OCR
Oxford Cambridge and RSA

Monday 14 January 2019 – Morning

LEVEL 3 CAMBRIDGE TECHNICAL IN APPLIED SCIENCE

05847/05848/05849/05874/05879 Unit 2: Laboratory techniques

Duration: 2 hours

C341/1901

C341 – 1901

You must have:
- a ruler
- the Data sheet (Insert) (C349)

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 **24** pages.

FOR EXAMINER USE ONLY	
Question No	**Mark**
1	/16
2	/15
3	/15
4	/15
5	/15
6	/14
Total	**/90**

Answer **all** the questions.

1 HeLa cells are cancer cells that are grown in cell culture in research laboratories across the world.

(a) HeLa cells were first removed from a cancer patient called Henrietta Lacks before she died in 1951.

The cells have been kept in culture since then.

Describe **three** key features of cell cultures.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(b) The following is part of a protocol for producing a culture of HeLa cells from stored, frozen HeLa cells.

1 Place 10 cm^3 of DMEM growth medium in a 50 cm^3 conical tube.

2 Remove a vial of frozen HeLa cells from the freezer and thaw them.

3 Transfer the cells in the vial to the conical tube.

4 Spin the cells in a centrifuge.

5 Remove the liquid with a glass Pasteur pipette, leaving the cells behind.

6 Add 15 cm^3 of fresh DMEM growth medium and resuspend the cells by pipetting up and down.

7 Transfer the 15 cm^3 of cell suspension to a flat-bottomed, glass culture flask.

8 Place the culture flask in an incubator containing 5% carbon dioxide.

(i) Describe how DMEM growth medium can be sterilised.

.....

.....

.....

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

(ii) Describe how the Pasteur pipette is sterilised and kept sterile until used.

.....

.....

.....

.....**[3]**

(iii) Describe how the culture flask is sterilised.

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

(c) Suggest **three** actions that would help to maintain a sterile work area.

1.....

.....

2.....

.....

3.....

.....

[3]

(d) The culturing of cells in a laboratory involves the use of standard aseptic procedures.

Bacteria are often added to the surface of growth media in an agar plate by streaking the plate.

Complete **Table 1.1** by describing **four** essential steps required when streaking an agar plate with bacteria.

Step	Description
1	
2	
3	
4	

Table 1.1

[4]

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

2 Aki is an astrobiologist. He is studying small aquatic animals called tardigrades, also called water bears.

(a) The average length of a tardigrade is 0.5 mm. The largest is 1.2 mm in length.

(i) Aki is collecting tardigrades from wet plants in a meadow.

Suggest a piece of equipment he can use to help him to see tardigrades on the plants.

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

(ii) In the laboratory, Aki produces a digital image of one of the tardigrades that he has collected.

The image is shown in **Fig. 2.1**.

