OCR
Oxford Cambridge and RSA

Level 3 Cambridge Technical in Laboratory Skills
05848/05849/05874

Unit 3: Scientific analysis and reporting
Thursday 14 June 2018 – Afternoon

Duration: 2 hours

C342/1806

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.
• 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 **100**.
• The marks for each question are shown in brackets **[ ]**.
• This document consists of **32** pages.

FOR EXAMINER USE ONLY	
Question No	**Mark**
1	/17
2	/15
3	/15
4	/12
5	/15
6	/9
7	/7
8	/10
Total	**/100**

OCR is an exempt Charity

Turn over

Answer **all** the questions.

1   Near-Earth Objects (NEOs) are comets and asteroids that have orbits which bring them close to the Earth.

    Fig. 1.1 shows an artist's impression of a comet orbiting the earth.

    Comets are icy bodies releasing dust or gas.

Fig. 1.1

    Table 1.1 shows the distance from Earth of some NEOs that passed by in early January 2017.

Date in January 2017	Distance from the Earth (Lunar Distance)
8th	47.1
8th	63.5
8th	1.5
9th	53.5
9th	39.4
9th	0.5
9th	11.0
10th	14.8
11th	15.1
13th	34.6
14th	29.2
14th	55.5
14th	6.7

Table 1.1

(a) Calculate the median for the distance from the Earth in **Table 1.1**.

median = ...
[1]

(b) Calculate the mean distance from the Earth in **Table 1.1**.

Show your working.

mean = ...
[2]

(c) The formula below can be used to calculate the standard deviation for the data in **Table 1.1**.

standard deviation $s = \sqrt{\frac{1}{N-1} \sum_{i=1}^{N} (x_i - \overline{x})^2}$

N is the number of NEOs observed from the 8th to the 14th of January 2017.

x_i is the distance to the NEO

$\overline{x}$ is the mean NEO distance

Use the formula above to calculate the standard deviation for the data in **Table 1.1**.

Give your answer to **1** decimal place.

Show your working.

standard deviation = ………………………
[6]

(d) The comet observed on January 10th 2017 had an estimated diameter of between 25 and 59 m.

Give **two** suggestions why the uncertainty of this estimate is so large.

1...

....

2...

....

[2]

Table 1.1 has been repeated below.

Date in January 2017	Distance from the Earth (Lunar Distance)
8th	47.1
8th	63.5
8th	1.5
9th	53.5
9th	39.4
9th	0.5
9th	11.0
10th	14.8
11th	15.1
13th	34.6
14th	29.2
14th	55.5
14th	6.7

Table 1.1

(e) One comet is a sphere with a diameter of 100 m.

(i) Calculate the surface area of the comet and give the units.

Use the formula: surface area = $4 \pi r^2$.

π = 3.14

Show your working.

surface area of comet = ………………units ………………

[2]

(ii) Calculate the volume of the comet and give the units.

Use the formula: volume = $\frac{4}{3} \pi r^3$.

π = 3.14

Show your working.

volume of comet = ………………units ………………

[2]

(f) The average orbital speed of a comet can be calculated using the following formula:

$$v = 2 \times \pi \times \frac{r}{T}$$

v = orbital speed

r = orbital radius

T = time period

Rearrange the equation to show how you could calculate the orbital radius of the comet.

Show your working.

orbital radius, r = ……..

[2]

