OCR
Oxford Cambridge and RSA

Thursday 23 May 2019 – Afternoon

LEVEL 3 CAMBRIDGE TECHNICAL IN APPLIED SCIENCE

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

Time allowed: 2 hours
C342/1906

C342-1-1906

You must have:
- a ruler

You may 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.
- 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 **24** pages.

FOR EXAMINER USE ONLY	
Question No	**Mark**
1	/16
2	/12
3	/16
4	/15
5	/13
6	/10
7	/18
Total	**100**

Answer **all** the questions.

1 A group of patients are anaemic.

They have regular blood tests to monitor the number of platelets in their blood.

The results of the blood tests are shown in **Table 1.1**.

Patient	Platelet count
1	105
2	92
3	81
4	86
5	110
6	98
7	101
8	92
9	92
10	83
11	102

Table 1.1

(a) Identify the mode of the platelet count in **Table 1.1**.

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

(b) Calculate the median of the platelet count in T**able 1.1**.

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

(c) Calculate the mean of the platelet count in **Table 1.1**.

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

Show your working.

mean = ...**[2]**

(d) The formula below can be used to calculate the standard deviation of the platelet count data in **Table 1.1**.

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

N is the number of blood tests to measure the platelet count

x_i is the platelet count

$\bar{x}$ is the mean platelet count calculated in **(c)**.

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 s = ...**[6]**

(e) **(i)** Calculate $\bar{x} + s$.

$\bar{x} + s$ = ...**[1]**

(ii) Calculate $\bar{x} - s$.

$\bar{x} - s$ = ...**[1]**

(iii) Use your answers to **(e)(i)** and **(e)(ii)** to determine the percentage of platelet counts that are within one standard deviation of the mean.

Show your working.

percentage of platelet counts within one standard deviation = ...% **[2]**

(f) The platelet count in **Table 1.1** is in an abbreviated form.

- A true platelet count is the number of platelets per microlitre of blood.
- A normal platelet count is 300 000 platelets per microlitre of blood.

Calculate the number of platelets in one litre of normal blood.

1 microlitre = 0.000001 litres

Give your answer in standard form.

number of platelets in one litre of normal blood = ...**[2]**

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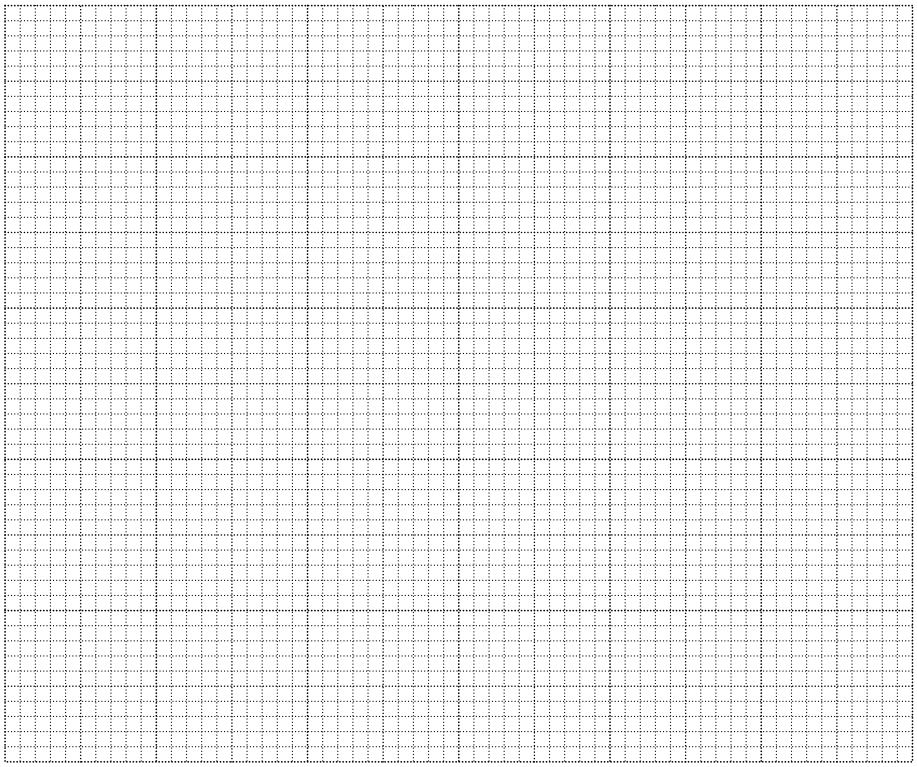
2 The concentration of sugar in the leaves of cereal plants varies with the time of day.

