OCR
Oxford Cambridge and RSA

Wednesday 15 January 2020 – Morning

Level 3 Cambridge Technical in Applied Science

05848/05849/05874 Unit 3: Scientific analysis and reporting

Time allowed: 2 hours
C342/2001

C342I120001

You must have:
- a ruler (cm/mm)

You can use:
- a scientific or graphical calculator

Please write clearly in black ink.

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

Date of birth | D | D | M | M | Y | Y | Y | Y |

INSTRUCTIONS
- Use black ink.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.

INFORMATION
- The Periodic Table is on the back page.
- The total mark for this paper is **100**.
- The marks for each question are shown in brackets **[ ]**.
- This document has **32** pages.

ADVICE
- Read each question carefully before you start your answer.

FOR EXAMINER USE ONLY	
Question No	**Mark**
1	/21
2	/15
3	/10
4	/17
5	/15
6	/7
7	/15
Total	**100**

Answer **all** the questions.

1 Mia is studying nearby stars for a college project.

She finds a webpage with information about the distances in light years of the 26 nearest stars to Earth.

The distances, measured in light years, of the stars are listed in **Table 1.1.**

0.0	4.2	4.3	4.3	6.0	7.7	8.2	8.4	8.4	8.6
8.6	9.4	10.4	10.8	10.9	11.1	11.1	11.2	11.2	11.2
11.2	11.4	11.4	11.6	11.6	11.7				

Table 1.1

(a) The nearest star to Earth is the Sun. This is shown in **Table 1.1** as 0.0 light years away from the Earth. The star **furthest** away from the Earth is Lacaille-9352.

One light year is approximately 9.461×10^{12} km.

Calculate the distance between Earth and Lacaille-9352 in **metres (m)**.

Give your answer in standard form and to **2** significant figures.

Distance = ... m **[4]**

(b) Mia decides to present the data as a histogram. She creates four groups of data.

Mia counts one star, the Sun, in the range 0 to 3.5 light years. She places this in Group 1.

