OCR
Oxford Cambridge and RSA

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

Unit 3: Scientific analysis and reporting

Wednesday 17 January 2018 – Afternoon

Time allowed: 2 hour

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.
- 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 **100**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **28** pages.

FOR EXAMINER USE ONLY	
Question No	**Mark**
1	/20
2	/14
3	/18
4	/10
5	/13
6	/15
7	/10
Total	**/100**

Answer **all** the questions.

1 A patient has a hearing test.

She listens to sounds with different frequencies.

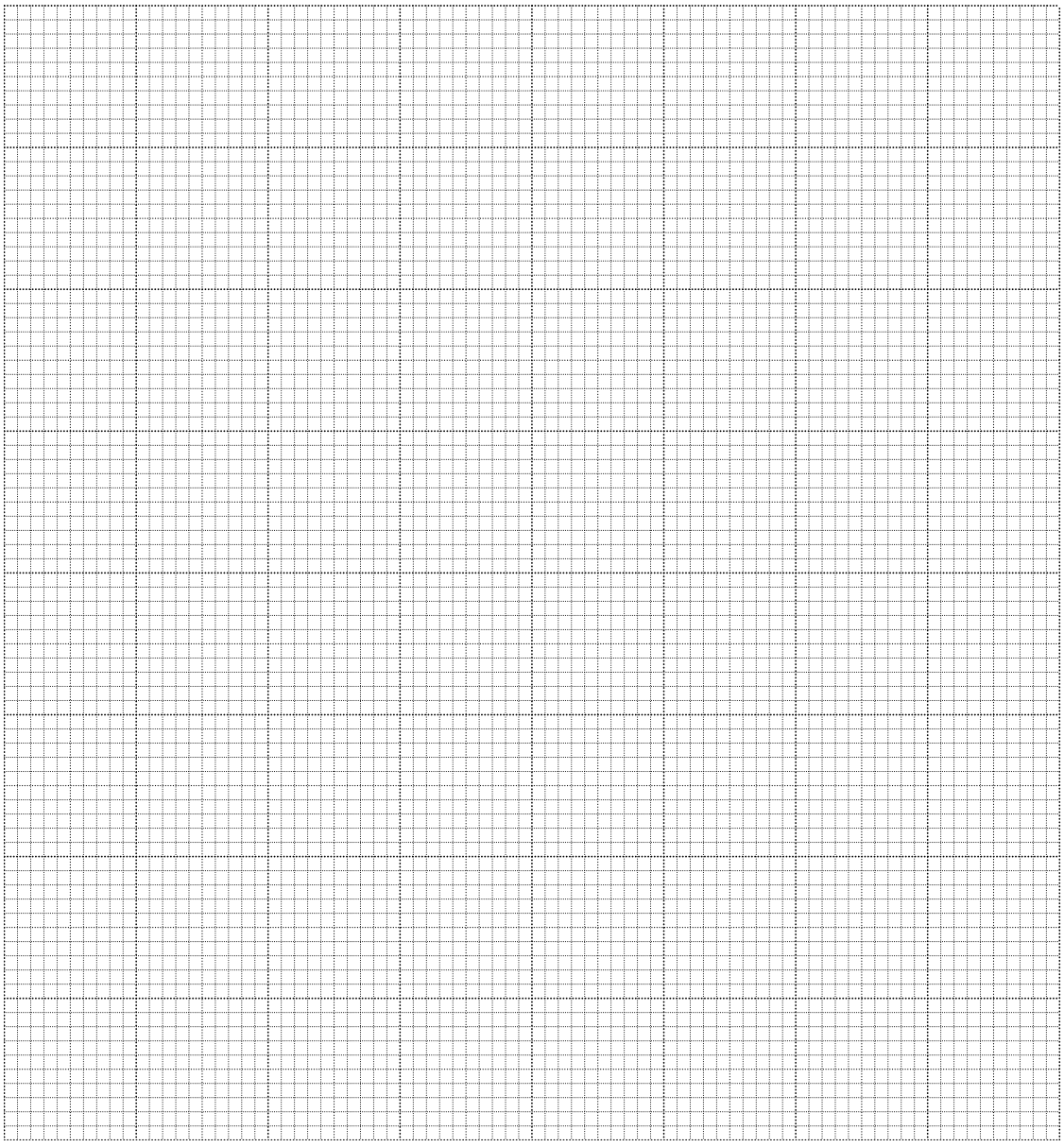
She presses a button when the sound is at the loudness level she can hear.