Table 2.1 shows results from an experiment analysing sugar concentration in leaves.

Time of day (h)	04:00	08:00	12:00	16:00	20:00
Sugar concentration (percentage of dry leaf mass)	0.44	0.70	1.75	2.00	1.40

Table 2.1

(a) Plot a graph of the results in **Table 2.1** and draw a curve of best fit.



[4]

(b) Use your graph to estimate the sugar concentration at 10:00.

sugar concentration = ... percentage of dry leaf mass **[1]**

(c) Use your graph to predict the sugar concentration at 22:00.

sugar concentration = ... percentage of dry leaf mass **[1]**

(d) (i) Calculate the gradient of the graph at 08:00.

Give the units.

Show your working.

gradient = ... units = ... **[4]**

(ii) Describe how the gradient of the graph changes between 04:00 and 10:00.

.....

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

(iii) Describe how the gradient of the graph changes between 12:00 and 16:00.

.....

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

3 Keys can be used for the identification of living organisms.

Table 3.1 shows some characteristics of native British plants.

Plant species	Form of reproduction	Presence of roots	Plant height (cm)	Other features
Selaginella kraussiana	Spore	No	15	Scale-like leaves
Equisetum telmateia	Spore	Yes	40	Fine grooves in stems
Equisetum palustre	Spore	Yes	60	Deep grooves in stems
Marchantia polymorpha	Spore	No	10	No true leaves
Lolium perenne	Seed	Yes	90	Hollow seeds, rounded stems
Agropyron repens	Seed	Yes	120	Hollow seeds, rounded stems
Carex capillaris	Seed	Yes	20	Solid seeds, 3-sided stems
Carex hirta	Seed	Yes	70	Solid seeds, 3-sided stems

Table 3.1

(a) **Fig. 3.1** shows a key to identify the different plant species in **Table 3.1**.

Use the data in **Table 3.1** to complete the blank spaces in the key.

Some of the key has already been completed.