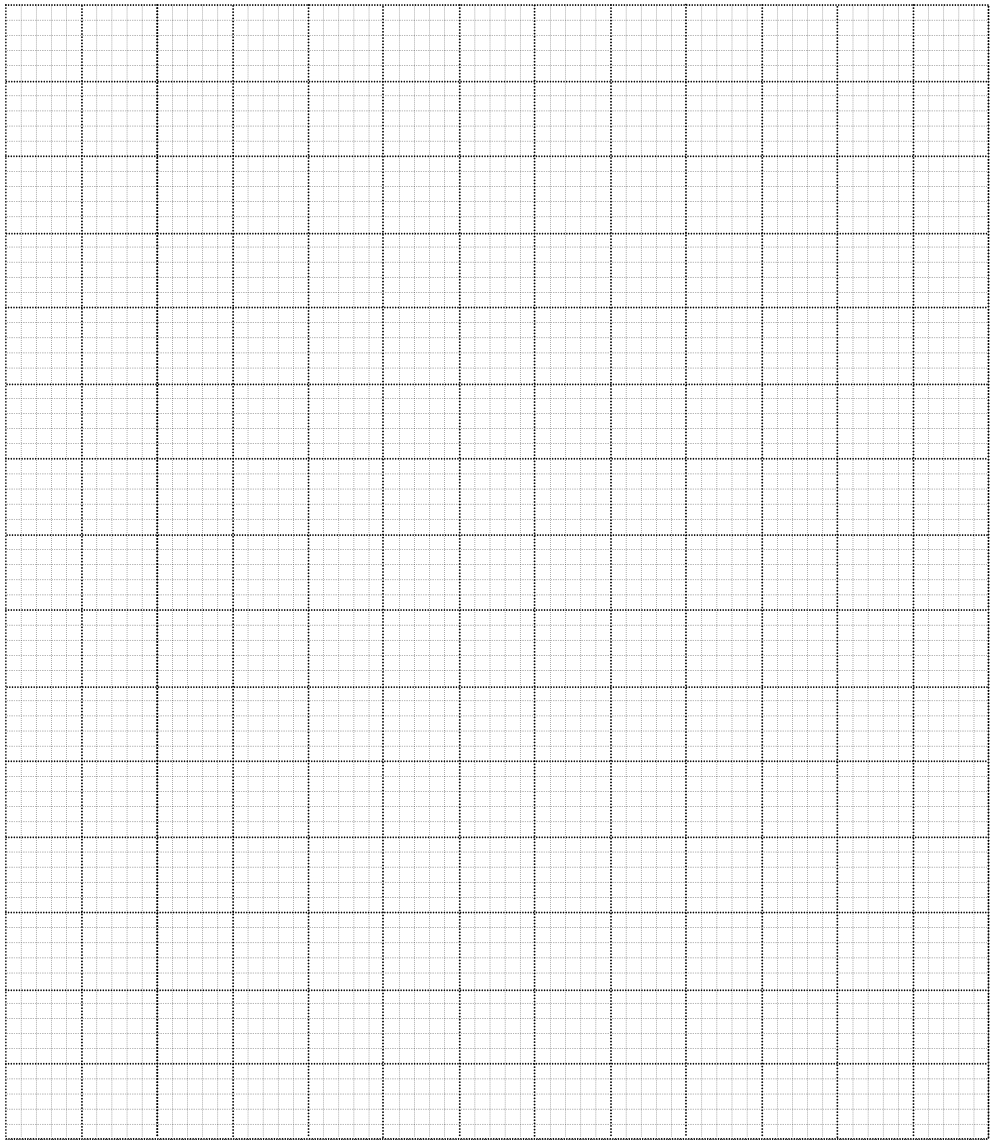
Complete **Table 1.2.**

Group 1	**Group 2**	**Group 3**	**Group 4**
0 to 3.5	3.6 to 7.1	7.2 to 10.8	……. to …….
1			

Table 1.2

[2]

(c) Draw a histogram of the data in **Table 1.2.**



[5]

(d) Mia also finds data about the absolute magnitude, M, of the 26 stars.

Absolute magnitude, M, is a number used to compare the brightness of stars. The lower the value of M, the brighter the star.

Mia uses this data to calculate:

- the average M for the stars in each group
- the range of M for the stars in each group.

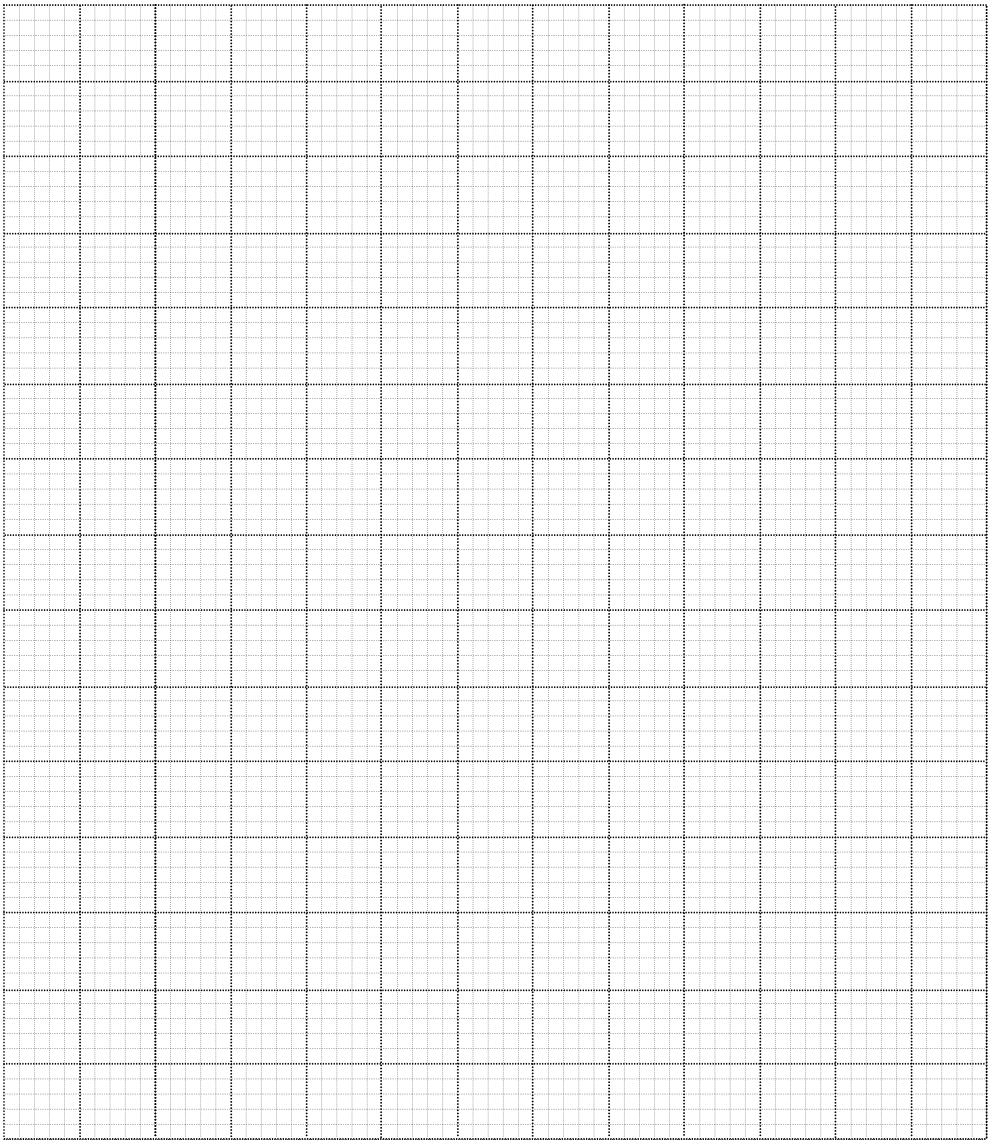
Mia summarises this data as shown in **Table 1.3.**