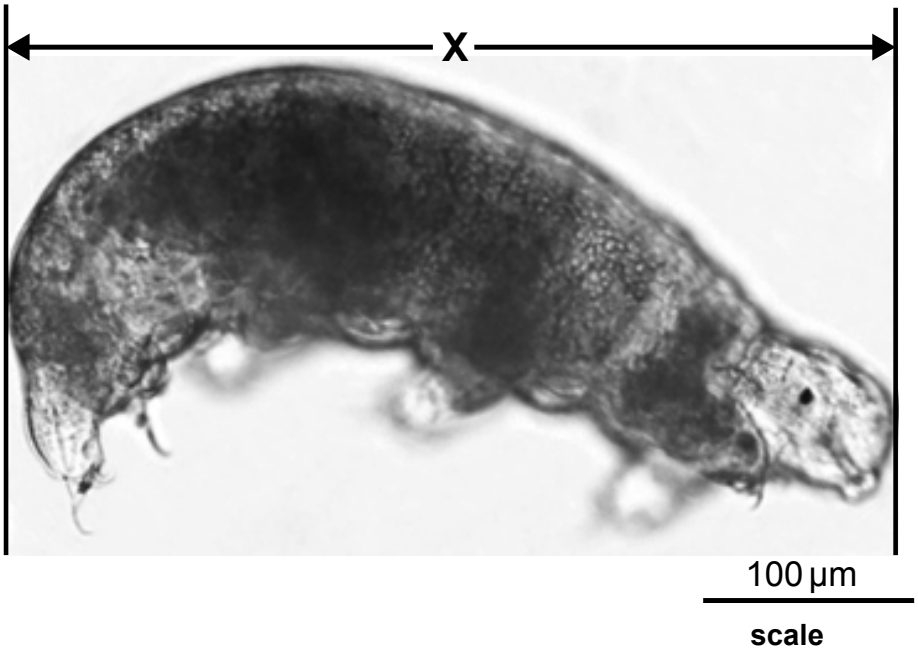


Fig. 2.1

What type of microscope was used to produce the image in **Fig. 2.1**?

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

(iii) Calculate the length of the tardigrade, as shown by line **X** in **Fig. 2.1**.

Show your working.

length of tardigrade = ... µm

[3]

(iv) Calculate the magnification of the tardigrade in **Fig. 2.1**.

Use the formula: magnification = measured size ÷ actual size

magnification = × .....

[3]

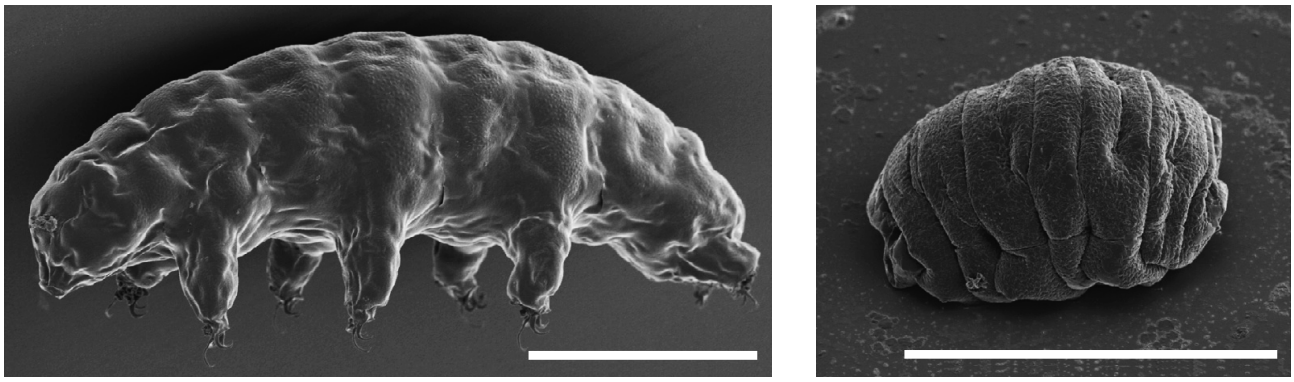
(b) Aki is researching the ability of tardigrades to survive for periods of time in extreme conditions.

He is exploring their potential to travel in space.

Aki dehydrates a number of tardigrades.

Fig. 2.2 shows one tardigrade in its normal and dehydrated state.

The scale bars represent 100 µm.



Normal **Dehydrated**

Fig. 2.2

(i) What type of microscope has been used to produce the images in **Fig. 2.2**?

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

(ii) Describe **one advantage** and **one disadvantage** of the microscope used in **Fig. 2.2** to investigate the effects of dehydration on the tardigrade.

Advantage .....

.....

.....

Disdavantage .....

.....

.....

[2]

(iii) The body of a tardigrade:

- consists of divisions called segments
- has four pairs of legs
- has claws on each leg
- has a head with a mouth that pierces plant food.

