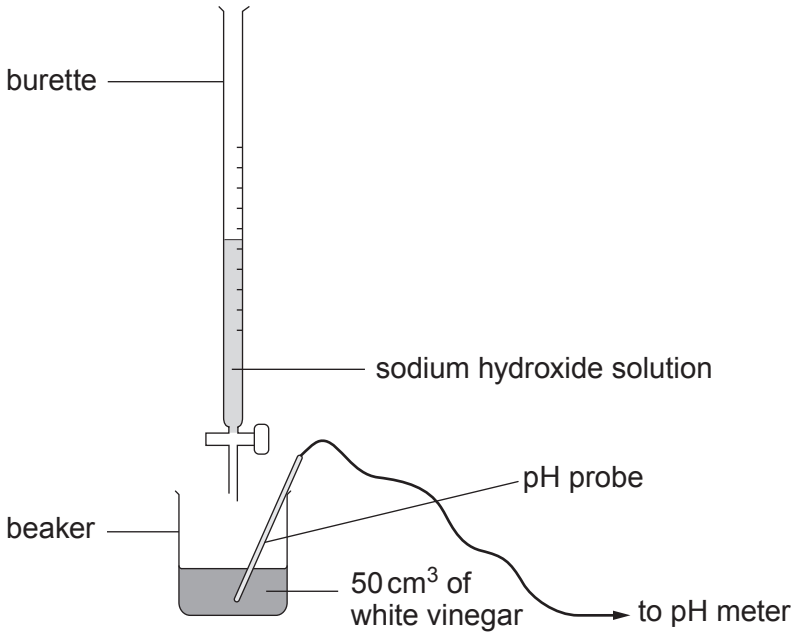
(iii) State **one other** use of DNA profiling. [1]

.....

3445UC01
03

© WJEC CBAC Ltd.

(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 0.01 mol/dm^3. Samples of the vinegar are taken and tested by titrating against 0.5 mol/dm^3 sodium hydroxide solution using the apparatus below.



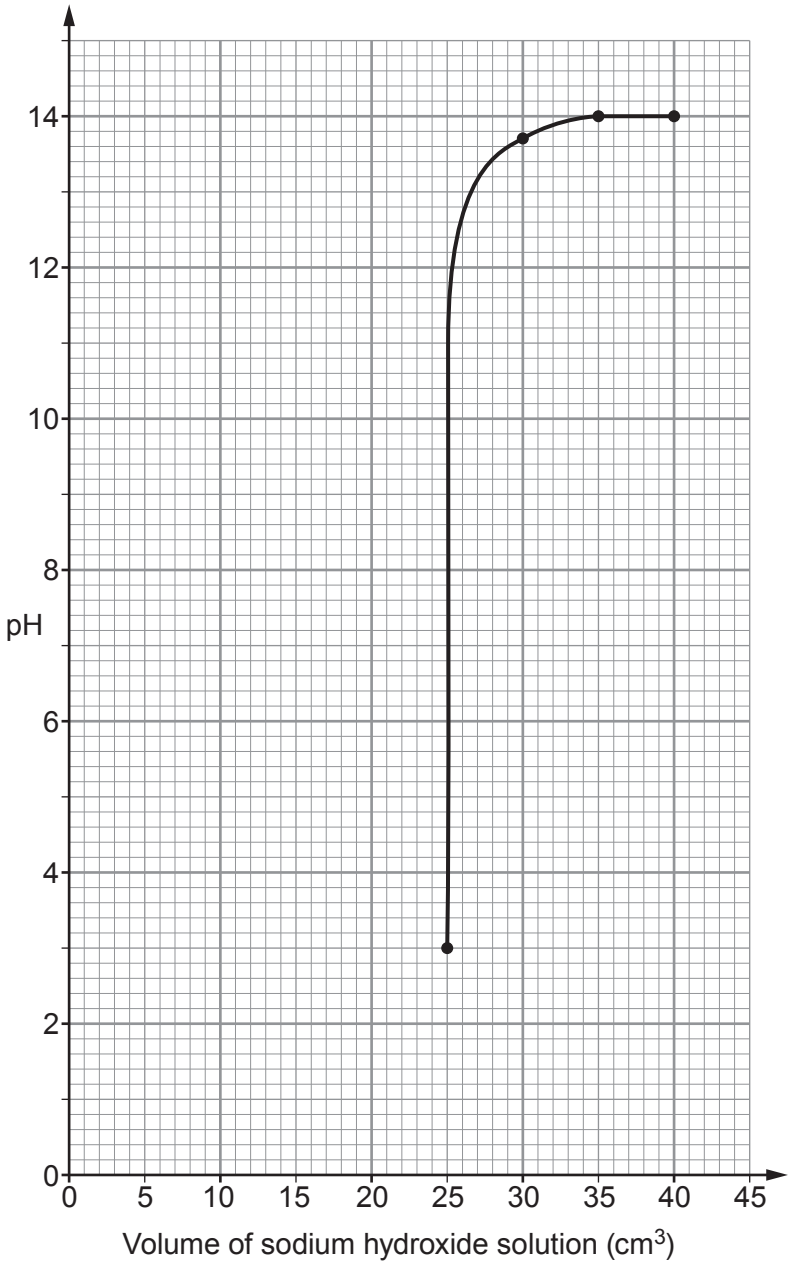
A pH meter is used to monitor the pH of the solution in the flask. The results are shown in the table below.

