OFFICE OF TASMANIAN ASSESSMENT, STANDARDS & CERTIFICATION

External Assessment 2021

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PHYSICAL SCIENCES

PSC315118

Part 1

Pages	16
Questions	5
Information Sheet	1

Reading time: 15 minutes – you may begin writing during this time

Suggested working time: 36 minutes

Instructions

- Attempt **all** questions and **all** parts within each question.
- Write your answers in the spaces provided in this exam paper.
  - Show working in answers to numerical questions and use appropriate units. Marks may not be given to answers without working.
  - Spare diagrams have been provided at the end of the exam booklet.
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  - If unsure, use the value given by the examiner.
- A TASC approved scientific calculator is allowed throughout the exam.
- All answers must be written in **English**.
- You **must** make sure your answers address:
  - Criterion 4 apply concepts and processes of atomic properties and nuclear reactions.

Marker use	
C4	32

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Guide to Exam Structure

	Questions available	How many questions to answer	Suggested working time	Marks available
Part 1	5	5	36 minutes	32
Part 2	5	5	36 minutes	32
Part 3	5	5	36 minutes	32
Part 4	5	5	36 minutes	32
Part 5	5	5	36 minutes	32
Total	**25**	**25**	**180 minutes (3 hours)**	**160**

Marker use

Question 1

Potassium is found in group 1, period 4 of the periodic table.

a) Complete the following table about **potassium**, or its **ion**:

2

	No. of protons	No. of neutrons	No. of electrons
$^{39}_{19}K$	19		19
		21	18

Spare diagram used (✓) ☐

b) Draw an electron shell diagram to represent a potassium atom and state how this structure is connected to its position on the periodic table.

2

Electron shell diagram:

How does its electron structure relate to potassium's position in group 1 and period 4?

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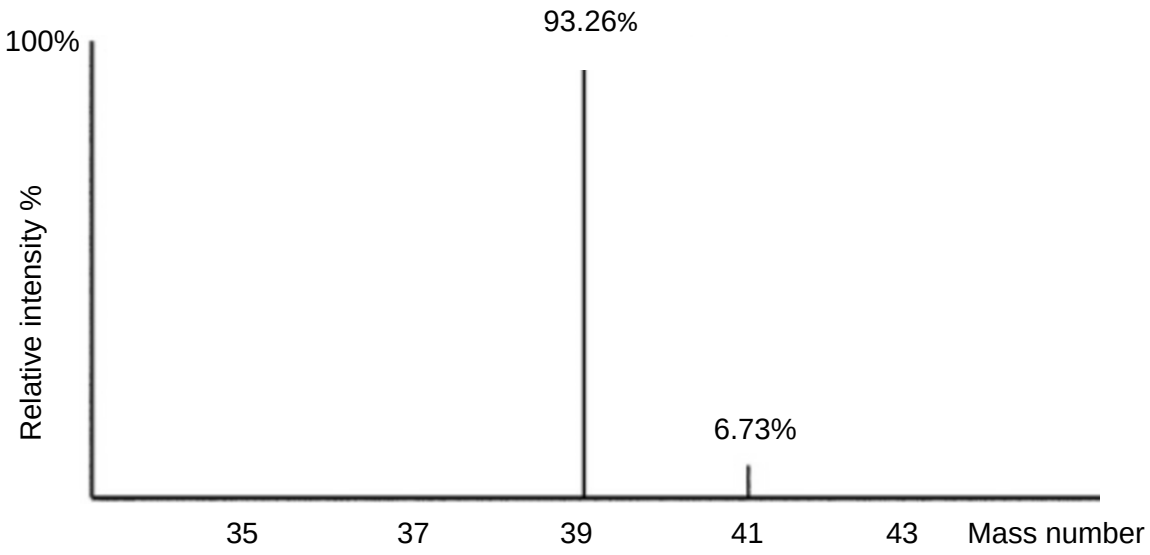
Question 1 continues

Marker use

c) Use data from the following mass spectrum of the main isotopes of potassium to calculate the relative atomic mass of potassium.

2



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Total Q1

6

Question 2

Part of an early periodic table from 1865 is given below. The 56 known elements were arranged in order of increasing atomic mass.