The results of her tests in May 2013 and May 2016 are shown in **Table 1.1**.

Test date		**Sound frequency (Hz)**							
		250	**500**	**1000**	**2000**	**3000**	**4000**	**6000**	**8000**
May 2013	Loudness level (dB)	25	35	40	50	55	60	70	70
May 2016	Loudness level (dB)	35	45	55	60	55	70	75	80

Table 1.1

(a) Draw a graph of **both** sets of data and draw lines of best fit.



[4]

(b) **(i)** Identify the ranges for the:

frequency measurement

.....

loudness level measurements

.....

[2]

(ii) Identify the interval of the loudness level (dB) measurements.

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

(c) Describe **two** trends shown in the data in **Table 1.1**.

1 .....

2 .....

[2]

(d) An audiologist conducts the hearing test on the patient.

He suspects there is an outlier in the 2016 data in **Table 1.1**.

(i) Identify the outlier in the 2016 data.

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

(ii) Having identified the outlier, suggest what the audiologist should do next.

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

(iii) Name the type of error that is most likely to have produced the outlier and suggest a possible cause.

.....

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

(iv) Use the graph you have drawn to suggest a more likely value for the outlier.

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

Table 1.1 is repeated below.

Test date		Sound frequency (Hz)							
		250	**500**	**1000**	**2000**	**3000**	**4000**	**6000**	**8000**
May 2013	Loudness level (dB)	25	35	40	50	55	60	70	70
May 2016	Loudness level (dB)	35	45	55	60	55	70	75	80

Table 1.1

(e) Analyse the data shown in **Table 1.1** and justify a conclusion about the quality of the patient's hearing.

.....

.....

.....

.....

.....

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

(f) The decibel scale is not linear. An increase of 10dB produces a sound that is 10 times louder.

Calculate how much louder a sound is at 80db compared with 30db.

Give your answer in **standard form**.

Show your working.

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

2 The features of flowers can be represented by different symbols.

Some of the symbols are shown in **Table 2.1**.

Flower feature	Symbol
Actinomorphic petal arrangement	⊕
Zygomorphic petal arrangement	%
Male	♂
Female	♀
Hermaphrodite	⚥
Number of sepals (the calyx)	**K**
Number of petals (the corolla)	**C**
Number of male parts in the androecium	**A**
Number of female parts in the gynoecium	**G** **G** inferior ovary **G** superior ovary

Table 2.1

(a) A group of symbols can be used to describe a type of flower.

The group of symbols is called the floral formula.

One type of flower in the *Asteraceae* family is described by the formula:

$$\% \; ♀ \; K_{\text{pappus}} \; C_{(5)} \; A_0 \; \overline{G} \; \overline{(2)}$$

(i) State the number of petals present in this flower.

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

(ii) Suggest why the number representing the androecium in this flower is zero.

.....

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

(b) Symbols can be used to represent the arrangement of petals within the flower.

Flowers are either actinomorphic ⊕ or zygomorphic **%**.

Fig. 2.1 shows the appearance of the two petal arrangements for family *Asteraceae.*

⊕ %

Fig. 2.1

The two flowers are different.

Describe **two** differences in petal arrangement, in terms of **symmetry**.

1.....

.....

2.....

.....

[2]

(c) *Bidens cernua* is shown in **Fig. 2.2**.

This plant is also a member of the *Asteraceae* family.

Fig. 2.2

(i) State the naming system used to identify *Bidens cernua*.

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

(ii) The term *Bidens* comes from the Latin *bis* ("two") and *dens* ("tooth").

The term *cernua* means nodding or hanging.

Use the structures seen in **Fig. 2.2** to suggest why this plant was given the botanical name *Bidens cernua*.

Bidens

.....

cernua

.....

[2]

(iii) State the type of data shown in **Fig. 2.2** and suggest **one** advantage of showing the image of the plant as an illustration.