	Group 1	**Group 2**	**Group 3**	**Group 4**
Average M	4.8	9.7	11.7	10.4
Range of M	4.8	4.4 – 15.5	1.4 – 16.7	2.6 – 14.5

Table 1.3

Draw a line graph of the data in **Table 1.3.**

Plot the group number on the x-axis against average M on the y-axis. Include range bars to show the range of M for each group.



[4]

(e) Mia analyses her graph, based on the data in **Table 1.3.**

Here is her conclusion:

'The further away from the Earth the less bright the stars.'

Discuss whether Mia's conclusion is correct. You should include data which supports and does not support her conclusion.

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

2 Polychaetes are commonly known as bristle worms. There are many species of this type of worm.

The external features of the worm are used to classify the species.

An example of a polychaete is shown in **Fig. 2.1.**

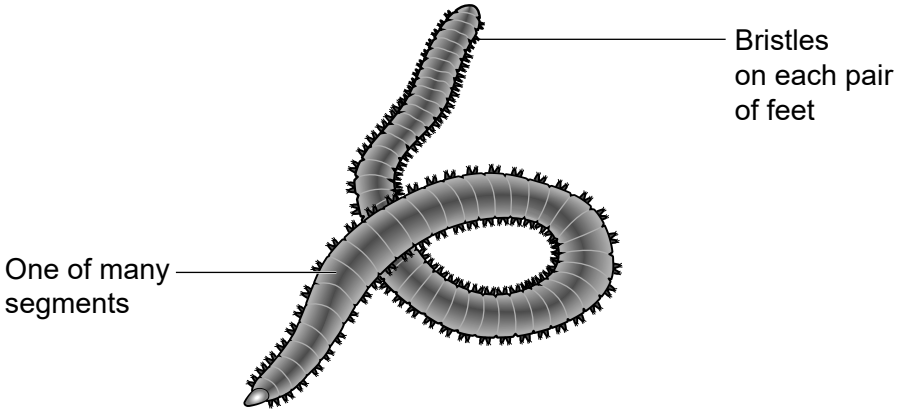


Fig. 2.1

Fig. 2.1 shows how the body of the polychaete is divided into segments. Each segment has a pair of 'feet'. The feet are edged on the upper or lower side with structures such as bristles, gills or tentacles.

Table 2.1 gives a list of some of these external features, along with their biological names and abbreviations.

External features found on the feet	Biological name	Abbreviation
Gills	Branchia	bran
Tentacles on upper side	Dorsal cirrus	dci
Bristles on lower side	Neurochaetae	neuc
Bristles on upper side	Notochaetae	notc
Tentacles on lower side	Ventral cirrus	vci

Table 2.1

(a) Suggest **one** advantage of classifying organisms on their external features.

.....

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

(b) Use the information in **Table 2.1** to identify **two** biological terms for each of the following external features.

Upper side = ... and .....

Lower side = ... and .....

[4]

(c) **Table 2.1** is an example of secondary data.

Give **one** example of primary data that can be used to support the features listed in **Table 2.1.**

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

(d) Suggest why it is helpful to use abbreviations for the external features listed in **Table 2.1.**

.....

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

(e) When polychaetes are classified they are often divided into two groups:

- Errantia
- Sedentaria.

Table 2.2 shows some of the polychaete families classified into the two groups.