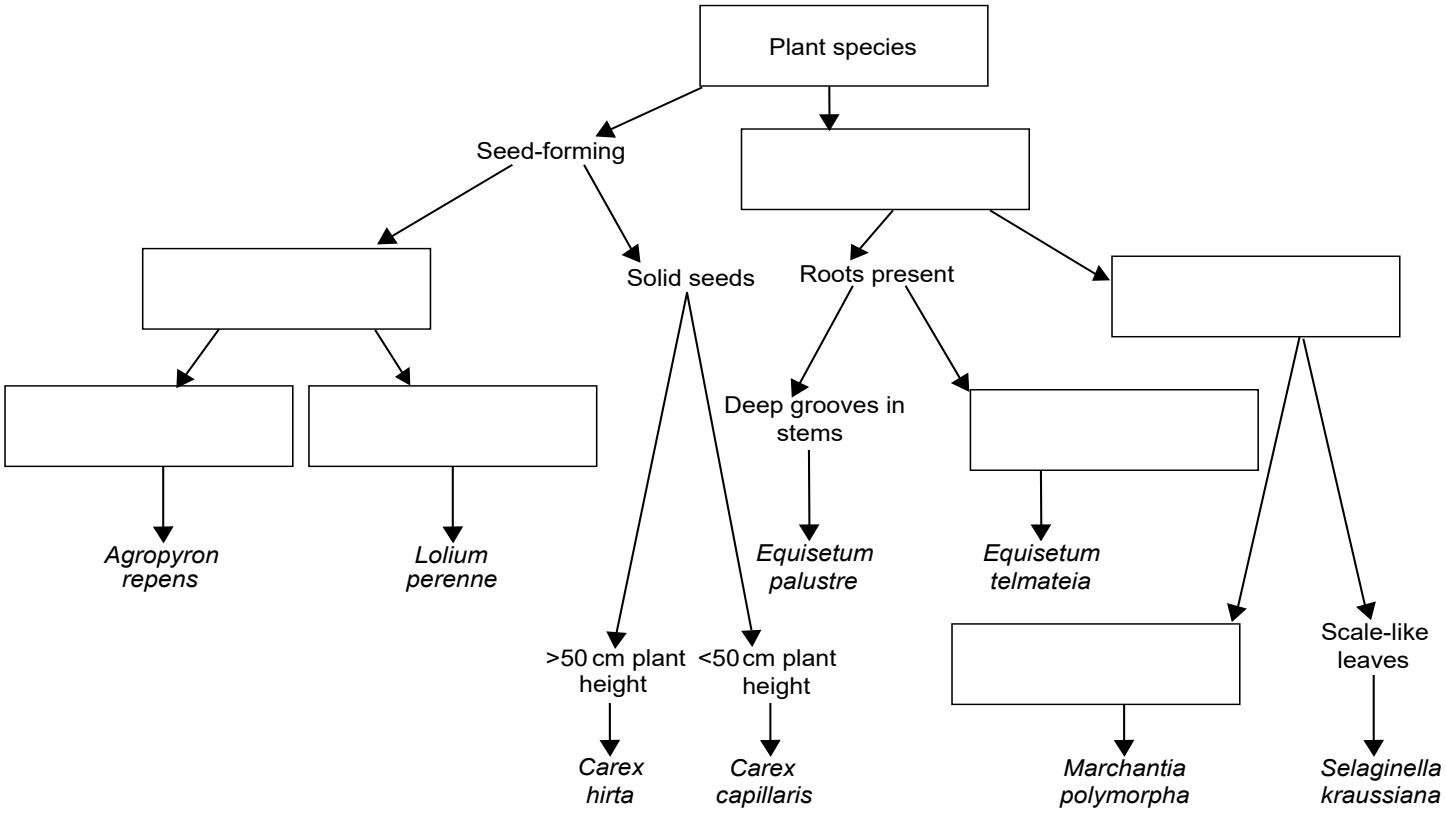


Fig. 3.1

[7]

(b) Plants are often known by their common names.

Horsetails, liverworts and mosses are the common names for three types of plant.

They produce spores during reproduction.

An example of each plant is shown in the photographs in **Fig. 3.2.**

Horsetail

Liverwort

Moss

Fig. 3.2

(i) Draw a line from the Latin name to the common name to identify the plants.

Use the information in **Table 3.1**, **Fig. 3.1** and **Fig. 3.2** to help you.

Latin name	Common name
Equisetum palustre	Horsetail
Marchantia polymorpha	Moss
Selaginella kraussiana	Liverwort

[2]

(ii) **Fig. 3.2** shows one type of primary data.

State another source of primary data to be used in the classification of plants.

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

(c) (i) Define the term **binomial nomenclature**.

.....

.....

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

(ii) Suggest why binomial nomenclature is used in the classification of plants.

.....

.....

.....

.....

.....

.....

.....

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

4 Beth is investigating the time period for a simple pendulum (**Fig. 4.1**) to swing from left to right.

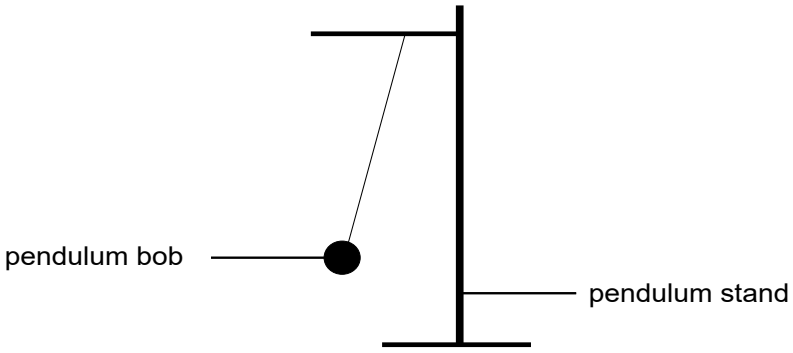


Fig. 4.1

She records the time taken for the heavy pendulum bob to swing from a set point.

She repeats the swing four times for each of four experiments, **A**, **B**, **C** and **D**.

The results of her four experiments are shown in **Table 4.1.**

Experiment	**Time period (s) for a simple pendulum**			
	Repeat			
	1	**2**	**3**	**4**
A	48.5	53.0	49.5	51.0
B	45.6	47.0	45.0	46.5
C	45.5	46.2	54.5	48.5
D	50.5	51.0	50.0	49.5

Table 4.1

(a) The **true value** of the period of the pendulum is 50.5 s.