2 Joe is investigating the speed of a ball rolling down a track.

Fig. 2.1 shows the apparatus used by Joe to show the relationship between

- the width of a channel *(e)* in a downwards sloping track and
- the acceleration of a ball *(a)* rolling down the channel in the track.
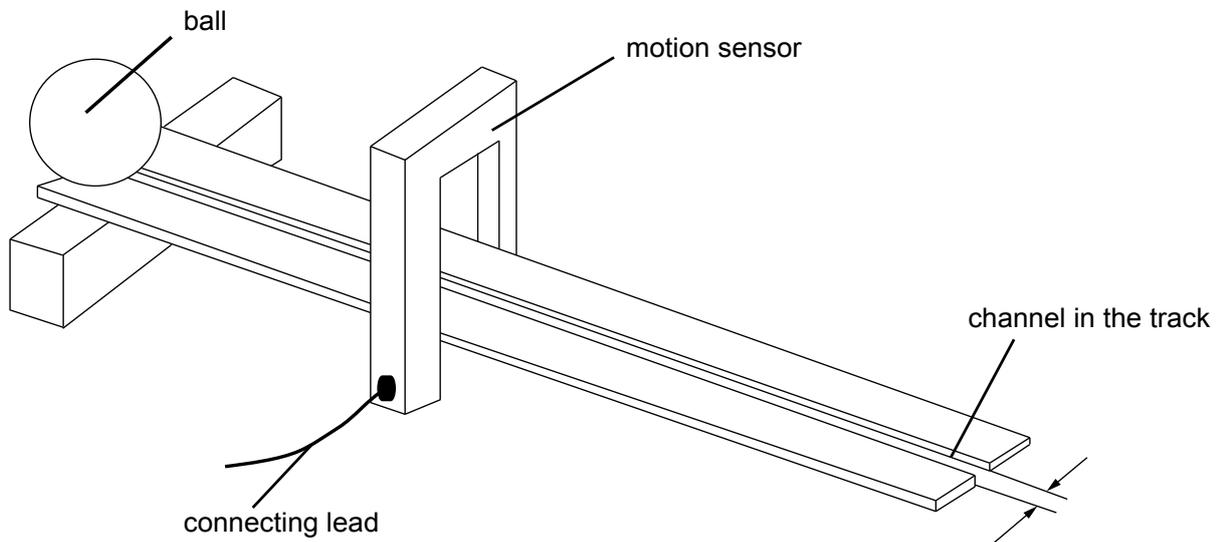
Fig. 2.1

Joe releases the ball at the top of the track. It passes through a motion sensor as it rolls down the track. The motion sensor measures the acceleration *(a)* of the ball.

Joe changes the width of the channel *(e)* in the track, and repeats the experiment.

The results of his investigation are shown in **Table 2.1**.

width of channel *(e)* (cm)	0.2	0.6	1.0	1.4	1.6	1.8	2.0
acceleration of the ball *(a)* (cm/s²)	350	343	326	293	225	222	148

Table 2.1

The diameter of the ball = 2.2 cm

The angle of the sloping track = 30°

(a) (i) Plot a graph of the acceleration *(a)* of the ball against the width of the channel *(e)* and draw a curve of best fit.

[3]

(ii) Draw a **circle** around the outlier in your graph.

[1]

(iii) Use the curve of best fit to predict the true value of acceleration at this point.

true value of acceleration = ………………....... cm/s^2

[1]

Turn over

(iv) Extrapolate the graph to find the value of the intercept with the x-axis when y = 0.

Suggest a reason for this value.

Intercept = ...

Reason ....

....

....**[2]**

(b) Draw a straight line that passes through your curve at *(e)* = 0.8 and *(e)* = 1.2

Calculate the gradient of this line and give the units.

Show your working.

gradient = ………………… units …………………

[4]

(c) Describe the trend shown by the graph in part **(a)(i)**.

....

....

....**[2]**

(d) Joe changes the angle of the track.

He decreases the angle to 15° and repeats the experiment.

Joe only records two measurements, as shown in **Table 2.2**.

width of channel *(e)* (cm)	0.2	0.6	1.0	1.4	1.6	1.8	2.0
acceleration of the ball *(a)* (cm/s²)	181	178					

Table 2.2

The diameter of the ball = 2.2 cm (unchanged from original experiment).

The angle of the sloping track = 15° (decreased from the original angle of 30°).

Suggest how the measurements in **Table 2.1** and **Table 2.2** and the data shown in the graph drawn in **(a)(i)** may be used to determine the values of *(a)* for values of *(e)* = 1.0 to *(e)* = 2.0.

....

....

....**[2]**

Turn over

3   The Wrasses are a family of marine fish called *Labridae*.

Many of these fish are brightly coloured and have a clear pattern (**Fig. 3.1**).
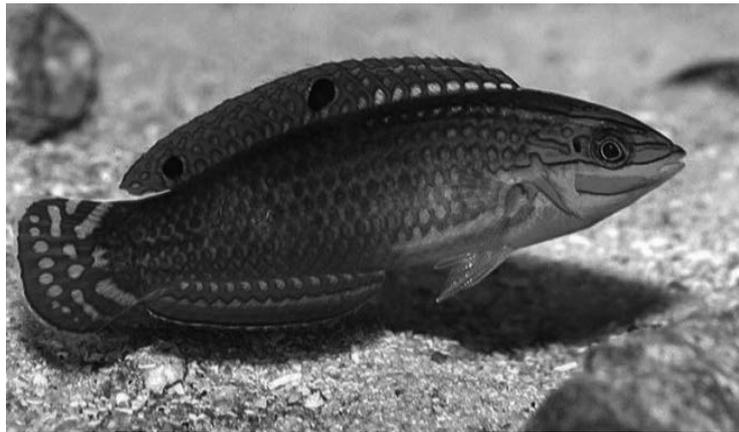
Fig. 3.1

Eastern Atlantic Wrasse are generally found at depths of 1 m to 50 m.