The external features found on the feet of different families are identified using the abbreviations shown in **Table 2.2.**

Group	Family name	External features found on feet (abbreviations)				
		bran	dci	neuc	notc	vci
Errantia	Arenicoidae	✓			✓	
	Cirratuladae	✓		✓	✓	
	Sabellidae			✓	✓	
	Terebellidae				✓	
Sedentaria	Nereididae		✓			✓
	Polyneidae		✓	✓		✓
	Eunicadae	✓	✓			✓
	Onuphidae	✓	✓			

Table 2.2

Identify the **two** external features used to group families into Errantia and Sedentaria.

Give a reason for your choice.

1.....

.....

2.....

.....

[2]

(f) The dichotomous key shown in **Table 2.3** was constructed to classify the polychaetes listed in **Table 2.2.**

Statement 1	bran present	
	YES	go to statement **2**
	NO	go to statement **4**
Statement 2	notc present	
	YES	go to statement **3**
	NO	go to statement **7**
Statement 3	neuc present	
	YES	Cirratuladae
	NO	.....
Statement 4	notc present	
	YES	go to statement **5**
	NO	go to statement **6**
Statement 5	neuc present	
	YES	.....
	NO	Terebellidae
Statement 6	neuc present	
	YES	Polyneidae
	NO	.....
Statement 7	vci present	
	YES	.....
	NO	.....

Table 2.3

Use the information in **Table 2.2** to complete the dichotomous key in **Table 2.3.**

Write the correct family name in each of the five spaces.

[5]

(g) Suggest why biological terms used to classify organisms are often derived from Latin.

.....

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

3 Sundip and Jane work for a company that develops alloys for use in biomedicine.

The two most widely used alloys for fixing bone fractures are stainless steel alloy AISI 316L and titanium alloy Ti6Al4V.

They decide to compare the mechanical properties of the two alloys by testing how much each alloy stretches when weights are added.

Sundip and Jane are asked to present their results to other researchers in the company.

(a) Sundip measures the extension of each sample of alloy when weights are added. She continues to add weights up to the point when the alloy sample breaks.

(i) Draw a suitable table of results, with appropriate headings, to show how Sundip could record her results for **one** of the alloys.

[2]

(ii) State why Sundip should include her table of results in the report.

.....

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

(iii) Sundip uses her results to calculate the stress and the % strain of each alloy.

She then plots a graph of stress against strain.

The graph is shown in **Fig. 3.1.**

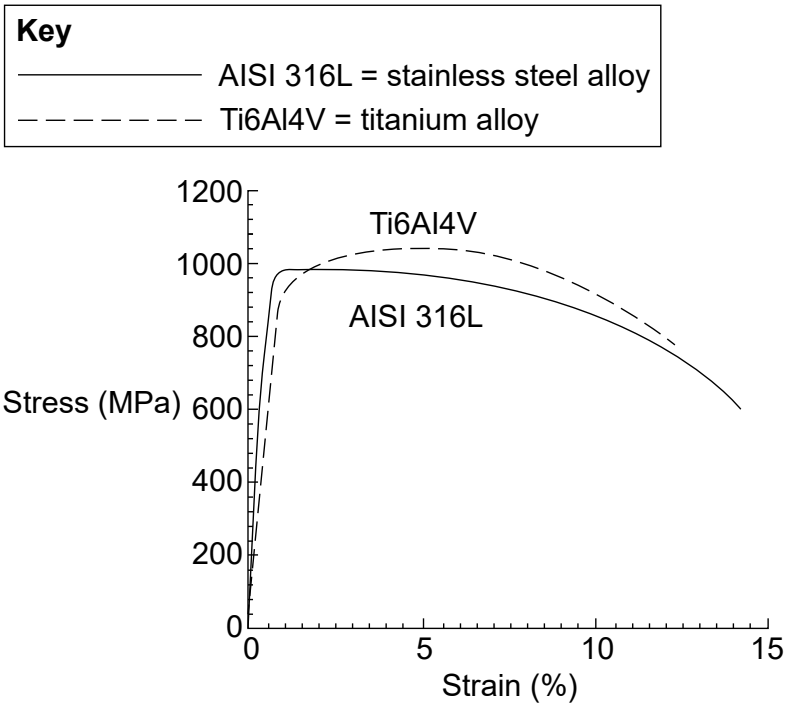


Fig. 3.1

Suggest **two** reasons why Sundip chose to present the results as a graph in the report.

1 .....

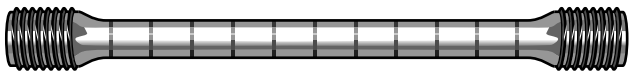
2 .....

[2]

(b) Jane photographs the alloy samples before and after they break.