Describe the effects of dehydration on the tardigrade shown in **Fig. 2.2**.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

3 Andy is a Health and Safety Manager in a large pathology laboratory.

(a) The pathology laboratory receives and then analyses blood samples.

(i) Describe and explain the Health and Safety procedures followed by his employees when working with blood suspected of being contaminated with pathogens.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....**[6]**

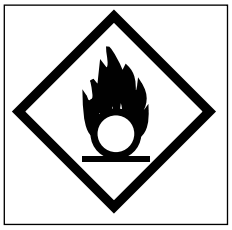
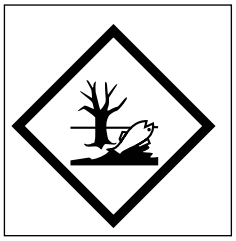
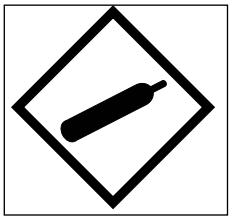
(ii) Blood can be contaminated with other substances in addition to pathogens.

Suggest **one** other contaminant substance of blood samples.

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

(b) The laboratory uses some chemical agents which may be hazardous.

(i) Draw lines to link the pictograms to the correct hazard description.

Pictogram	Hazard description
	Corrosive
	Gas under pressure
	Health hazard
	Irritant
	Oxidising
	Toxic to the aquatic environment

[4]

(ii) The pathology laboratory uses a form to compile a risk assessment for each laboratory activity.

Suggest **four** sections that should make up a risk assessment form.

1.....

2.....

3.....

4.....

[4]

4 Amy is using High Performance Liquid Chromatography (HPLC) to analyse drugs for contaminants.

(a) **Fig. 4.1** shows a diagram of HPLC.

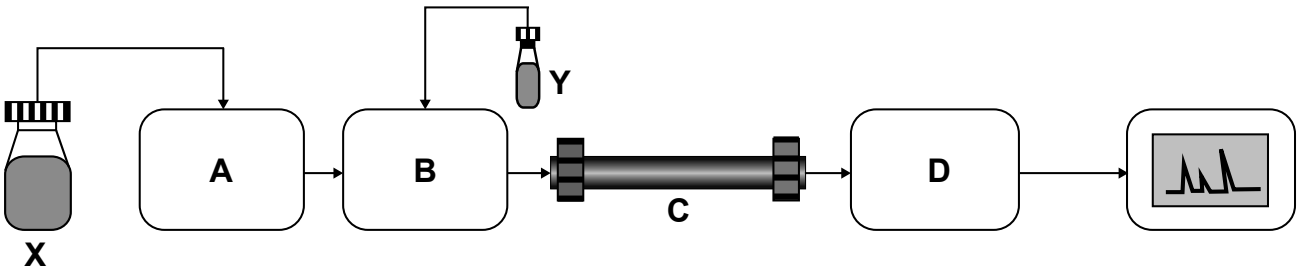


Fig. 4.1

(i) Identify the four parts of the HPLC labelled **A**, **B**, **C** and **D** in **Fig. 4.1**.

Draw lines to link the letter to the correct part shown in **Fig. 4.1**.

A	Column
B	Detector
C	Injector
D	Pump

[4]

(ii) Complete **Table 4.1** to identify the **two** components of the process, **X** and **Y**, as shown in **Fig. 4.1.**

Letter	Component of the HPLC process
X	
Y	

Table 4.1

[2]

(b) The retention factor (*k*) is a way of assessing the retention of an analyte on an HPLC column.

The retention factor is equal to the ratio of the retention time of the analyte on the column to the retention time of a non-retained compound.

The retention factor is given by the equation:

$$k = \frac{(t_R - t_0)}{t_0}$$

t_R = retention time of the analyte

t_0 = retention time of the non-retained compound.

Amy is analysing samples of codeine suspected of being contaminated with drug **W**.

She must first assess the suitability of different stationary phases.

She uses the same mobile phase each time.