Male Wrasse build nests in different shapes from a variety of nesting materials.

The males may form a distinct pairing with a single female during breeding or they may live in a harem with several females.

Table 3.1 shows some of the distinguishing features of different types of Eastern Atlantic Wrasse.

Type of Wrasse	Depth range (m)	Pairing behaviour	Nest shape or nesting material	Common length (cm)
Symphodus baillonie	1 – 50	distinct	dish-shaped	18
Symphodus cinereus	1 – 20	harem	algae fragments	8
Symphodus mediterraneus	1 – 50	distinct	dish-shaped	12
Symphodus melops	1 – 30	distinct	large seaweed	20
Symphodus ocellatus	1 – 30	distinct	algae fragments	8.5
Symphodus roissali	1 – 30	harem	large seaweed	12
Symphodus rostratus	1 – 50	harem	algae fragments	9
Symphodus tinca	1 – 50	harem	large seaweed	25

Table 3.1

(a) (i) Explain the naming system used to identify Eastern Atlantic Wrasse.

....

....

....

....**[3]**

(ii) Use the data in **Table 3.1** to complete the blank spaces of the key shown in **Fig. 3.2**.
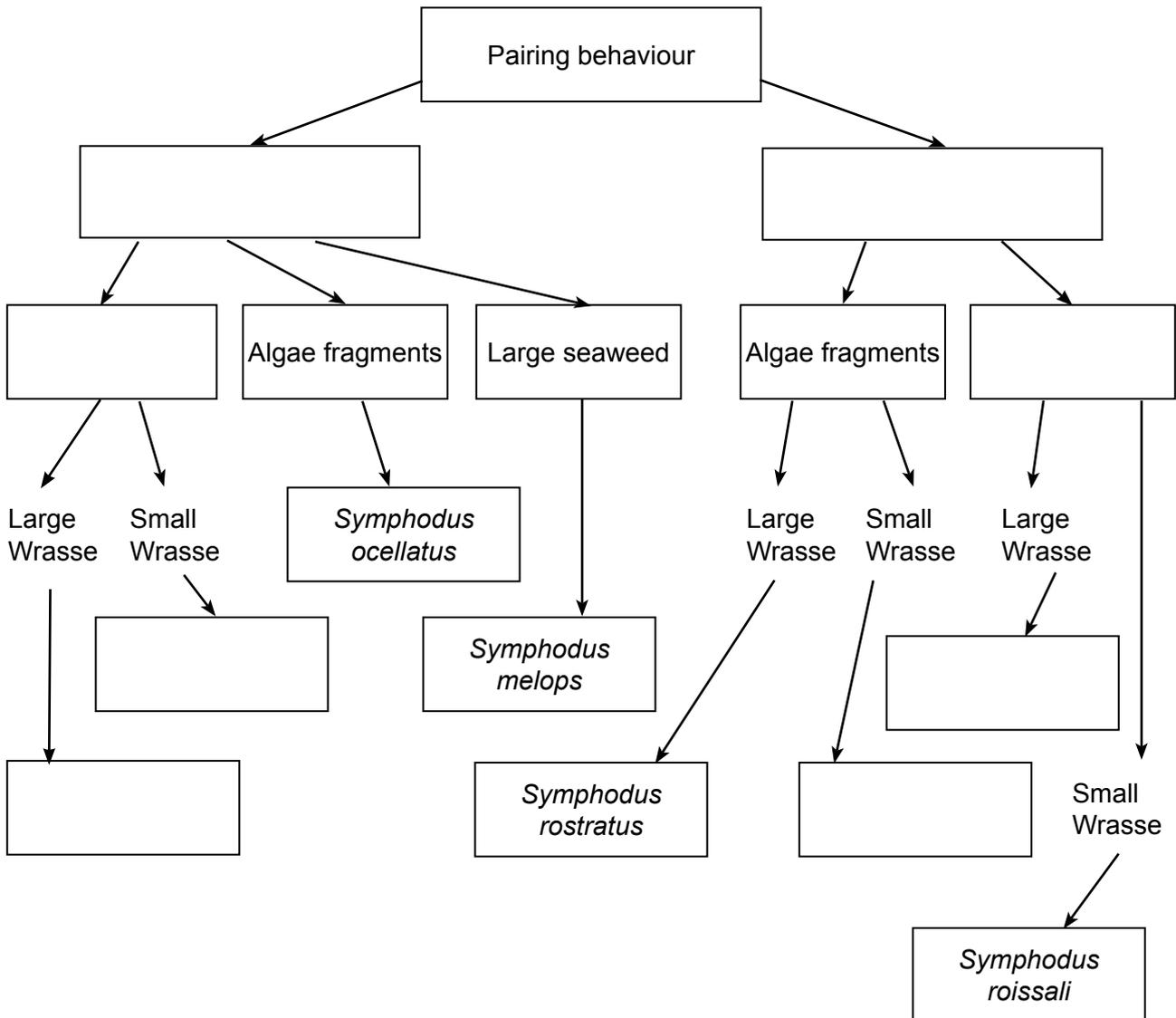
Fig. 3.2