H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe

a) The shaded column does not correspond with a group in the modern periodic table. Identify how the properties of this group are inconsistent with the modern periodic table with reference to **one (1)** physical property **and** the valency of the elements in this group. **2**

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b) Atomic number is used to organise the modern periodic table.

i. Define the term atomic number. **1**

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ii. Why is atomic number used for arranging the elements in the modern periodic table? **1**

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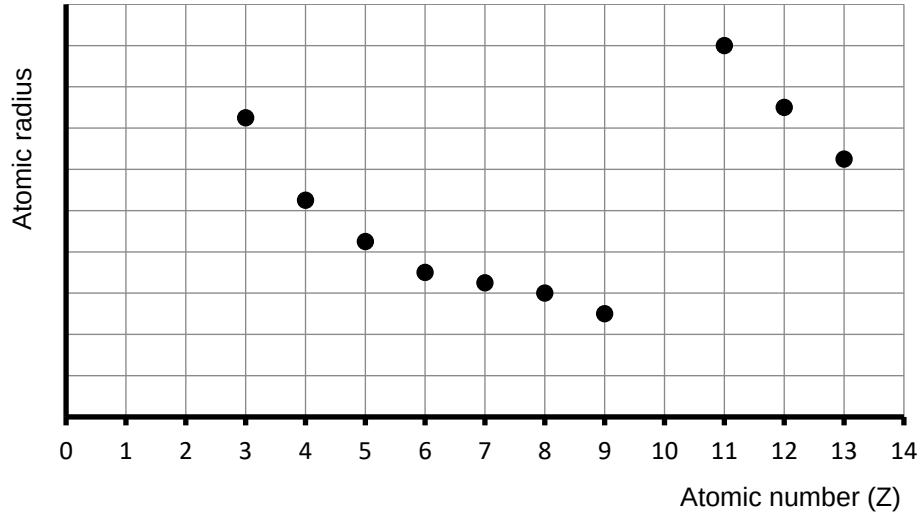
Question 2 continues

Question 2 continued

The graph below shows the variation in the atomic radius as the atomic number (Z) increases for part of the modern periodic table.



c) Explain why there is a small decrease in the atomic radius between Z = 8 (oxygen) and Z = 9 (fluorine), but a large increase in the atomic radius between Z = 9 and Z = 11 (sodium).

3

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Total Q2

7

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Exam continues on the next page

Question 3

Marker use

On the Information Sheet for Physical Sciences a proton is given the symbol $^{1}_{1}\mathrm{H}$ and the α (alpha) particle the symbol $^{4}_{2}\mathrm{He}$.

a) Justify that the terms hydrogen ion and proton can be used interchangeably.

1

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b) Rewrite the symbols for a proton and an alpha particle to better reflect the **exact chemical** nature of these particles.

1

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c) Alpha particles are highly ionising. Explain why with reference to how an alpha particle ionises an atom.

2

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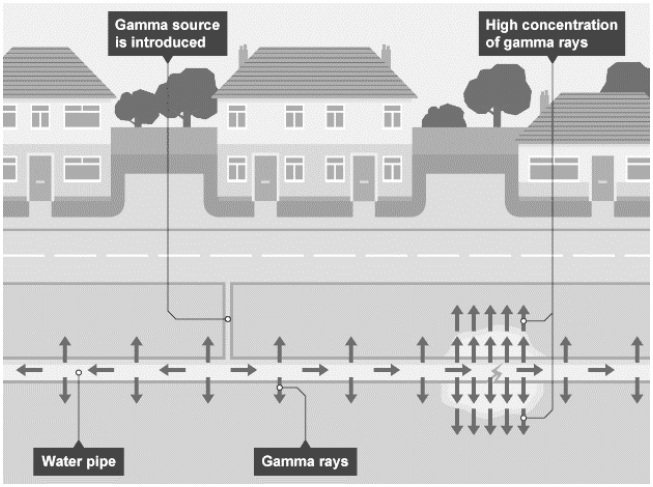
Total Q3

4

Question 4

Radiotracers are radioisotopes used for tracing the movement of substances through systems. They are used in both industry and medicine.

a) In industry, radiotracers can be used to detect water leaks in underground pipe systems. Tracers are put into the water, and after a few hours leaks can be detected by increased amounts of radiation in a specific location.