Fig. 4.2 shows her results using a Discovery C8 column.

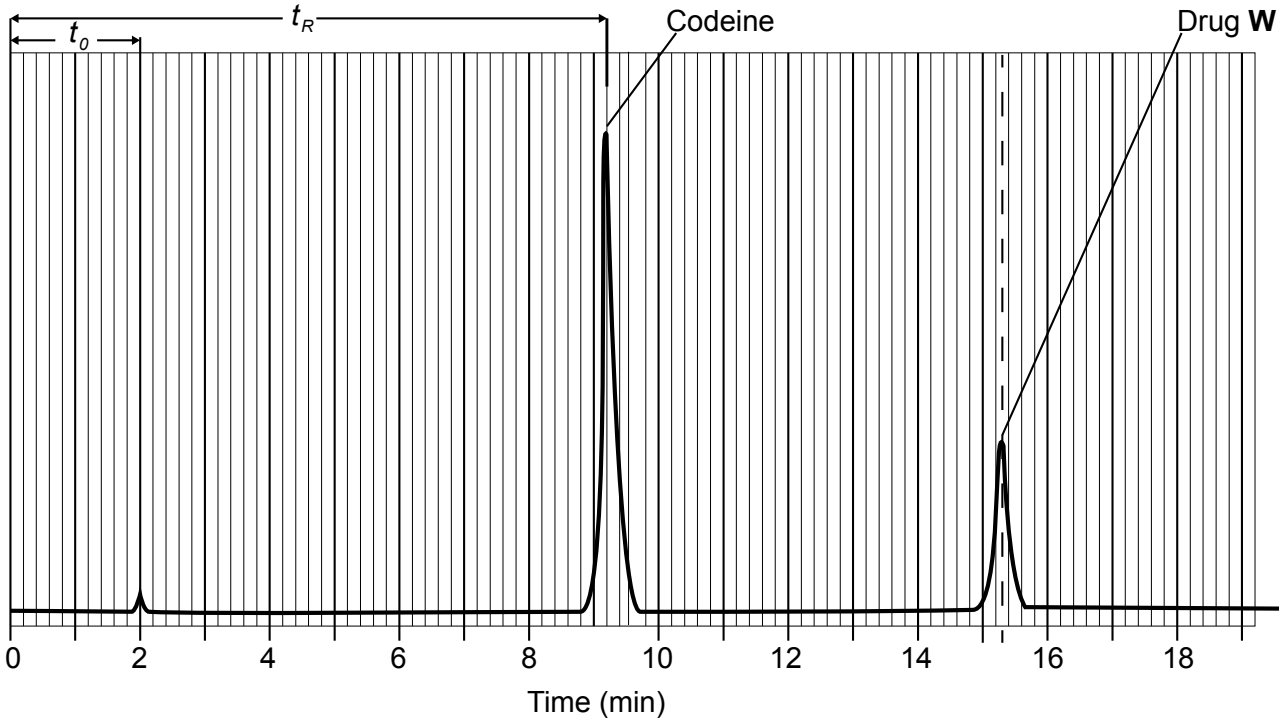


Fig. 4.2

The retention factor (*k*) for codeine is 3.6.

Calculate the retention factor (*k*) for drug **W** using the results shown in **Fig. 4.2**.

Show your working.

retention factor (*k*) = ...

[4]

(c) The selectivity factor (α) is the ability of the column to distinguish between the two drugs in the sample.

It is the ratio of the two retention factors of the two peaks observed, given by the formula:

$$\alpha = \frac{k_2}{k_1}$$

α = selectivity factor
k_1 = retention factor of first peak
k_2 = retention factor of second peak

Table 4.3 shows the characteristics of some HPLC columns.