Type of data

.....

Advantage

.....

.....

[2]

(d) Keys can be used for the identification of living organisms.

Table 2.2 shows the characteristics of the flowers of some plant families.

Plant family	Characteristics of flowers	
	Number of sepals and petals	**Number of stamens (male parts)**
Caryophyllaceae	5	5 or 10
Crassulaceae	5	5 to 10
Cruciferae	4	6
Guttiferae	5	Numerous, in 3 or 5 bunches
Liliaceae	3	6
Onagraceae	4	8

Table 2.2

Fig. 2.3 shows a key used to identify the different plant species in **Table 2.2**.

Use the data in **Table 2.2** to complete the blank spaces in **Fig. 2.3**.

Some of the key has already been completed.

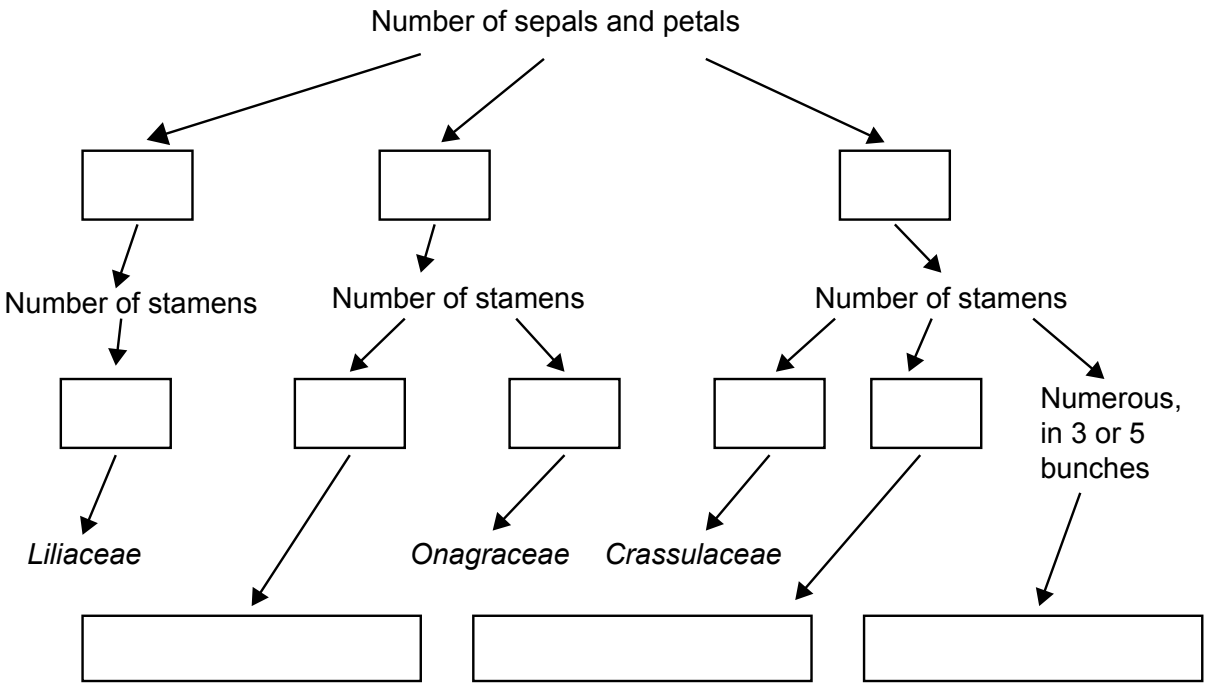


Fig. 2.3

[3]

(e) **Fig. 2.4** shows a single flower of a different plant, *Sedum ternatum*.