An isotope used for this purpose is metastable bromine-82, which decays by gamma emission and has a half-life of 35 hours.

i. Write the decay equation for metastable Br-82. 1

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ii. Explain why Br-82 is a good choice as a radiotracer for this purpose. 2

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Question 4 continues

Question 4 continued

b) Radiotracers are also use medically. An example is iodine, which is taken up by the thyroid gland. When a patient is given a low dose of radioactive iodine-131 or iodine-123, an overactive thyroid can be detected from outside the body by measuring an increase in activity over the thyroid gland.

i. Both isotopes of iodine can be used as radiotracers. Outline the similarities and difference in the atomic structure of these isotopes. **2**

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ii. Iodine-131 decays by beta negative emission. Write the equation for this decay. **2**

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iii. Iodine-123 decays by gamma emission. Which of the two isotopes would be safer for the patient? Justify your choice. **2**

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Total Q4

9

Question 5

A student heard that mobile phones produce radiation and therefore decided to carry out an experiment to compare the radiation produced by a mobile phone and that from a radioisotope.

The student placed an ionisation counter 10 cm from a designated spot in the school laboratory. They first placed nothing at the location and took measurements, then repeated their experiment with a mobile phone and then with a gamma source each in the same location.

They measured the number of counts per 30 seconds three times for each source and obtained the following results:

	Counts per 30 seconds			
	Trial 1	Trial 2	Trial 3	Average
Nothing	8	6	4	6
Mobile phone	6	10	3	6.3
Gamma source (Tc-99m)	222	178	194	

a) When nothing was in front of the counter there were still counts recorded. List **two (2)** possible sources of the radiation measured in this case. **1**

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b) **Show that** the average count rate of the gramma source alone is 6.4 counts per second. **2**

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c) Explain the results of the experiment, with reference to the difference between radiation from a phone and nuclear radiation. **1**

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Question 5 continues

Marker use

d) The student repeated the experiment 24 hours later and the average count rate of the gamma source alone was now measured as 0.40 counts per second. Calculate the half-life of the gamma source.

/ 2

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Total Q5

/ 6

Spare Diagram

Question 1a)

	No. of protons	No. of neutrons	No. of electrons
$^{39}_{19}\mathrm{K}$	19		19
		21	18

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End of Part 1

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PHYSICAL SCIENCES

PSC315118

Part 2

Pages	16
Questions	5
Information Sheet	1

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Marker use	
C5	32

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Total	**25**	**25**	**180 minutes (3 hours)**	**160**

Question 6

Marker use

a) A boat travelled 3.20 km east in 30.0 minutes and then 4.50 km north in 45.0 minutes.

i. Calculate the distance travelled by the sailing boat in km.

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ii. Calculate the average speed of the boat in km h^{-1}.

1

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iii. Using a vector diagram, calculate the displacement of the boat.

3

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iv. Hence calculate the average velocity of the boat.

1

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Question 6 continues

Marker use

b) Later, the 3670 kg boat was positioned so that the wind applied a force on the sail which produced an acceleration of 0.220 m s^{-2} west. The boat was initially travelling at 2.30 m s^{-1} west.

i. Calculate the net force on the boat.

1

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ii. Calculate the distance the boat will have travelled when it reaches a speed of 6.00 m s^{-1}.

1

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iii. When the boat reaches 6.0 m s^{-1}, the wind stops and hence no longer exerts a force on the boat. Describe and explain the motion of the boat over the next few seconds using Newton's law(s).

2

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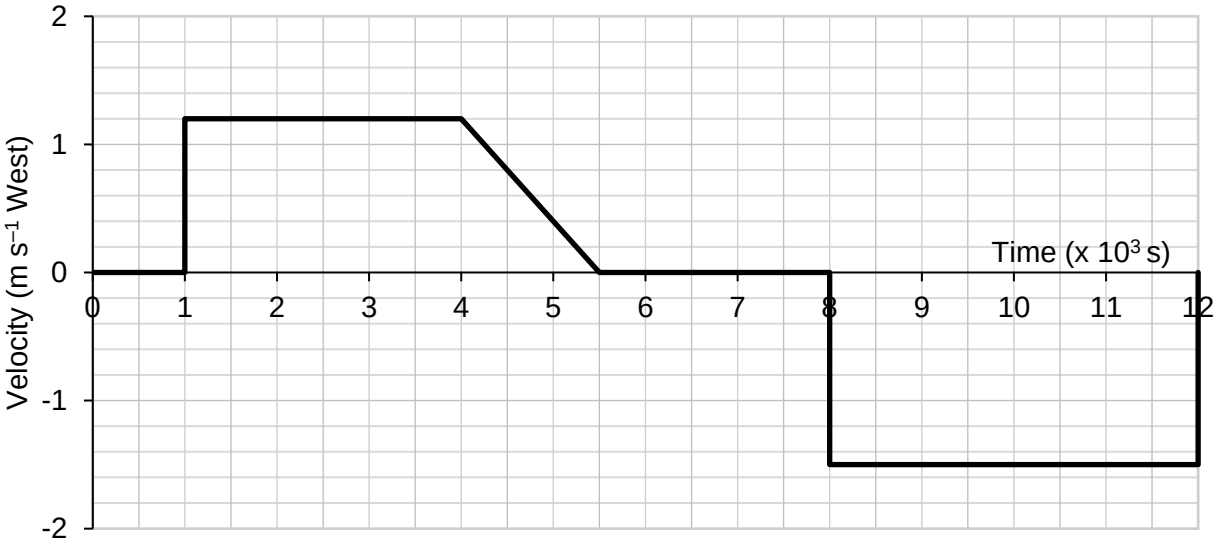
Total Q6