Volume of sodium hydroxide solution (cm^3)	pH reading
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

© WJEC CBAC Ltd.

Examiner only

(i) Use the data in the table to complete the graph on the grid below. [3]



(ii) Use the graph to find the volume of sodium hydroxide solution required to neutralise the white vinegar. [1]

volume = ... cm^3

3445UC01
05

© WJEC CBAC Ltd.

Turn over.

Examiner only

(iii) Use the information on pages 4 and 5 and the equation

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

to determine whether or not the samples had been tampered with. [3]

.....

.....

(iv) Complete the word equation for the reaction between an acid and a base. [2]

acid + base → .....

(v) Explain why taking multiple readings will increase the accuracy of the result. [2]

.....

.....

.....

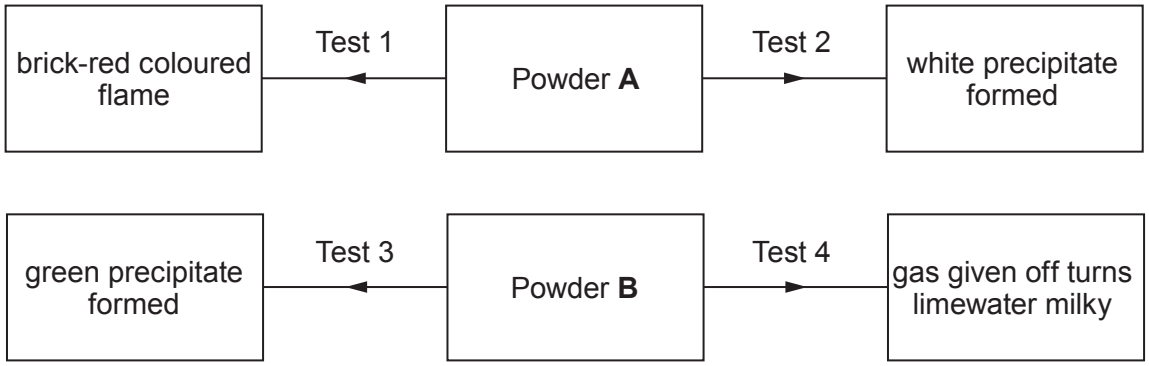
© WJEC CBAC Ltd.

Examiner only

(c) Powders **A** and **B** are collected at a crime scene. The following tests are used to identify them.

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

The results are given below.



Identify powders **A** and **B**. [4]

Powder **A** .....

Powder **B** .....

19

3445UC01
07

© WJEC CBAC Ltd.

Examiner only

2. Microorganisms are regularly used in food production. However, unless precautions are taken, microorganisms can also cause food poisoning.

(a) (i) Describe the process of making cheese from milk. [3]

.....

.....

.....

.....

(ii) State the optimum conditions required in this process. [3]

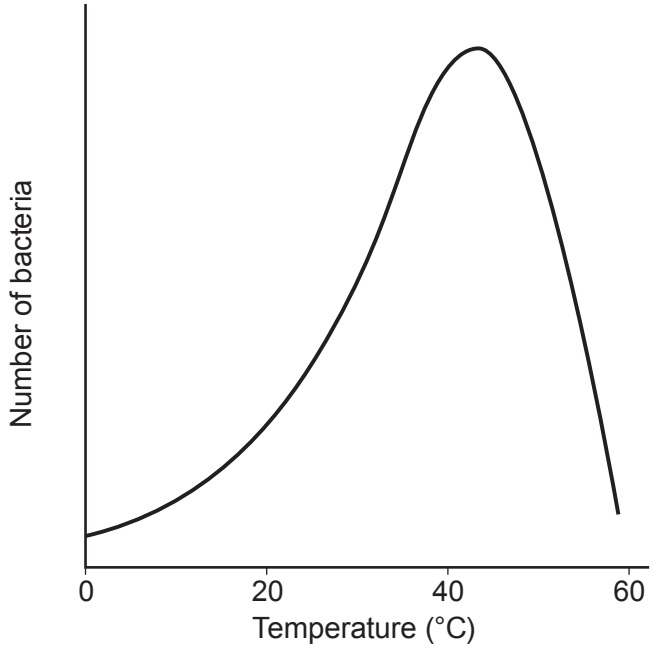
.....