(i) Which experiment, **A**, **B**, **C** or **D**, is precise and accurate?

.....

[1]

(ii) Which experiment, **A**, **B**, **C** or **D**, is precise but **not** accurate?

.....

[1]

(iii) Which experiment, **A**, **B**, **C** or **D**, is accurate but **not** precise?

.....

[1]

(iv) Which experiment, **A**, **B**, **C** or **D**, is **not** precise or accurate?

.....

[1]

(b) Determine the range of the times recorded in Experiment **C**.

Show your working.

range = ... s **[2]**

(c) Suggest what Beth should specify to make her investigation **repeatable**.

.....

.....

.....

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

(d) Time was measured in this investigation.

Beth started and stopped a stopwatch.

This introduced a source of error.

(i) Describe the **cause** of this error.

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

(ii) What type of error is caused when a person starts and stops a stopwatch?

Tick (✓) **one** box.

Measurement error ☐

Random error ☐

Systematic error ☐

[1]

(iii) Explain your answer to **d(ii)**.

.....

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

(e) The reading on a stopwatch lies between a minimum time value and a maximum time value.

The manufacturer states that the stopwatch has an accuracy of 0.3%.

The stopwatch shows a reading of 1000.0 s.

(i) Calculate the minimum and maximum time values.

minimum = ... s

maximum = ... s

[3]

(ii) What **type** of error is due to the accuracy of the stopwatch?

Tick (✓) **one** box.

Measurement error	☐
Random error	☐
Systematic error	☐

[1]

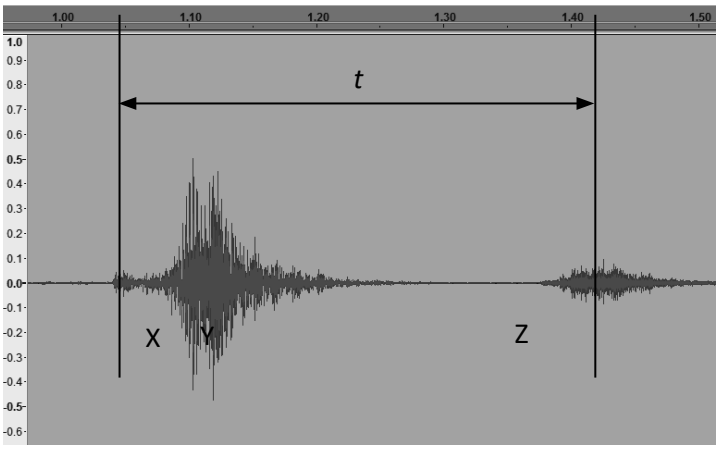
5 Amir is carrying out an investigation using voice recognition software to display sounds as wave forms on a computer screen.

He asks two of his friends to say a single-syllable word into a microphone.

Each wave form is recorded as a trace on the computer screen.

Fig. 5.1 shows the trace recorded for each of Amir's friends.

Trace 1



Trace 2

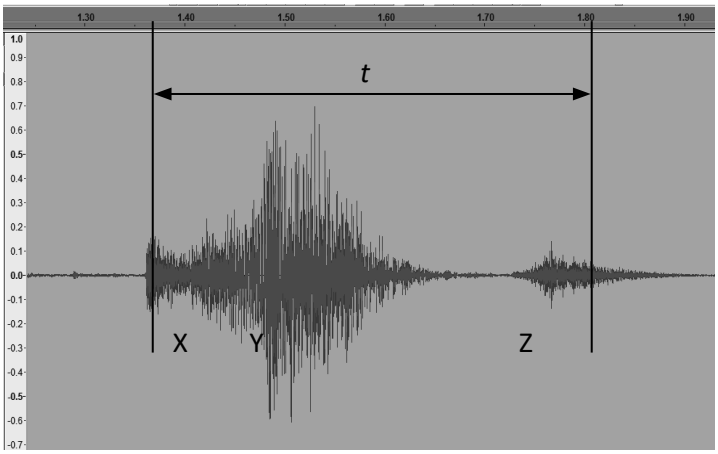


Fig. 5.1

(a) The horizontal axis of each trace shows the time taken to speak the single-syllable word.

Amir concludes that the same word was spoken by both of his friends.

Do you agree with Amir's conclusion?

Use **traces 1** and **2** to explain your answer.