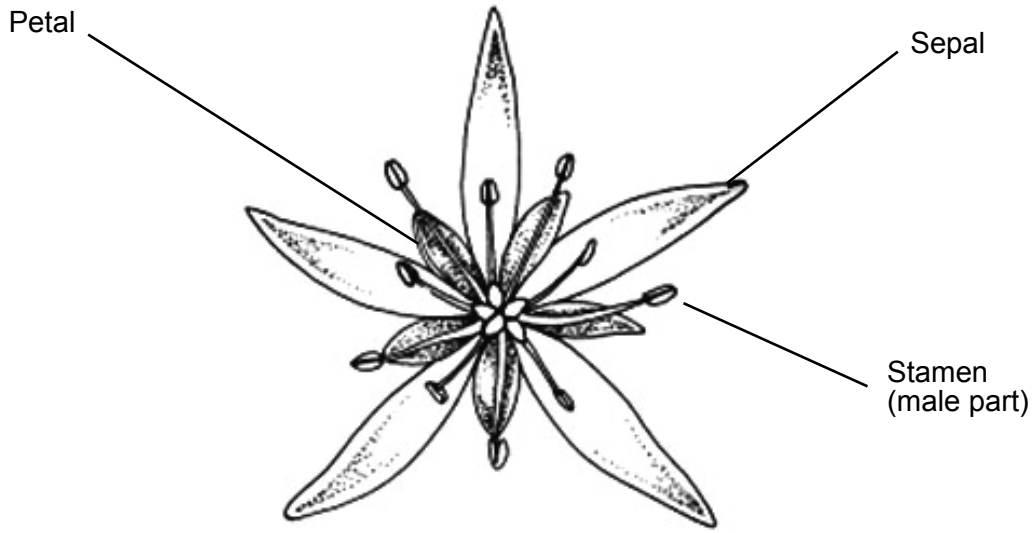


Fig. 2.4

Explain why the key shown in **Fig. 2.3 cannot** be used to fully identify the specific family that *Sedum ternatum* (**Fig. 2.4**) belongs to.

.....

.....

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

3 The radius of the Moon at its equator is 1738.14 km.

(a) (i) Use the formula below to calculate the volume of the Moon.

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

Give your answer in **standard form** to **two** significant figures.

Show your working and give the units.

volume of the Moon = ... units ..... **[3]**

(ii) The radius of the Moon at its poles is 2.17 km **less** than the radius at its equator.

Calculate the ratio of the polar radius to the equatorial radius.

Give your answer as a percentage.

Show your working.

percentage = ... % **[3]**

(iii) The average density ρ of the Moon is 3.34 g/cm^3

Use the formula below to calculate the mass m, **in kg**, of the Moon, where V is the volume calculated in **a(i)**.

$$\rho = \frac{m}{V}$$

Show your working.

m = ... kg **[3]**

(b) The Moon has a constant orbital period of 27.32 days.

The Moon's distance ***r*** from Earth varies during its orbit.

Fig. 3.1 shows the variation in this distance **(r)** during the first four months of 2014.

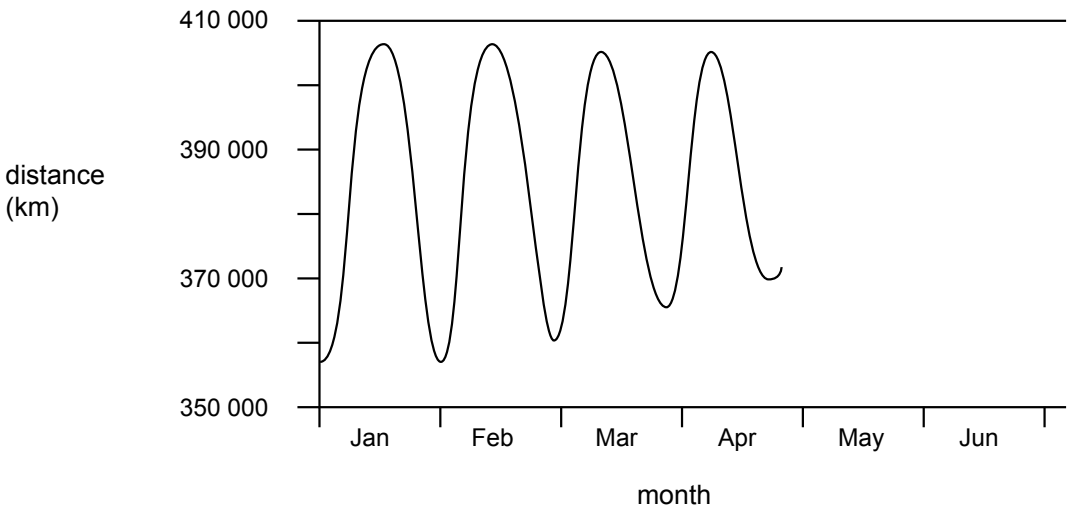


Fig. 3.1

(i) Describe the feature of the graph of **Fig. 3.1** that shows that the orbital period of the Moon is constant.