[6]

(b) Explain **two** limitations of the key in **Fig. 3.2** when using it to distinguish between different types of Eastern Atlantic Wrasse.

Limitation 1 ....

....

....

Limitation 2 ....

....

....

[4]

(c) *Labrus bergylta* is another type of Wrasse found in the Eastern Atlantic.

Use your understanding of the classification system to suggest the level of similarity between *L.bergylta* and *S.baillonie*.

....

....

....**[2]**

4 Radar guns are used by the police to measure the speed of vehicles.

Ross carries out a controlled investigation on four radar guns (**W**, **X**, **Y** and **Z**).

He points each radar gun at a car moving away at a constant speed.

He repeats each test four times.

The results of his investigation are shown in **Table 4.1**.

Radar gun	Speed (km/h)			
	Test 1	**Test 2**	**Test 3**	**Test 4**
W	63.2	67.1	65.9	59.6
X	60.2	54.2	63.4	61.7
Y	59.7	59.9	60.3	60.1
Z	56.5	55.8	57.1	56.3

Table 4.1

(a) The true constant speed of the car is indicated by a satellite navigation (SatNav) device mounted on the car dashboard. This indicates 60.0 km/h.

(i) Comment on the accuracy and precision of radar gun **Y**.

....**[1]**

(ii) What is the range of the results for radar gun **Y**?

range =...
[1]

(iii) Calculate the interval of the results for radar gun **Y** as a percentage.

interval = ...%
[2]

(b) The speedometer on the dashboard of the car indicates that it is travelling at 64 km/h, as shown in **Fig. 4.1**.
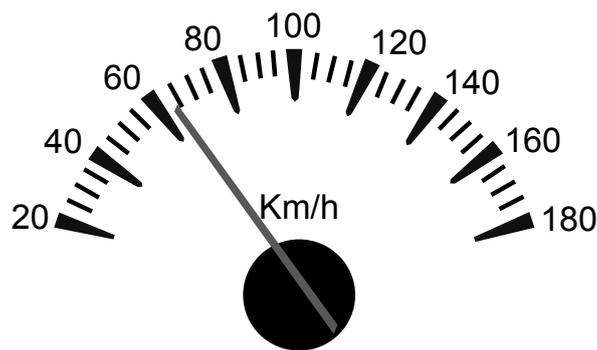
Fig. 4.1

The speedometer is not precise.

This leads to errors when monitoring the speed of the car.

(i) Which type of error is involved?

Put a (**ring**) around the correct answer.

Driving   Instrument   Mathematical   Random

[1]

(ii) Using **Fig. 4.1**, give a reason for your choice in **(b)(i)**.

....[1]

(iii) Define the terms **repeatable** and **reproducible**.

Repeatable ....

....

Reproducible ....

....

[2]

(c) Ross suggests calculating the speed of the car by using a stopwatch to time it as it moves between two marked lines 10 metres apart.

(i) Describe **one** source of measurement error in the method proposed by Ross.

....

....

....[1]

(ii) State and explain how Ross could reduce the error in his proposed method to calculate the speed of the car.

....

....

....**[2]**

(iii) Ross uses a stopwatch with a high sensitivity.

Suggest what is meant by the term **sensitivity** when it is used to describe the reading on the stopwatch.

....**[1]**

Turn over

5 Three student technicians are designing electric circuits.

One of the students, Nina, needs a resistor of resistance 9.0 Ω in one branch of her circuit.

She has a 1.0 m length of resistance wire labelled **X**.