One of the photographs is shown in **Fig. 3.2.**

New test piece



Broken test piece

Fig. 3.2

(i) Give **two** reasons why Jane included photographs in the report.

1 .....

2 .....

[2]

(ii) Jane also takes a photograph of the experimental set-up to include in the report.

Suggest an alternative way of showing the experimental set-up.

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

(c) Sundip thinks that recording a video of the alloy as it stretches and breaks would provide clearer data.

Suggest **one** reason why making a video would give more useful data than photography.

.....

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

(d) Sundip and Jane research the results of other scientists' investigations by reading articles in peer reviewed scientific journals.

Describe what peer reviewed means.

.....

.....

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

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4 Kai is a Science teacher.

On a flight from Dubai to Manchester he takes two photographs of the flight information screen. The photographs are shown in **Fig. 4.1.**

Flight Dubai to Manchester	
Speed	737 km/h
Altitude	5885 m
Outside Temp	-19 ºC
Distance travelled	**5535 km**
Time to destination	0h 17m
Distance to destination	127 km
Time at destination	07:26
Estimated time of arrival	07:43

Photograph 1

Flight Dubai to Manchester	
Speed	729 km/h
Altitude	5709 m
Outside Temp	-18 ºC
Distance travelled	**5535 km**
Time to destination	0h 17m
Distance to destination	124 km
Time at destination	07:26
Estimated time of arrival	07:43

Photograph 2

Fig. 4.1

The distance to the destination is updated more frequently than the distance travelled.

The speed, altitude and outside temperature are monitored continuously.

(a) Kai posts the photographs from **Fig. 4.1** on Instagram. He says:

"I took these photos a few seconds apart"

Describe the evidence from the two photographs that shows Kai's claim is correct.

.....

.....

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

(b) (i) An Instagram follower replies:

"Did the aircraft stop moving when you took these photos?"

Outline the conflicting evidence from the two photographs in **Fig. 4.1** that causes this uncertainty.

.....

.....

.....

.....

.....

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

(ii) Suggest what further information is required to explain the data.

.....

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

(c) Use the data from **Fig. 4.1** to describe the relationship between altitude and temperature. Use a calculation to support your answer.

.....

.....

.....

.....

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

(d) The altitude of the aircraft is uncertain between photograph 1 and photograph 2 in **Fig. 4.1**. Which of the following is the best assessment of this uncertainty?

Put a (ring) around the correct answer.

5885 ± 176 **5797 ± 176** **5797 ± 88** **5709 ± 88** **[1]**

(e) **(i)** Use the data from the photographs in **Fig. 4.1** to calculate the mean speed of the aircraft.

Mean speed = ... $km\,h^{-1}$ **[2]**

(ii) The time taken between photograph 1 and photograph 2 can be calculated using the equation:

Change in “Distance to destination” = mean speed × time

Calculate the time, to the nearest second, between the two photographs.

Time = ... s **[4]**

(iii) Suggest **two** reasons why the actual time between the two photographs could be different from the value calculated in **e(ii).**

1 .....

.....

2 .....

.....

[2]

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5 Nina is investigating the potential difference (p.d.) across a resistance wire.

She uses an analogue voltmeter that is capable of measuring a p.d. of up to 5.0 V to a precision of 0.1 V.

(a) At one length of the resistance wire Nina records a p.d. of 2.2 V.

State the minimum and maximum possible values of this p.d. due to the precision of the instrument.

minimum ..... V and maximum ..... V **[1]**

(b) **Fig. 5.1** shows the voltmeter Nina uses.

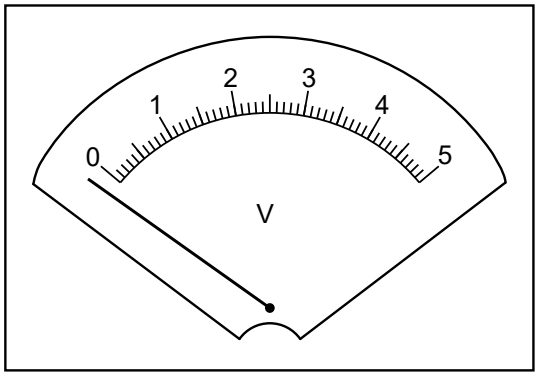

Fig. 5.1

(i) What type of error is shown on the voltmeter?

Tick (✓) **one** box.

Measurement error	☐
Random error	☐
Systematic error	☐

[1]

(ii) Explain how the type of error identified in **(b)(i)** will affect the precision and accuracy of Nina's measurements.

Effect on precision .....

Effect on accuracy .....