.....

.....

.....

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

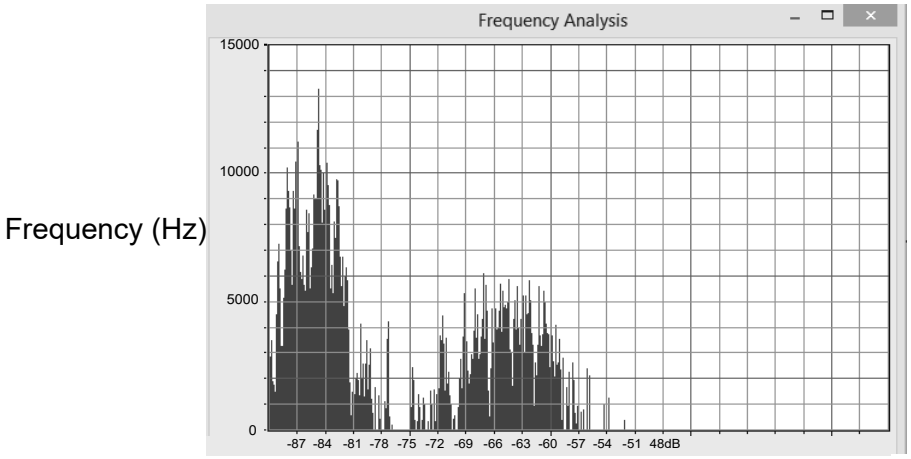
(b) The voice recognition software used by Amir also gives a frequency analysis of each trace.

Frequency, in Hertz (Hz), is plotted against the loudness of the sound, in decibels (dB).

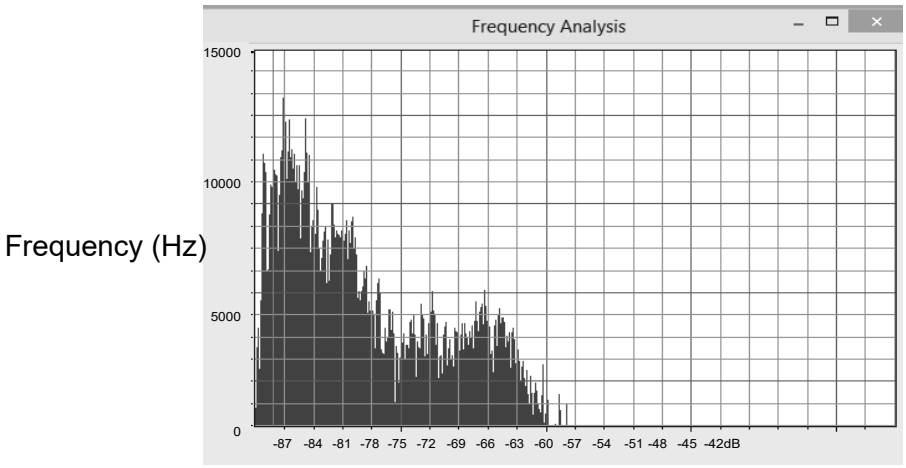
Amir recorded the frequency of the sounds produced by three different friends on a computer screen when they said the same word.

The results of the frequency analysis are shown as three traces in **Fig. 5.2.**

Trace 1



Trace 2



Trace 3

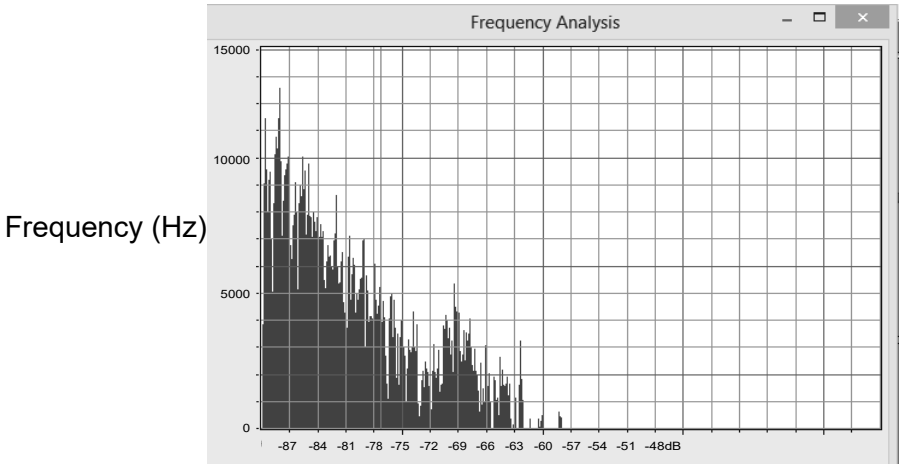


Fig. 5.2

Compare the three traces in **Fig. 5.2** to describe how they confirm that the same word was spoken and describe why the traces are not identical.

