OCR
Oxford Cambridge and RSA

Tuesday 14 January 2025 – Afternoon

Level 3 Cambridge Technical in Applied Science

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

Time allowed: 2 hours
C342/2501

C342/2501

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

You can use:
- a scientific or graphical calculator
- an HB pencil

05848/03

Please write clearly in black ink. **Do not write in the barcodes.**

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

First name(s) _____

Last name _____

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

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- 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.
- Answer **all** the questions.

INFORMATION
- The total mark for this paper is **100**.
- The marks for each question are shown in brackets **[ ]**.
- The Periodic Table is on the back page.
- This document has **28** pages.

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

1 There are many brands of apple juice on the market.

Different brands contain different amounts of sugars and are made from different types of apple. Fructose is one of the main sugars in apple juice.

The table shows how the fructose concentration, in $g\,dm^{-3}$, varies in eight different brands of apple juice.

Brand	Fructose concentration ($g\,dm^{-3}$)
1	40
2	42
3	50
4	66
5	68
6	72
7	78
8	80

(a)

(i) Use the data in the table to determine the mean, median and range of the fructose concentrations in these eight brands of apple juice.

- mean .....
- median .....
- range .....

[3]

(ii) Calculate the variance s^2 and standard deviation s of the fructose concentrations shown in the table.

Use the equation:

$$(n-1) \times s^2 = \Sigma (X - \overline{X})^2$$

where n is the number of samples, X is the concentration of each sample and $\overline{X}$ is the mean fructose concentration calculated in **(a)(i)**.

Show your working.

s^2 = ...

s = ...

[4]

(b) A group of students carries out a survey at their school to find out which concentration of fructose people prefer.

They ask 30 students in their year-group to taste samples of the eight brands shown in the table in **(a)** and ask them which brand tastes the best.

They find that most participants prefer the apple juice with a concentration of $50\,g\,dm^{-3}$.

(i) Which brand of apple juice did most participants prefer?

brand number ..... **[1]**

(ii) They conclude that most people in the school prefer the brand which has a concentration of $50\,g\,dm^{-3}$.

Suggest **two** ways they could modify their survey design to make their conclusion more secure.

1 .....

.....

2 .....

.....

[2]

(iii) The students predict that if they dilute a sample of Brand 8, more people would prefer it to the original concentration. They take $1\,dm^3$ of Brand 8, add $0.6\,dm^3$ water and mix thoroughly.

Calculate the concentration of fructose in this diluted sample and explain why their prediction is reasonable.

- Calculation

- Explanation .....

.....

[3]

(iv) Suggest an assumption the students made when making their prediction.

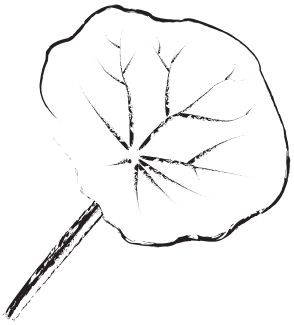
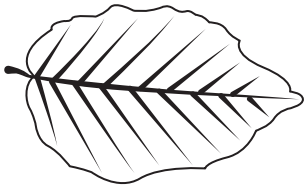
.....

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

2 Leaf veins provide support for the leaf. They also transport water and nutrients through the leaf and on to the rest of the plant. The patterns formed by the veins (venation) can be used to identify the plants on which they grow.

Fig. 2.1 shows leaves from six plants with different patterns of venation.

Fig. 2.1

A	B	C
		
D	**E**	**F**
		

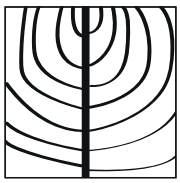
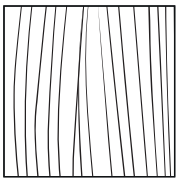
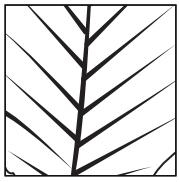
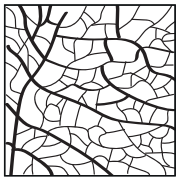
The key in **Fig. 2.2** can be used to identify the leaves in **Fig. 2.1**.