Nina tests wire **X** and concludes that it has a resistance of 9.0 Ω.

The two other students, Rob and Ali, carry out tests on wires **Y** and **Z**.

The students record their measurements in **Table 5.1**.

Wire	Length of wire (m)	Potential difference (V)	Current (A)	Resistance (Ω)	Resistance of 1.0 m length of wire (Ω)
X	1.0				9.00
Y	0.5	4.5	0.81	....	....
Z	0.25	3.7	1.34	....	....

Table 5.1

(a) (i) Complete **Table 5.1** for wires **Y** and **Z**.

Use the equation: resistance = potential difference ÷ current

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

[4]

(ii) Ali concludes:

'We all tested wires made of the same material'.

Explain whether Ali's conclusion is correct or incorrect.

Use the data in **Table 5.1** and your calculations in **(a)(i)** to justify your answer.

....

....

....

....

....**[3]**

(iii) Rob and Ali discuss their test results.

They conclude that Nina is wrong and the resistance of wire **X** is not $9.00\,\Omega$.

Explain what further evidence Rob and Ali need to make their conclusion more secure.

....

....

....**[2]**

(b) Fig 5.2 shows another equation for calculating resistance.

$$R = \frac{\rho l}{A}$$

Fig. 5.2

R = resistance (Ω)

l = length of wire (m)

ρ = resistivity (Ω.m)

A = cross-sectional area of the wire

Rob uses the equation to show Nina that her conclusion about wire **X** is incorrect.

Nina says:

'You have made assumptions about things you have not measured.'

Suggest **two** assumptions made by Rob.

1...

....

2...

....

[2]

18

(c) Nina uses a balance to measure the mass of each piece of wire.

Her results are shown in **Table 5.2**.

Wire	Mass (g)
X	1.03
Y	0.21
Z	0.42

Table 5.2

Discuss whether the evidence in **Table 5.2** supports or conflicts with the evidence in **Table 5.1**.

....

....

....

....

....**[2]**

(d) Describe how Nina, Ali and Rob should use primary and secondary sources of information to confirm whether wires **X**, **Y** and **Z** are made from the same material.

....

....

....**[2]**

6   James is a public analyst. He is analysing the concentration of sodium hypochlorite in a series of samples of household bleach.

He uses **redox titrations** to find the concentration of hypochlorite in the bleach.

(a)   The steps in the titration of a bleach sample are shown in **Table 6.1**.

The steps are **not** in the **correct** order.

A	add starch indicator
B	iodine is formed
C	titrate the brown mixture against sodium thiosulfate solution
D	dilute the sample of bleach
E	the colour fades to yellow
F	add an excess of acidified potassium iodide solution

Table 6.1

Put the steps in the correct order. One has been done for you.

Complete the table below.

D					

[4]

(b)   (i)   James prepares a sodium thiosulfate solution (0.2 mol dm^{-3}) and dilutes a sample of bleach for titration.

Suggest **two** reasons why the bleach samples are diluted.

1 ....

....

....

2 ....

....

....

[2]

(ii) The concentration of the sodium thiosulfate solution prepared by James is approximate. It must be standardised before use.

The sodium thiosulfate solution is standardised with potassium iodate solution using a titration.

Information from the titration recorded is shown in **Table 6.2**.

Concentration of the potassium iodate solution	0.033 mol dm^{-3}
Volume of potassium iodate in conical flask	25.0 cm^3
Average volume of sodium thiosulfate used	24.25 cm^3

Table 6.2

Calculate the concentration of the sodium thiosulfate solution.

Use the equation:

$$\text{concentration sodium thiosulfate} = \frac{\text{concentration potassium iodate} \times \text{volume of potassium iodate} \times 6}{\text{volume of sodium thiosulfate}}$$

Give your answer to **2** significant figures.

concentration = ……..........…….mol dm^{-3}

[3]

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PLEASE DO NOT WRITE ON THIS PAGE

Turn over for the next question

7 Mia is a technician working in a plant science laboratory.

She is producing a set of temporary microscope slides of plant roots.