.....

.....

.....

(b) Pasteurisation is a process that allows milk to be stored for longer.
The graph shows how bacterial growth varies with temperature.



Use the information in the graph to explain why milk is pasteurised at temperatures of about 70 °C. [2]

.....

.....

.....

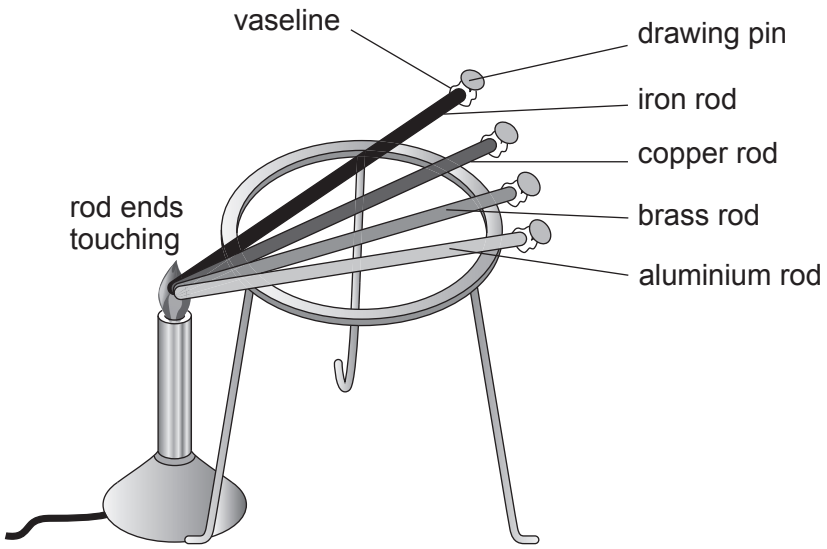
8

© WJEC CBAC Ltd.

Examiner only

3. Metals are good conductors of heat and electricity.

(a) Three students investigated the thermal conductivity of four metal rods as shown below.



State **two** ways in which the students will make the experimental method valid. [2]

.....

.....

.....

.....

(b) The table shows results from the students' investigation together with theoretical values of thermal conductivity.

Metal	Time taken for pin to drop (s)	Thermal conductivity (W/m K)
iron	17	80.4
copper	7	401
brass	12	109
aluminium	5	210

Use the data to explain whether the students' results are as expected. [3]

.....

.....

.....

.....

© WJEC CBAC Ltd.

Examiner only

(c) Explain, in terms of structure and bonding, why the electrical conductivity of sodium chloride is dependent upon its state. [3]

.....

.....

.....

.....

.....

8

4. Food self-sufficiency means that a country produces enough food to feed all of its people without having to import food from other countries.

(a) Discuss the impact of using fertilisers **and** pesticides in farming. [4]

.....

.....

.....

.....

.....

.....

.....

(b) Students investigated the effect of one type of NPK fertiliser.

Rice plants were treated with solutions of different concentrations of this NPK fertiliser. They were treated each day for five weeks.

The growth of each plant was recorded and the results are shown in the table below.

Concentrations of NPK fertiliser (units)	Plant growth after 5 weeks (mm)				
	plant 1	plant 2	plant 3	plant 4	mean
0.2	27	29	32	28	29
0.4	55	57	58	62	58
0.6	65	67	68	72	68
0.8	70	72	73	77	73

© WJEC CBAC Ltd.

Examiner only

(i) Calculate the difference in mean plant growth **per week** for the plants treated with 0.2 and 0.6 units of NPK fertiliser. [3]

difference = ... mm/week

(ii) John suggests that mean growth **always** doubles if the concentration of fertiliser is doubled. Use data from the table to explain whether you agree with him. [3]

.....

.....

(c) Describe how plant breeding programmes are used to produce crops with higher rice yields. [4]

.....

.....

.....

.....

.....

.....

.....

(d) Hydroponics is used to grow plants under controlled conditions.
Describe how hydroponics differs from traditional methods of growing plants. [2]

.....

.....

.....

.....

16

© WJEC CBAC Ltd.

Examiner only

5. The release of a cloud of highly toxic methyl isocyanate **(MIC)** gas from a pesticide plant in Bhopal led to the deaths of thousands of people.
On the night of the disaster **MIC** reacted with water that leaked into a storage tank, causing an explosion. As a result, **MIC** was released into the atmosphere.