Fig. 2.2 Key

1	Secondary veins are paired opposite to each other and do not divide further.	YES – go to 2 NO – go to 3
2	**European Beech**	
3	Veins radiate from a point in the centre of the leaf.	YES – go to 4 NO – go to 5
4	**Nasturtium**	
5	Veins are arranged alongside each other without showing any connections.	YES – go to 6 NO – go to 7
6	**Tulip**	
7	Smaller veins form a finely branched network.	YES – go to 8 NO – go to 9
8	**Rose**	
9	Several primary veins diverge from a point on one side of the leaf.	YES – go to 10 NO – go to 11
10	**Rhubarb**	
11	Secondary veins bend towards the apex or tip of the leaf.	YES – go to 12
12	**Dogwood**	

The diagrams in **Fig. 2.3** can be used to identify the pattern of venation in each leaf.

Fig. 2.3 Patterns of venation

		
Arcuate	Cross-venulate	Dichotomous
		
Longitudinal	Palmate	Parallel
		
Pinnate	Reticulate	Rotate

(a) Use **Fig. 2.2** to identify the type of plant using leaves **A** to **F** and use **Fig. 2.3** to identify the pattern of venation in each leaf.

	Type of plant	**Pattern of venation**
A	.....	.....
B	.....	.....
C	.....	.....
D	.....	.....
E	.....	.....
F	.....	.....

[12]

(b) European Beech is classified as *Fagus sylvatica*.

Explain the nomenclature used to classify plants and animals.

.....

.....

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

3 An electromagnet is produced when a current is passed through a coil of wire.

A student is investigating how the distance of an electromagnet from a permanent magnet affects the strength of the magnetic field.

Method

- Place a magnet on a two decimal place balance and set the reading to 0.00 g.
- Place a coil of wire connected to a power supply at a distance *d* mm from the magnet.
- Switch on the power and measure the reading on the balance.
- Repeat the experiment for different values of *d*, keeping the current in the wire constant.

The current in the wire, I = 1.2 A and the length of wire in the coil, L = 0.3 m.

The strength of the magnetic field B for each value of d can be calculated using the equation:

$$B = \frac{m \times g}{1000 \times I \times L}$$

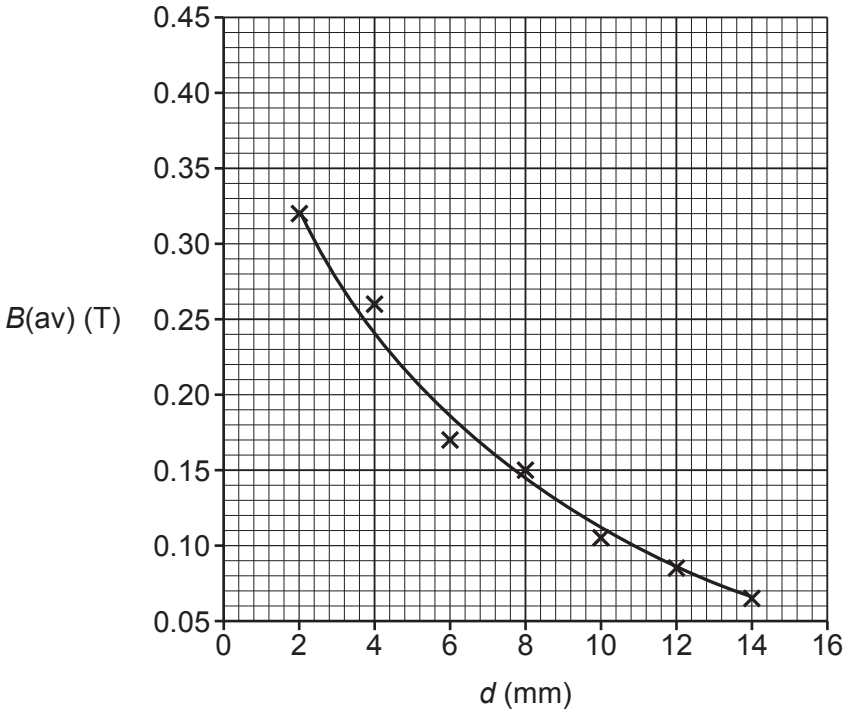
where g = 9.81 N kg^{-1}, m is the balance reading in g and B is the magnetic field strength in Teslas (T).