Fig. 7.1 shows a section of a plant root when viewed using a light microscope.
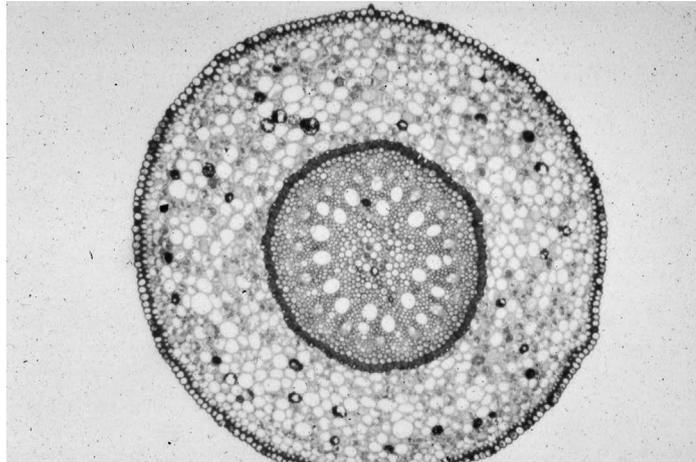
Fig. 7.1

(a) The production of a temporary microscope slide involves a number of steps.

The following steps are **not** in the correct order.

Step	Order
Add a drop of water to the plant root section.	
Cut the plant root to obtain a thin section.	
Place the section of plant root onto a dry microscope slide.	
Put the microscope slide on the stage of a light microscope.	5
Place a coverslip above the root section.	

Write the correct number (1 to 4) in each of the boxes to show the correct order.

One has been completed for you.

[4]

(b) Mia has been asked to produce permanent slides of plant root sections.

Identify **two** additional steps, other than staining, to be completed when making a permanent slide.

1...

2...

[2]

(c) Stains can be added to plant tissues when making temporary or permanent slides.

Give **one** reason for staining plant tissues.

....

....**[1]**

Turn over

8 A scientific study in Ontario in Canada analysed the effects of living close to major roads on three neurological conditions: dementia, Parkinson's disease and multiple sclerosis.

The study was carried out between 2001 and 2012. During that time, the number of people who developed the three conditions was recorded.

Details of two groups of people studied in Ontario are shown in **Table 8.1**.

Group studied	Age range	Number of people	Neurological condition(s) analysed
1	55 – 85	2 165 268	dementia and Parkinson's disease
2	20 – 50	4 372 720	multiple sclerosis

Table 8.1

The two groups were based on people who:

- were free from the three conditions in 2001

- were born in Canada

- had lived in Ontario for 5 years or longer.

The numbers of people who developed the conditions between 2001 and 2012 are shown in **Table 8.2**.

Condition	Number developing the condition	Percentage developing the condition (as a % of the group studied)
dementia	243 611	11.3
Parkinson's disease	31 577	
multiple sclerosis	9 247	

Table 8.2

(a) Complete **Table 8.2** by calculating numbers of people who developed the condition as a percentage of the people studied in each group (as indicated in **Table 8.1**).

[2]

(b) What conclusion can be made from the data in **Table 8.1**?

Tick (✓) **one** box.

People who are 50 to 55 years old do not develop multiple sclerosis. ☐

The development of specific neurological conditions does not appear to be age dependent. ☐

Young people less than 20 years old do not develop neurological conditions. ☐

More females are found in the 50 to 55 year old age group. ☐

[1]

Turn over

(c) The distance people in the study lived from the major roads in Ontario was calculated from their postcodes.

The association between distance from major roads and developing the three conditions was assessed.

The data from the study are shown in **Table 8.3**.

Distance from major road (m)	Hazard ratio (probability of developing the condition relative to people living over 300 m away from the roads (where the hazard ratio = 1.00))		
	Dementia	**Parkinson's disease**	**Multiple sclerosis**
< 50	1.07	1.01	1.02
50 – 100	1.04	1.01	0.93
101 – 200	1.02	0.99	1.01
201 – 300	1.00	0.99	1.01

Table 8.3

The data in **Table 8.3** were adjusted to take into account a series of factors, including diabetes, brain disease and household income.

Suggest why the data were adjusted in this way.

....

....**[1]**

(d) The researchers carrying out this study are invited to present their findings at a scientific conference.

(i) Suggest **two** conclusions that can be made from the study.

1..

....

2..

....

[2]

(ii) Suggest **two** limitations of the study.

1..

....

2..

....

[2]

(iii) Suggest **two** recommendations for future research.

1..

....

2..

....

[2]

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(b) or 6(a).

The Periodic Table of the Elements

Key
atomic number
Symbol
name
relative atomic mass

(1)	(2)												(3)	(4)	(5)	(6)	(7)	(0)
1																		**18**
1 **H** hydrogen 1.0																		2 **He** helium 4.0
	2												**13**	**14**	**15**	**16**	**17**	
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	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**		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		

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

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