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

(c) The data shown in **Fig. 5.1** and **Fig. 5.2** are primary data.

(i) Describe **one** feature of primary and secondary data.

Primary data .....

.....

Secondary data .....

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

(ii) Suggest **three** advantages of using secondary data.

1 .....

2 .....

3 .....

[3]

6 Scientific findings are shared with a wide range of people.

Scientific authors can be either public information scientists or scientific journalists.

(a) For each type of author in **Table 6.1** put a tick (✓) in the correct box to indicate if they are public information scientists or scientific journalists.

Type of author	Public information scientist	Scientific journalist
University scientist		
Scientific book authors		
Government scientific agencies		
Newspaper article authors		
Scientific companies		
TV programme producers		
Blog author		

Table 6.1

[7]

(b) When writing a scientific report it is important to consider the audience that the report is written for.

Suggest **three** different audiences that scientific reports can be written for.

1.....

2.....

3.....

[3]

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7 Iron tablets are used to treat people with a low level of iron in their blood.

The active ingredient in iron tablets is iron(II) sulfate, $FeSO_4$.

(a) Susan carries out a titration to check the mass of iron in an iron tablet.

She follows three key steps.

Step 1 - The iron tablet is ground to a fine powder using a pestle and mortar and transferred to a conical flask.

Step 2 - 100 cm^3 of dilute sulfuric acid is added to the powder, and then the flask is shaken until the iron tablet dissolves.

Step 3 - A few drops of indicator are added and the solution is titrated with 0.010 mol dm^{-3} potassium dichromate.

Susan records the initial and final burette readings as part of the titration, and calculates the volume needed to reach the end-point.

She obtains the results shown in **Table 7.1**.

Initial burette reading (cm^3)	0.10
Final burette reading (cm^3)	19.00
Volume of 0.010 mol dm^{-3} potassium dichromate added (cm^3)	18.90

Table 7.1

(i) Calculate the number of moles of potassium dichromate required to react with the iron in the tablet.

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

number of moles =.....**[2]**

(ii) In the titration, 6 moles of iron(II) ions react with 1 mole of dichromate ions.

Calculate the number of moles of iron in the tablet.

Use your answer from **(a)(i)**.

number of moles = ... **[1]**

(iii) The relative atomic mass of iron is 55.8.

Calculate the mass, in mg, of iron in the tablet.

Use the equation: mass (g) = number of moles x relative atomic mass

Use your answer from **(a)(ii)**.

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

mass of iron = ... mg **[4]**

(iv) The bottle of iron tablets states that **each** tablet contains 65 mg.

Calculate the error in Susan's value from **a(iii)** as a percentage of the value shown on the bottle.

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

(v) Susan considers using a spectrophotometer to determine the mass of iron in the tablet.

Suggest **one** advantage and **one** disadvantage of using a spectrophotometer rather than completing a titration.

Advantage .....

.....

Disadvantage.....

.....

[2]

(b) Chromatography can be used to purify (prepare) a chemical for further use or to quantify the amount of a chemical present.

(i) Complete the sentences below using words from this list.

Each word may be used once, more than once or not at all.

elution **protonometry** **scraping** **radiology** **nephrology**

Preparative samples can be obtained from column chromatography by

..... .

Preparative samples from thin layer chromatography (TLC) can be obtained by

..... or ..... .

[3]

(ii) Densitometry can be used to quantify the amount of substance separated on a TLC plate.

Complete the sentences below using words from this list.

Each word may be used once, more than once or not at all.

scanned **intensities** **less** **protracted** **cyclons**

greater **calibration** **wavelengths** **similar**

A beam of light is ……..... across the TLC plate.

Different chemicals absorb specific ……..... of light.

The more substance present, the ……..... the amount of light absorbed. The amount of substance present can be estimated by comparing the absorption of the spot with a ……..... graph.

[4]

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).

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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