(a) Use the equation to calculate the value of B when m = 6.24 g.

B = ... T **[2]**

(b) For each value of *d*, the student measures two values of *m*. These values are used to calculate two values of *B* and the average strength of the magnetic field, *B*(av).

The student plots a graph of *B*(av) against *d* as shown below.



The student draws a line of best fit on the graph.

Give **two** reasons why the line in the graph above is of good quality and appropriate for this data.

Good quality .....

.....

Appropriate .....

.....

[2]

(c) Use the graph opposite to determine:

(i) the distance d when B(av) = 0.2 T

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

(ii) the value of B(av) when d = 5 mm

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

(iii) an estimated value of B(av) when d = 1 mm

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

(d) The table shows a pair of readings of m when d = 8 mm. The student determines two values of B and calculates the average, B(av).

m_1 (g)	m_2 (g)	B_1 (T)	B_2 (T)	B(av) (T)
5.58	5.43	0.152	0.148	0.150

(i) Calculate the absolute uncertainty in the value of B(av).

Use the equation: Uncertainty = $\frac{B_1 - B_2}{2}$.

absolute uncertainty = ± ..... T **[1]**

(ii) Calculate the percentage uncertainty in the value of B(av).

percentage uncertainty = ... % **[1]**

(iii) Suggest **three** sources of error which could result in the % uncertainty in the values of *B*(av).

1 .....

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2 .....

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3 .....

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[3]

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Turn over for the next question

4 Lipase is an enzyme which causes fats to break down into fatty acids and glycerol.

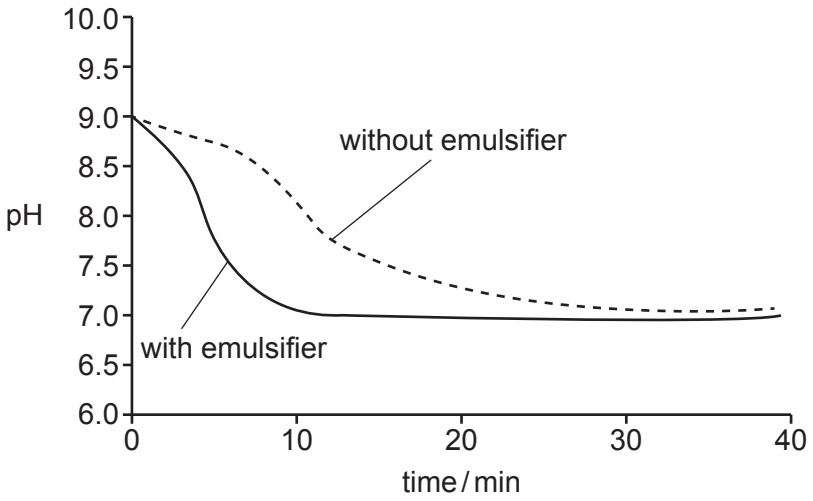
An emulsifier is a food additive which helps to prevent oil and water separating.

A food scientist is investigating how the pH of milk changes with and without the addition of an emulsifier.

Method

- Place 5.0 cm^3 of high-fat milk in a boiling tube in a water bath.
- Use a sensor attached to a datalogger to measure the pH of the milk.
- Add drops of sodium carbonate solution to the milk until the pH of the mixture is pH 9.
- Add 5.0 cm^3 of lipase solution to the milk mixture in the boiling tube and record the pH, using the datalogger, for 40 minutes.
- Repeat the procedure using a fresh sample of high-fat milk with a few drops of an emulsifier added to the mixture.