[2]

(c) Nina takes more measurements of p.d. using different lengths (x) of the resistance wire.

She plots a graph of p.d. against length of wire, x, as shown in **Fig. 5.2.**

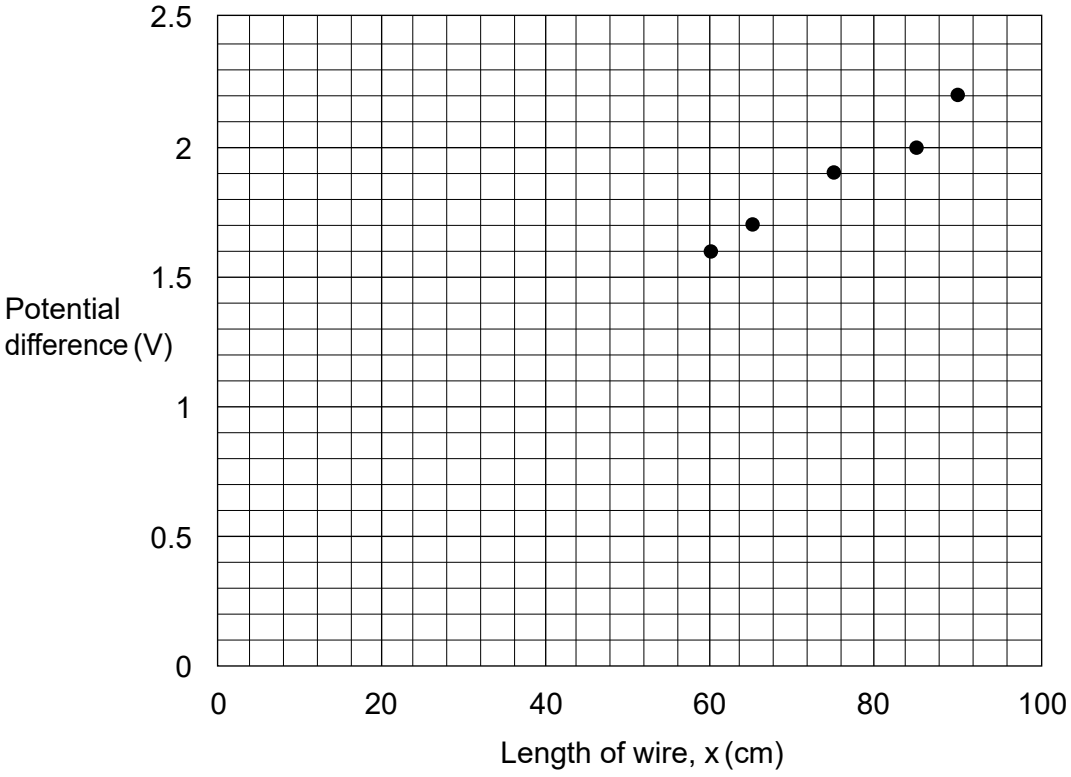

Fig. 5.2

(i) On **Fig. 5.2** draw the straight line of best fit. **[1]**

(ii) Use the graph in **Fig. 5.2** to determine the p.d. V when x = 0 cm.

V = ... V **[1]**

(iii) Determine the gradient of the line of best fit.

Show your working.

Gradient = ... **[2]**

(d) The resistance wire is in series with a lamp.

An estimate of the resistance R of the lamp can be determined from the equation:

$V = I \times R$

Where the current I in the lamp is 0.3 ± 0.05 A and V is the p.d. of the intercept of the graph determined in **(c)(ii).**

(i) Calculate the maximum value of the resistance of the lamp.

Maximum resistance = ... Ω **[3]**

(ii) Suggest **two** reasons why the actual resistance of the lamp is different from the value calculated in **(d)(i).**

1 .....

2 .....

[2]

(e) Nina repeats her investigation using an identical analogue voltmeter and a digital multimeter.

The voltmeter reading is also 2.2 V for the same length of wire used in part **(a).**

The multimeter reading is 3.1 V for this length of wire.

Complete the sentences. Use words from the list.

You can use each word once, more than once, or not at all.

accurate	**random**	**repeatable**
reproducible	**systematic**	

The voltmeter reading shows that the method Nina uses in her investigation

is ..... .

The multimeter reading shows that the method Nina uses in her investigation

is **not** ..... .

[2]

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6 Alex is investigating the effect of artificial fertiliser on a population of water plants.

He places 100 cm^3 of water in two identical glass beakers, **A** and **B**.

In each beaker he places three individual plants.