.....

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

(ii) The distance from the Earth to the Moon decreases during May and June.

Extend and **draw** the line on **Fig. 3.1** to predict how the Earth-Moon distance varies during May and June.

[2]

(iii) A webpage claims the following statement:

The speed of the Moon around the Earth is 1000 m/s.

Is this statement correct?

Justify your answer with a calculation.

You may use the information in **Fig. 3.1** and the formulae:

- Circumference of a circle = $2\pi r$
- Speed = distance ÷ time

Show your working.

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

4 Sosana is using an ammeter in the science laboratory.

She notices that the needle does not point exactly at zero (**Fig. 4.1**) even when not connected in a circuit.

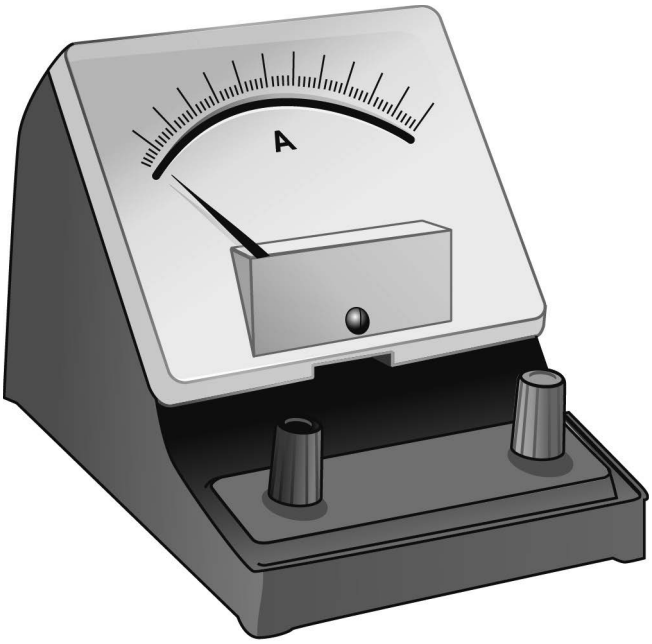

Fig. 4.1

(a) (i) Describe what Sosana must do **to avoid** instrument error and measurement error.

Instrument error

.....

.....

Measurement error

.....

.....

[2]

(ii) The manufacturer of the ammeter (**Fig. 4.1**) claims that the meter is accurate to ±2% of the full scale reading.

The full scale reading is 12A, as shown in **Fig. 4.1**.

Calculate the uncertainty in the ammeter reading.

Show your working.

uncertainty = ± ……..... A **[2]**

(b) Sosana uses the ammeter to measure current in a circuit.

She repeats her measurements.

Her results are shown in **Table 4.1**.

	Repeat		
	1	**2**	**3**
Current (A)	2.65	2.85	2.80

Table 4.1

(i) The true value for the current is 2.70A.

Use your calculated uncertainty value in **(a) (ii)** to evaluate the accuracy of Sosana's measurements.

.....

.....

.....

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

(ii) Use the measurements in **Table 4.1** to calculate the mean current.

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

Show your working.

mean current = ... A **[2]**

(iii) Describe **two** things Sosana could do to find out whether her measurements are reproducible.

1 .....

2 .....

[2]

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PLEASE DO NOT WRITE ON THIS PAGE

Turn over for the next question

5 Gusti is a scientist working within a research team.

The team are investigating gamma radiation.

The effects of gamma radiation on the mortality (death) of mice is shown in **Fig. 5.1**.

- Mice were placed into three groups and received different daily exposures to gamma radiation.
- The percentage of survivors was plotted against time as shown in the graph below.