The graph shows the graphical output from the datalogger.



(a)

(i) Suggest why the graphical output from the datalogger is suitable for this data.

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

(ii) Describe the trends in the data in the graph opposite.

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

(iii) Suggest explanations for the trends in the graph opposite.

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

(b) The procedure followed by the food scientist does not have enough information for it to be repeatable.

What information should be included in the procedure so that it is repeatable?

1 .....

2 .....

3 .....

[3]

(c) Suggest how the technician would know whether the procedure is reproducible.

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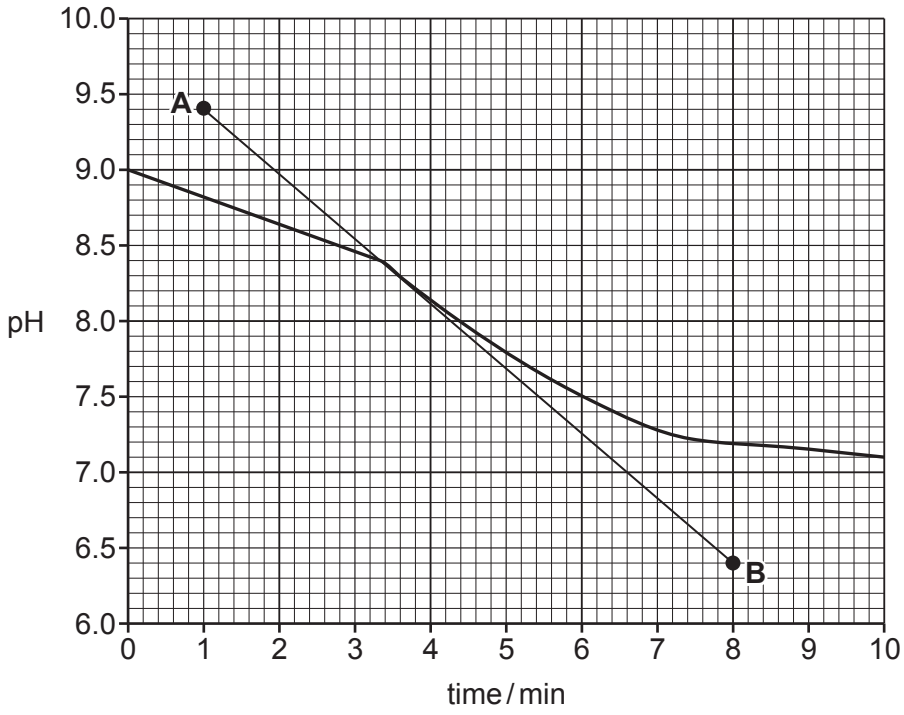
..... **[3]**

(d) The technician decides to calculate the fastest rate of change of pH without the emulsifier.

The graph shows a print-out of a small section of the graph.



The technician draws a tangent to the curve at the steepest part of the curve and determines the coordinates of points **A** and **B** on the tangent.

(i) Calculate the gradient *G* of the tangent.

Show your working on the graph and record your answer to **2** significant figures.

G = ... **[3]**

(ii) Explain why this method gives an accurate value for *G* at this point on the curve.

.....

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

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Turn over for the next question

5

(a) Millions of tonnes of plastic waste are buried in the ground (landfill) each year.

Uncollected plastic waste can enter rivers and oceans and cause environmental damage.
One study concluded that 8 million tonnes of plastic enter the oceans every year in the form of thousands of billions of small pieces called microplastics.

Some processes that remove plastic waste from the environment are described in the table:

Process	Description
Incineration	Plastic is burned in the air, producing carbon dioxide and other gases, heat and ash. The heat can be used to convert water to steam for electricity generation.
Gasification	Plastic is reacted with a gasifying agent (e.g. steam) at temperatures in the range from 500 °C to 1300 °C. This produces energy-rich gases such as hydrogen and methane. These can be burned for electricity generation or converted into diesel, ethanol or other chemicals.
Pyrolysis	Plastic is heated at temperatures in the range 300 °C to 650 °C in the absence of oxygen. This produces energy-rich oils with similar properties to diesel.