HPLC column	Analyte	Retention factor (*k*)	Selectivity factor (α)
Discovery C8	Codeine		1.86
	Drug W		
Discovery Cyano	Codeine	1.00	1.60
	Drug W	1.60	
Discovery RP-Amide 16	Codeine	2.80	3.00
	Drug W	8.40	
Discovery C18	Codeine	3.30	2.30
	Drug W	7.70	

Table 4.3

(i) Which HPLC column in **Table 4.3** gives the best separation of the two drugs?

Tick (✓) **one** box.

Discovery C8 ☐

Discovery Cyano ☐

Discovery RP-Amide 16 ☐

Discovery C18 ☐

[1]

(ii) Explain your answer to **(c)(i)**.

.....

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

(d) Suggest **one** reason why Amy is using HPLC as a separation technique rather than Gas Chromatography (GC).

.....

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

(e) When analysing samples of drugs, Amy must be absolutely certain that the peaks separated are codeine and drug W.

(i) Which other technique would confirm her identification of these compounds?

Tick (✓) **one** box.

Electrophoresis ☐

GC mass spectrometry ☐

HPLC mass spectrometry ☐

Serial dilution ☐

[1]

(ii) Which technique would give a quick separation of the two drugs in the sample?

Tick (✓) **one** box.

Electrophoresis ☐

Polymerase Chain Reaction (PCR) ☐

Serial dilution ☐

Thin Layer Chromatography (TLC) ☐

[1]

5 The acidity of milk increases as it ages. This is due to the increase in the lactic acid content.

Lactic acid is a **weak acid**.

Dairy technicians often use an acid-base titration to measure the concentration of lactic acid in milk samples.

Milk samples are titrated against a solution of sodium hydroxide.

(a) Jo is a dairy technician.

The first thing she does is standardise a solution of sodium hydroxide which is approximately 0.1 mol dm^{-3}. She does this by titrating a measured volume of 0.100 mol dm^{-3} potassium hydrogen phthalate (KHP) (which is a primary standard) against the sodium hydroxide.

The relative formula mass of KHP is 204.2 g mol^{-1}.

Calculate the mass of KHP needed to prepare 500 cm^3 of 0.10 mol dm^{-3} solution.

mass = ... g

[4]

(b) Describe the technique Jo uses to standardise the sodium hydroxide solution.

In your answer include the equipment she uses.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....**[6]**

(c) Jo now carries out a titration of the standardised sodium hydroxide against the milk.

The titration shows that 0.025 dm^3 of a milk sample contains 4.2×10^{-4} moles of lactic acid.

The relative formula mass of lactic acid is 90.1 g mol^{-1}.

Calculate the concentration, in g dm^{-3}, of lactic acid in the milk.

Use the equation: $c = n \div V$
c = concentration (mol dm^{-3})
n = number of moles
V = volume (dm^3)

Give your answer to **2** decimal places.

concentration = ... g dm^{-3}

[5]

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

6 Sam reads an old chemistry textbook in her college library.

The book describes an experiment where 1 dm^3 of seawater is heated and evaporated in stages.

At each stage, as the water is reduced in volume, chemicals come out of solution as a solid residue.

Each solid residue that separates is filtered using a Buchner funnel.

The residue is then either tested as a solid, or dissolved in a small amount of distilled water for each test.

(a) Information on each solid residue formed is given in **Table 6.1**.

Stage	Evaporation		Chemicals in the residue
	From (cm^3)	To (cm^3)	
1	1000	500	none
2	500	250	calcium carbonate
3	250	125	calcium carbonate
			calcium sulfate
4	125	75	sodium chloride
			sodium sulfate
5	75	50	sodium chloride
6	50	25	sodium chloride

Table 6.1

(i) Describe a test to identify the **cation** separated in **Stage 2** and the result you expect to see.

Test .....

Result.....

[2]

(ii) Describe a test to identify the **anion** separated in **Stage 2** and the result you would expect to see.

Test .....

Result.....

.....

[2]

(iii) Describe a test to identify the **cation** separated in **Stages 5** and **6**.

Test .....

Result.....

.....