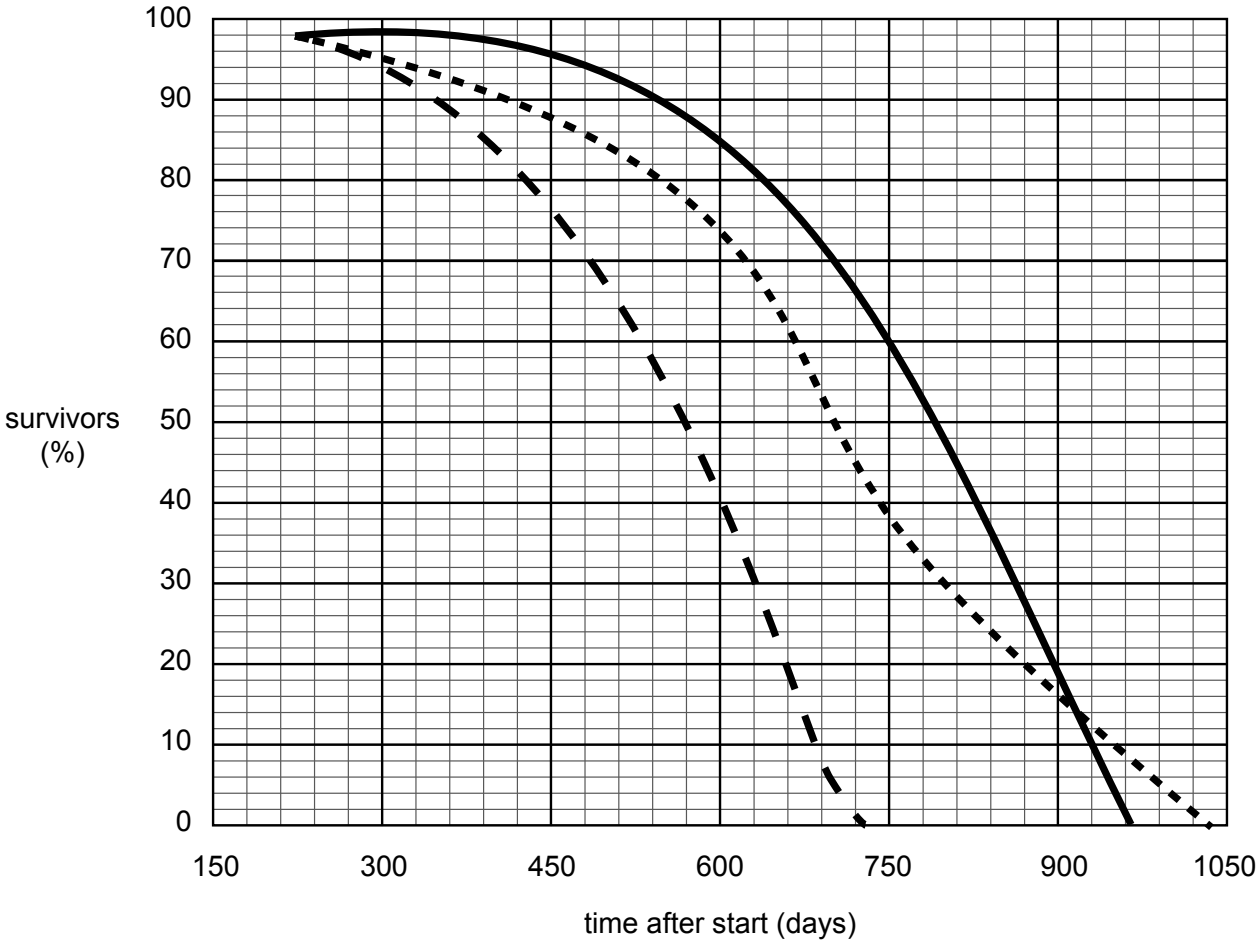

Fig. 5.1

Key for the three groups of mice

high daily dose of gamma radiation

control group – no exposure

low daily dose of gamma radiation

(a) At 750 days after the start of exposure to gamma radiation, 60% of the mice receiving a low daily dose were still alive.

Calculate the gradient of the **low dose graph** at this point and give the units.

Show your working.

gradient = …… units = …… **[4]**

(b) **(i)** Use **Fig 5.1** to draw conclusions about the effect of gamma radiation on the mortality of mice.