(i) Some countries have decided that incineration is the best option, rather than gasification or pyrolysis.

Which reasons might be put forward to support this decision?

Tick (✓) **three** boxes.

A Ash is buried in landfill. ☐

B Diesel is inexpensive in their country. ☐

C Gasification does not produce CO_2. ☐

D Incineration releases CO_2 into the atmosphere. ☐

E Incineration would decrease the need to burn coal. ☐

F The cost of waste collection is high. ☐

G Waste hot water can be used to heat local schools and offices. ☐

[3]

(ii) Suggest **two** reasons why pyrolysis may be chosen instead of gasification.

1 .....

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2 .....

.....

[2]

(iii) Recycling is another option for waste plastic.

Suggest **three further** pieces of evidence needed to show that the processes described in the table are better options than recycling.

1 .....

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2 .....

.....

3 .....

.....

[3]

(b) Water pollution is also an environmental issue.

(i) Potassium thiocyanate is often used to test for the presence of Fe^{3+} ions in water samples.

What colour is seen when potassium thiocyanate is added to a solution containing Fe^{3+} ions?

Tick (✓) the correct box.

Blue ☐

Green ☐

Purple ☐

Red ☐

[1]

(ii) A technician prepares solutions of known concentrations of Fe^{3+} ions and adds an equal volume of potassium thiocyanate to each solution.

Outline how colorimetry can be used to determine the concentration of Fe^{3+} ions in a sample of water.

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

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Turn over for the next question

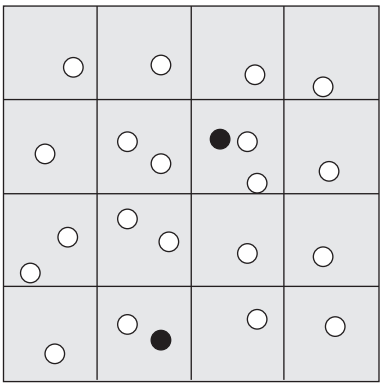
6 Methylene blue is a stain that can be used in light microscopy. It stains dead cells blue, but the stain is decolourised within living cells.

(a) Methylene blue can be used to determine the percentage of living cells in an animal cell culture.

The following method is used.

- Mix 1.00 cm^3 of cell culture with 1.00 cm^3 of methylene blue solution.
- Place a 1 mm^3 portion in a haemocytometer and view down a light microscope.
- Count the total number of cells in a 4 by 4 grid and count the number of cells not stained blue.

The volume of this 4 by 4 grid is 0.1 mm^3.



(i) Count the number of living cells in the grid.

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

(ii) Calculate the number of living cells per cm^3 of the cell culture.

number of living cells per cm^3 ..... **[3]**

(iii) Calculate the percentage of cells that are alive in the cell culture.

percentage = ... % **[2]**

(b) **Fig. 6.1** shows a temporary microscope slide of onion cells.

Fig. 6.2 shows a permanent slide of animal cells stained with methylene blue.

Fig. 6.1

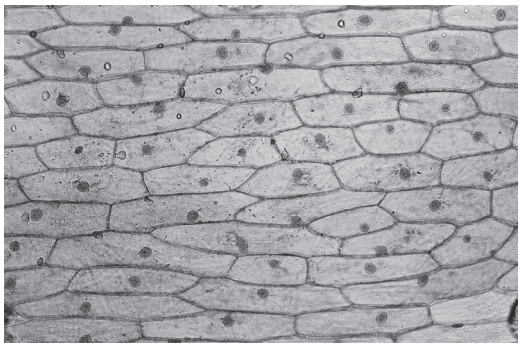
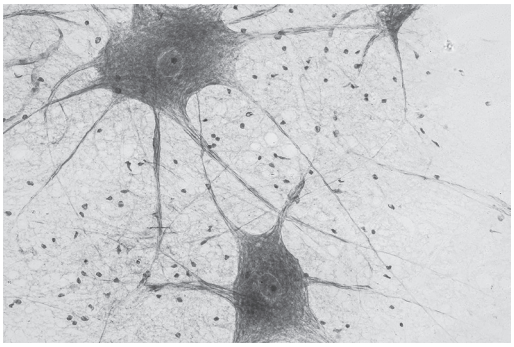


Fig. 6.2



(i) Name **one** stain that binds to and shows up starch molecules in plant cells.