[2]

(iv) Describe a test to identify the **anion** separated in **Stages 5** and **6**.

Test .....

Result.....

.....

[2]

(b) Silver nitrate solution can be used to distinguish between the halides chloride, bromide and iodide.

Draw a line to link the halides to the result you would expect to see when the halides are tested with silver nitrate solution.

Halide	**Result**
Chloride	Pale cream precipitate
Bromide	White precipitate
Iodide	Pale yellow precipitate

[3]

(c) Sam also finds out that there are alternative tests that can improve separation, sensitivity and quantification of ions.

Identify the correct feature for three of these tests.

Draw a line between each test and its correct feature.

Test	**Feature**
Ion chromatography	Energy supplied by electric currents produced by electromagnetic induction.
Atomic Emission Spectroscopy (AES)	Chemical analysis that uses light intensity emitted from a sample at a particular wavelength.
Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES)	Separates ions and polar molecules based on their affinity to an ionic exchanger.

[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)(i).

The Periodic Table of the Elements

(1)	(2)												(3)	(4)	(5)	(6)	(7)	(0)
1													**13**	**14**	**15**	**16**	**17**	**18**
1 **H** hydrogen 1.0	**2**																	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** sulfur 32.1	17 **Cl** chlorine 35.5	18 **Ar** argon 39.9
19 **K** potassium 39.1	20 **Ca** calcium 40.1	21 **Sc** scandium 45.0	22 **Ti** titanium 47.9	23 **V** vanadium 50.9	24 **Cr** chromium 52.0	25 **Mn** manganese 54.9	26 **Fe** iron 55.8	27 **Co** cobalt 58.9	28 **Ni** nickel 58.7	29 **Cu** copper 63.5	30 **Zn** zinc 65.4	31 **Ga** gallium 69.7	32 **Ge** germanium 72.6	33 **As** arsenic 74.9	34 **Se** selenium 79.0	35 **Br** bromine 79.9	36 **Kr** krypton 83.8
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	44 **Ru** ruthenium 101.1	45 **Rh** rhodium 102.9	46 **Pd** palladium 106.4	47 **Ag** silver 107.9	48 **Cd** cadmium 112.4	49 **In** indium 114.8	50 **Sn** tin 118.7	51 **Sb** antimony 121.8	52 **Te** tellurium 127.6	53 **I** iodine 126.9	54 **Xe** xenon 131.3
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	79 **Au** gold 197.0	80 **Hg** mercury 200.6	81 **Tl** thallium 204.4	82 **Pb** lead 207.2	83 **Bi** bismuth 209.0	84 **Po** polonium	85 **At** astatine	86 **Rn** radon
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 **Rg** roentgenium	112 **Cn** copernicium		114 **Fl** flerovium		116 **Lv** livermorium			

Key
atomic number
Symbol
name
relative atomic mass

●	57 **La** lanthanum 138.9	58 **Ce** cerium 140.1	59 **Pr** praseodymium 140.9	60 **Nd** neodymium 144.2	61 **Pm** promethium 144.9	62 **Sm** samarium 150.4	63 **Eu** europium 152.0	64 **Gd** gadolinium 157.2	65 **Tb** terbium 158.9	66 **Dy** dysprosium 162.5	67 **Ho** holmium 164.9	68 **Er** erbium 167.3	69 **Tm** thulium 168.9	70 **Yb** ytterbium 173.0	71 **Lu** lutetium 175.0
●●	89 **Ac** actinium	90 **Th** thorium 232.0	91 **Pa** protactinium	92 **U** uranium 238.1	93 **Np** neptunium	94 **Pu** plutonium	95 **Am** americium	96 **Cm** curium	97 **Bk** berkelium	98 **Cf** californium	99 **Es** einsteinium	100 **Fm** fermium	101 **Md** mendelevium	102 **No** nobelium	103 **Lr** lawrencium

OCR
Oxford Cambridge and RSA