Justify your conclusions.

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

(ii) Study the evidence provided in **Fig. 5.1**.

Identify the evidence needed to make your conclusions more secure.

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

(c) Gusti plans to compare the results obtained from his investigation with secondary data sources.

Suggest **one** advantage and **one** disadvantage of using secondary data sources.

Advantage .....

.....

Disadvantage.....

.....

[2]

6 Samit works in a hospital microbiology laboratory.

He uses different growth media to identify microorganisms in samples sent for analysis.

(a) Samit uses **selective**, **differential** and **enriched** growth media to help to identify microorganisms.

Explain how each medium helps in the identification of bacteria.

(i) Selective media

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.....

.....

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

(ii) Differential media

.....

.....

.....

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

(iii) Enriched media

.....

.....

.....

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

(b) Samit uses Mannitol-Salt-Agar (MSA) to investigate the presence of the bacteria, *Staphylococcus* species.

Some of the constituents of this medium are shown in **Table 6.1**.

Constituent	**Information**
Mannitol	a sugar-alcohol fermented by some microorganisms to produce acidic products
Sodium chloride (7.5%)	this concentration of salt is too high for the growth of most bacteria
Neutral red	acid-base indicator red at pH 7.4 and above yellow below pH 6.8

Table 6.1

(i) Which type of medium is MSA?

Put a tick (✓) in the boxes next to the **two** correct answers.

differential ☐

enriched ☐

liquid ☐

nutrient ☐

selective ☐

[1]

(ii) Different species of *Staphylococcus* grow in a different way on MSA.

The growth of three species of *Staphylococcus* on MSA is shown in **Table 6.2**.

Key for growth	**+** = less dense	**++** = more dense

Species	**Growth**	**Tolerant of high sodium chloride concentrations**	**Ability to ferment mannitol**	**Colony colour**
Staphylococcus aureus	**+**	✓	✓	golden-yellow
Staphylococcus epidermidis	**++**	✓	**X**	white
Staphylococcus saprophyticus	**+**	✓	✓	white

Table 6.2

Samit receives samples of nose swabs collected from two patients.

Table 6.3 shows the results after inoculating and incubating MSA plates with samples from the nose swabs.

Source of nose swab sample	**Appearance of MSA plate**
Patient 1	A few small yellow colonies with yellow zones around them
Patient 2	Many small white colonies on pink agar

Table 6.3

Consider the data provided in **Tables 6.1**, **6.2** and **6.3**.

Identify the bacterium collected from each of the patients. Give evidence to support your conclusion.

Patient 1

Bacterium present .....

Evidence

.....

.....

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

Patient 2

Bacterium present .....

Evidence

.....

.....