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

(ii) Outline the steps involved in producing a permanent, stained microscope slide and explain the purpose of each step.

Suggest some advantages and disadvantages of preparing a permanent slide compared to a temporary slide.

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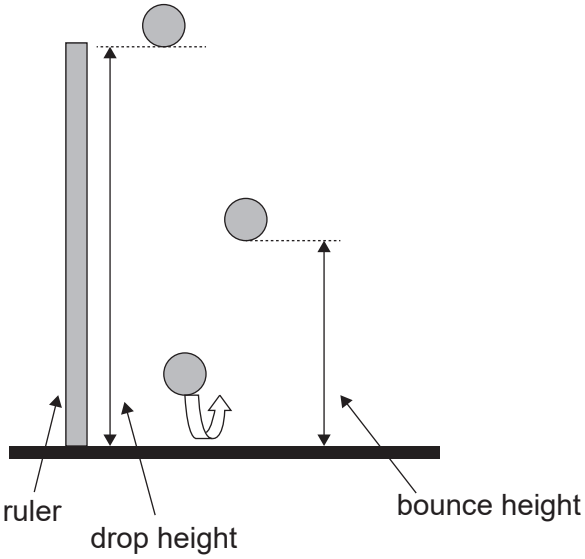
..... **[6]**

7 Two students are investigating how the height a tennis ball is dropped from (the 'drop height') affects the height the ball bounces (the 'bounce height').

They set up the experiment as shown below.



- One student drops the ball from a known height and the other student estimates the bounce height.
- For each drop height, the students measure the bounce height three times (h_1, h_2 and h_3).

(a) The students record their results and calculate an average bounce height, as shown in their table.

Drop height	Bounce height			Average bounce height
	h_1	h_2	h_3	
1.0	0.80	0.81	0.78	0.796667
1.2	0.95	0.97	0.98	0.966667
1.4	1.1	1.05	1.11	1.086667
1.6	1.25	1.14	1.26	1.246667
1.8	1.4	1.43	1.41	1.413333
2.0	1.55	1.54	1.53	1.54

(i) State **two** improvements the students need to make to the presentation of their results.

1 .....

2 .....

[2]

(ii) Put a (ring) around the outlier in the table of results. **[1]**

(b) The students could have used a video camera to measure bounce height.

Explain how a video camera could be used to improve the quality of the data collected.
You may draw a diagram to help your explanation.

.....

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

(c) The students present their data in a scatter graph.

(i) State what variables they should plot on the axes.

- *y*-axis .....
- *x*-axis .....

[1]

(ii) The graph they plot is a straight line starting from 0,0.

What can they conclude from this?

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

(iii) The students include range bars on their graph.

Explain how range bars can be used to evaluate the quality of their conclusion.

.....

.....

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

(d) PowerPoint is a computer slide show which projects text and images onto a screen. It enables the presenter(s) to communicate to a live audience.

The students decide to use PowerPoint to present their results to their peers.

Suggest **three** reasons why PowerPoint is suitable for their presentation.

1 .....

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2 .....

.....

3 .....

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[3]

(e) The teacher suggests that the students should do further investigations using different types of sports balls.

Suggest **two other** variables that the students could investigate that might be of interest to a sports equipment manufacturer.

1 .....

.....

2 .....

.....

[2]

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

The Periodic Table of the Elements

Key
atomic number
Symbol
name
relative atomic mass

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