The chemical formula of MIC is CH_3NCO and the equation for the reaction of MIC with water is shown below.

$$2CH_3NCO + H_2O \rightarrow C_3H_8N_2O + CO_2$$

(a) Calculate the relative molecular mass *(M_r)* of MIC using information from the Periodic Table on page 16. Show your workings, starting with the relative atomic mass (A_r) of each element found in **MIC**. [4]

M_r = ...

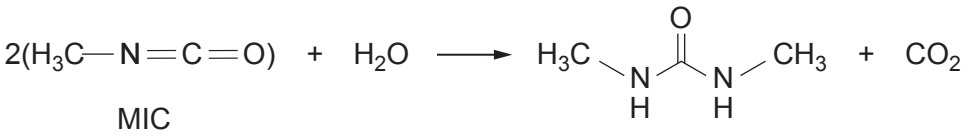
(b) Approximately 30 000 kg of MIC gas was released. Calculate the number of moles released to three significant figures using your answer in (a). [3]

number of moles = ...

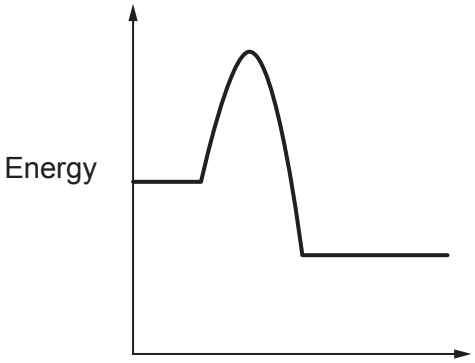
© WJEC CBAC Ltd.

Examiner only

(c) The structural equation and reaction pathway for the reaction causing the explosion in the Bhopal plant are shown below.



1,3–dimethylurea



Use **all** the information above to explain why the reaction between MIC and water resulted in an explosion in terms of reaction pathway, bond energies and thermal runaway. [6 QER]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

13

© WJEC CBAC Ltd.

Examiner only

6. Modern javelins are made of aluminium alloys or aluminium composite materials.

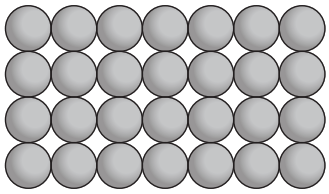
(a) Describe what is meant by the term 'composite material'. [2]

.....

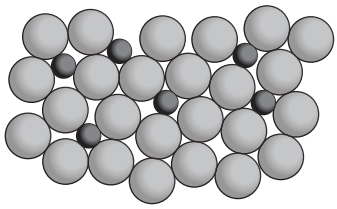
.....

.....

(b) Pure aluminium is too flexible to make javelins. Copper can be mixed with aluminium to produce an alloy.



Pure aluminium



Copper and aluminium alloy

Use the diagrams and your own knowledge of alloys to explain how the presence of copper atoms in the aluminium results in the alloy being more rigid than pure aluminium. [3]

.....

.....

.....

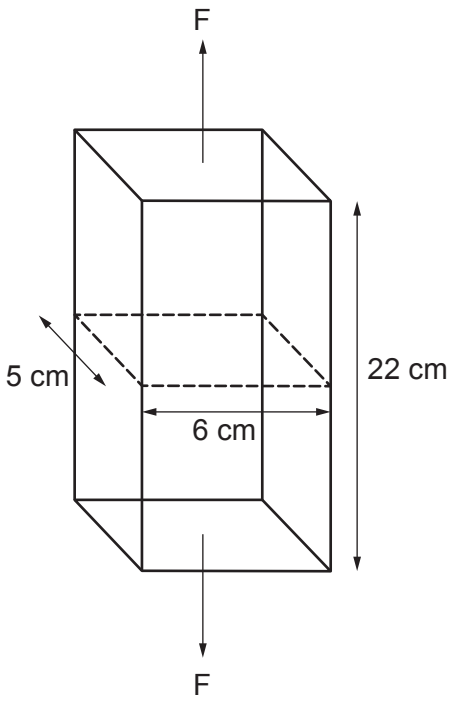
.....

.....

© WJEC CBAC Ltd.

Examiner only

(c) An engineer was asked to determine the force required to break a pure aluminium rectangular bar.



The tensile strength of pure aluminium is 90 MN/m^2.

Use the information above and the equation

$$\text{tensile strength} = \frac{\text{force}}{\text{cross-sectional area}}$$

to calculate the force (F) required to break this bar. [6]

(1 MN = 10^6 N and 1 cm^2 = 10^{-4} m^2).

force (F) = ... N

11

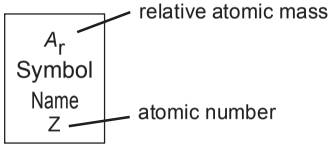
END OF PAPER

© WJEC CBAC Ltd.

THE PERIODIC TABLE

1	2	Group										3	4	5	6	7	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key



© WJEC CBAC Ltd.

16