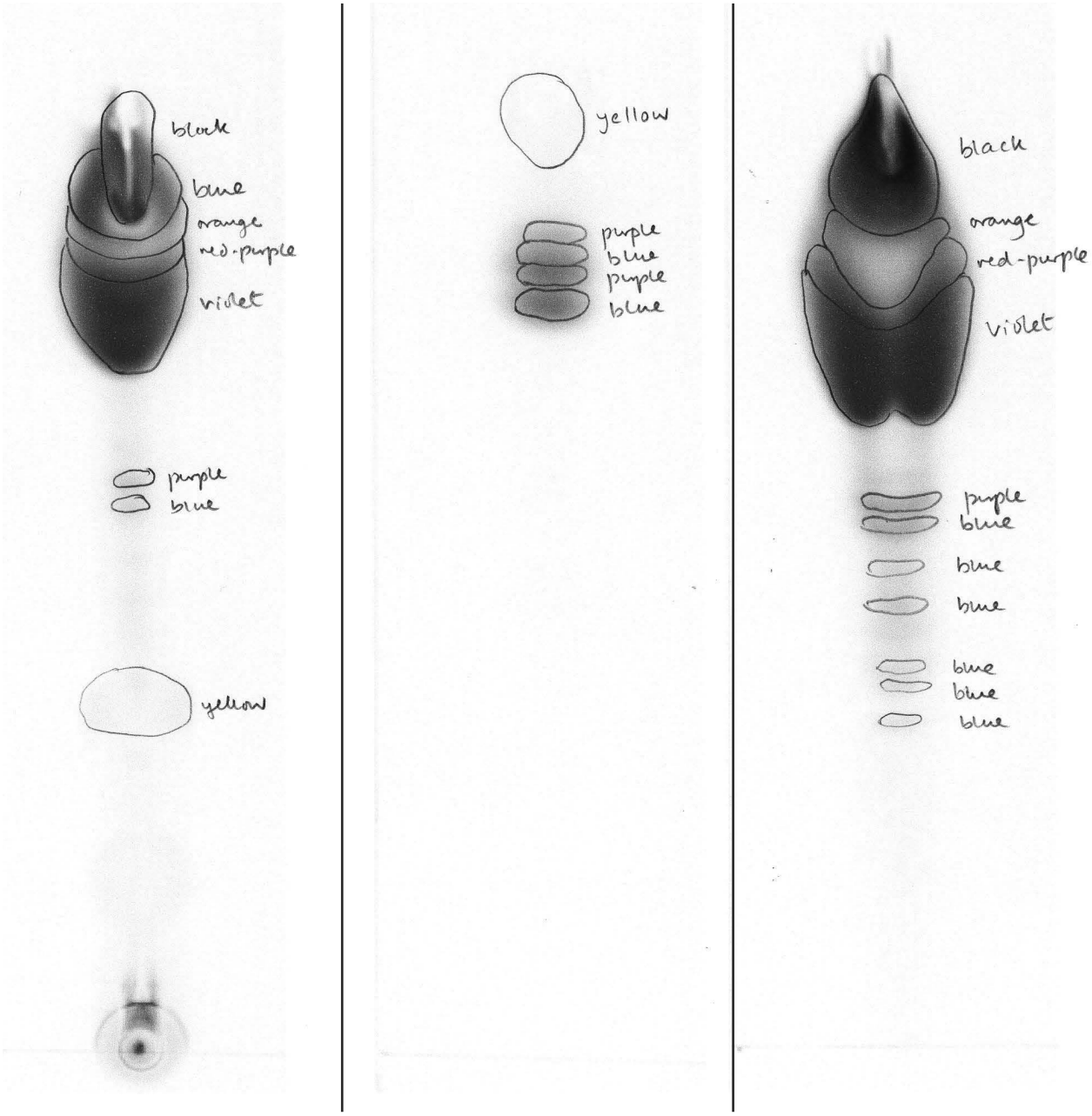
.....**[3]**

7 Charlie is a science student. She was provided with samples from a mock crime scene:

- ink extracted from a hand-written note found at the scene
- ink extracted from the pen of suspect A and suspect B.

She used thin-layer chromatography (TLC) to separate the constituents of the three ink samples to identify the source of the crime scene ink.

Charlie scanned the TLC plates and circled the spots (**Fig. 7.1**) in her logbook.



Ink extracted from the hand-written note | Ink from the pen of suspect A | Ink from the pen of suspect B

Fig. 7.1

(a) Charlie wrote the following observations in her logbook.

The ink on the note was obviously a match to the ink from the pen of suspect B.
The spots were in the same position.

I calculated the R_f values for each spot and compared them between the 3 samples.

$$R_f \text{ value} = \frac{\text{distance moved by spot}}{\text{distance moved by solvent}}$$

This confirmed that the crime scene pen came from suspect B.

(i) Charlie asked some other students in her science group to review her results and conclusions.

Give the name of this type of review.

……**[1]**

(ii) The students suggested that Charlie should improve the validity of her conclusion.

Suggest **two** ways of improving the validity of Charlie's conclusion.

1 ……

2 ……
[2]

(iii) Charlie used scanned images and calculations in her logbook.

State **three** other ways of presenting data for scientific analysis.

1……

2……

3……
[3]

(b) Forensic scientists must record their findings in a 'Forensic Scientist Report'.

This type of report may be referred to by the police and the judge and jury in a court of law.

The results of chromatographic analysis are often included in the Forensic Scientist Report.

When forensic scientists include findings of chromatographic analysis in their reports, suggest:

- What the report should include.
- The style it should be written in.

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.....**[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).

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

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