Into beaker **A** he adds a soluble fertiliser containing essential mineral salts.

Alex places beakers **A** and **B** side by side on a window ledge.

At the end of each week he counts the number of plants in each beaker.

He plots a graph of the number of individual plants in each beaker as shown in **Fig. 6.1.**

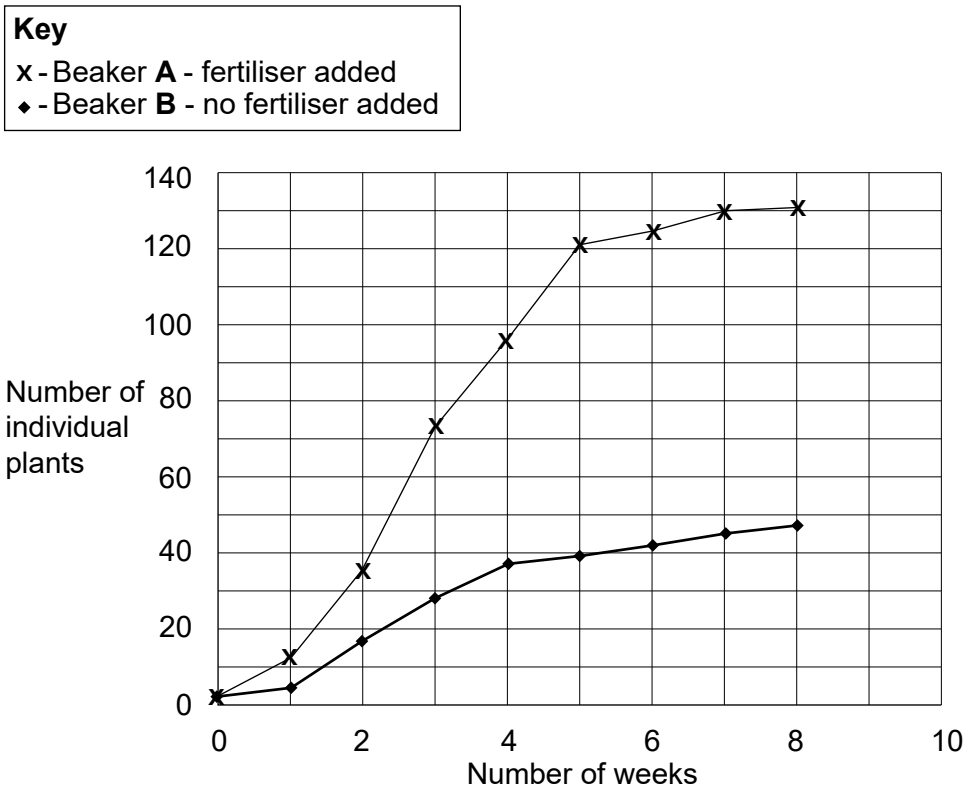

Fig. 6.1

(a) Which is the most likely source of error in this investigation over the eight week period?

Tick (✓) **one** box.

The amount of fertiliser. ☐

The amount of water. ☐

The number of plants in each beaker. ☐

The size of the beaker. ☐

The temperature of the water. ☐

[1]

(b) (i) Use **Fig. 6.1** to estimate the number of plants in beaker **A** (containing fertiliser), at the end of weeks 2 and 5.

Week 2.....

Week 5.....

[1]

(ii) Use your answers in **(b)(i)** to estimate the average rate of increase **per day** over this time period for plants in the beaker containing fertiliser.

Rate of increase = ... plants per day **[1]**

(c) Alex writes **four observations** about the data shown in **Fig. 6.1**:

1. Each week there are more plants in beaker **A** than beaker **B**.
2. Beaker **A** and beaker **B** show similar trends.
3. Other factors such as light and temperature were controlled.
4. There is a lower growth rate in beaker **A** after week 5.

(i) State which **two** observations support the conclusion:
'Fertiliser increases population growth'.

Observation number ……..……. and ….....…… **[2]**

(ii) State which observation supports the conclusion:
'Mineral salts in the fertiliser were used up'.

Observation number ..... **[1]**

(iii) State which observation supports the conclusion:
'The size of the beaker did not limit the population'.

Observation number ..... **[1]**

7 Vitamin C is a water-soluble vitamin that is essential to health. It helps prevent illnesses such as scurvy.

Vitamin C can be found in citrus fruits such as oranges and in some vegetables such as potatoes.

Amaya watches a television programme that suggests that raw potato peel contains more vitamin C than raw potato flesh, so she decides to investigate this.

The peel and flesh of a potato are shown in **Fig. 7.1.**

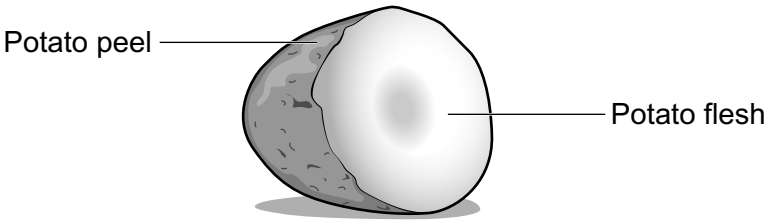

Fig. 7.1

Amaya determines the amount of vitamin C by titration against iodine, using starch as the indicator.

(a) Vitamin C reacts immediately with the iodine.

When all the vitamin C is used up, the iodine reacts with the starch indicator forming a coloured complex.

What is the colour of this starch-iodine complex?

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

(b) Amaya carries out her investigation into potato peel using the following steps:

- Weigh out 150 g of raw potato peel.
- Add 50 cm^3 of distilled water and grind using a mortar and pestle to make a vegetable extract.
- Filter the vegetable extract and wash thoroughly with 20 cm^3 of distilled water.
- Make the filtered extract up to a final volume of 100.0 cm^3 and shake to mix.
- Pipette 20.0 cm^3 of this solution into a conical flask and add a few drops of starch solution.
- Titrate this against 0.001 mol dm^{-3} iodine solution.
- Repeat the titration until concordant results (titres within 0.1 cm^3) are obtained.

(i) Explain why the titration should be repeated until concordant results are obtained.

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

(ii) Explain why the filter residue and paper are washed thoroughly with distilled water before the filtered extract is made up to the final volume of 100.0 cm^3.

.....

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

(iii) Which piece of equipment should Amaya use when making the filtered extract up to 100.0 cm^3?

Tick (✓) **one** box.

Beaker	☐
Burette	☐
Conical flask	☐
Volumetric flask	☐

[1]

(c) **Table 7.1** shows Amaya's results using the potato peel.

Titration	Titration 1	Titration 2	Titration 3
Volume of 0.001 mol dm^{-3} iodine solution needed /cm^3	21.30	20.95	21.05

Table 7.1

She uses the results to calculate the number of mg of vitamin C in 100 g of potato peel using the following steps.

(i) Calculate the mean titre that Amaya should use for analysing her results.

Mean titre = ... cm^3 **[2]**

(ii) Calculate the mean number of moles of iodine used in the titration experiment.

Use the equation: number of moles = $\frac{\text{concentration (mol dm}^{-3}) \times \text{ mean titre (cm}^3)}{1000}$

Number of moles of iodine = ... mol **[1]**

(iii) In this titration **one** mole of vitamin C reacts with **one** mole of iodine.

Use the reacting ratio to calculate the number of moles of vitamin C in 20 cm^3 of potato extract.

Number of moles = ... mol **[1]**

(iv) Calculate the number of moles of vitamin C in 100 cm^3 of the potato extract.

Number of moles = ... mol **[1]**

(v) In her investigation, Amaya used 150 g of potato peel to prepare 100 cm^3 of potato extract.

Calculate the number of moles of vitamin C present in 100 g of potato peel.

Number of moles = ... mol **[1]**

(vi) The molar mass of vitamin C is 176 g mol^{-1}.

Calculate the mass, in **mg**, of vitamin C in 100 g of potato peel.

Use the equation: mass (g) = number of moles × molar mass

Give your answer to **3** significant figures.

Mass of vitamin C in 100 g of potato peel = ... mg **[2]**

(d) Amaya repeats the experiment using potato flesh instead of potato peel.

She finds that the vitamin C content in 100 g of potato flesh is 4.92 mg

Calculate how many times greater the vitamin C content in 100 g of potato peel is compared to the vitamin C content in 100 g of potato flesh.

Number of times greater = ... **[1]**

(e) **(i)** Calculate the mean value of the mass of vitamin C content in 100 g of potato peel and in 100 g of potato flesh.

Mean value = ... mg **[1]**

(ii) The average content of vitamin C in a whole potato is much less than the value you calculated in **(e) (i).**

Suggest why the average value in a whole potato is much less.

.....

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

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

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The Periodic Table of the Elements

Key
atomic number
Symbol
name
relative atomic mass

(1) 1	(2) 2	3	4	5	6	7	8	9	10	11	12	(3) 13	(4) 14	(5) 15	(6) 16	(7) 17	(0) 18
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** 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