10

Marker use

Question 7

A hiker went on a walk whilst wearing a GPS watch. After the walk, she analysed the data and produced a graph of velocity versus time as shown below.



a) Identify the time period(s) when she was stationary.

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1

b) Calculate her acceleration at 4.5 x 10^3 seconds.

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1

c) Calculate her displacement at the end of the walk.

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2

Total Q7

4

Marker use

Question 8

Two skydivers with parachutes jumped from a plane.

Both skydivers reached terminal velocity before they opened their parachutes.

a) Define the term terminal velocity.

1

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b) Both skydivers present the same surface area as they fall but the second has a greater mass. Would the heavier skydiver reach a terminal velocity which is **lower**, **higher** or the **same as** the other skydiver? Explain your reasoning.

2

The heavier skydiver would reach a ..... terminal velocity.

Explanation: .....

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Total Q8

3

Question 9

A stationary archer is practising their archery. The 45.0 g arrow leaves the bow horizontally at a velocity of 63.0 m s^{-1}. Ignore air resistance when answering this question.

a) The arrow is accelerated for 0.025 s by the bow string.

i. Calculate the magnitude of the change in momentum of the arrow during this time. 1

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ii. Calculate the average force exerted on the arrow by the bow string in this time. 1

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b) As shown in the diagram on the next page (page 9), the target is supported by a diagonal brace which provides support in the horizontal direction. With reference to Newton's laws, explain why the target needs horizontal support. 2

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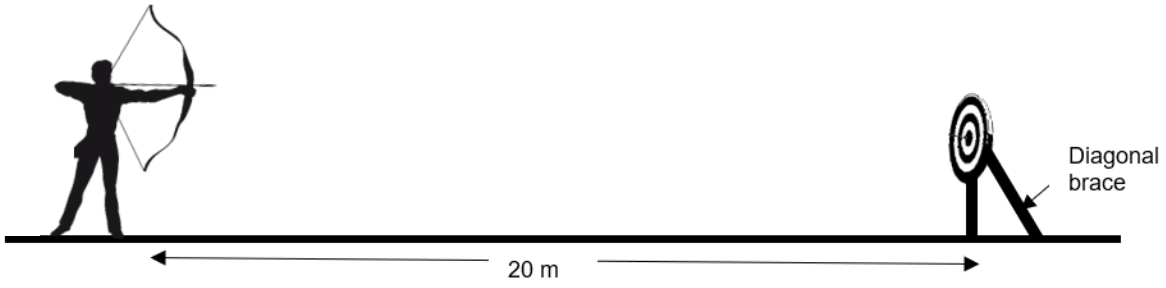
Question 9 continues

Question 9 continued

The archer, shooting horizontally at 63.0 m s^{-1}, hits a target 20.0 m away.



c) **Show that** the time the arrow spends in the air is approximately 0.3 s. **1**

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d) Calculate the **vertical** velocity of the arrow when it hits the target. **1**

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e) Calculate how far the arrow has fallen during this flight. **2**

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Total Q9 **8**

Question 10

In April 2021 the Mars Ingenuity helicopter conducted the first controlled powered flight on another planet. It has a mass of 1.80 kg and has been designed with oversized rotor blades to give sufficient lift in Mars' thin atmosphere.

On Mars, the acceleration due to gravity is 3.72 m s^{-2}. However, the atmosphere is so thin that the blades only provide a maximum lift force of 8.00 N when the helicopter is operating at full power.

a) Calculate the weight of the helicopter on Mars.

1

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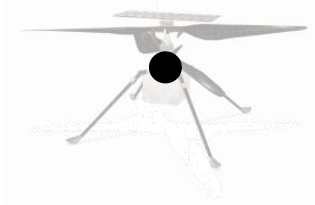
b) On the centre of mass dot (●) provided below, draw labelled forces acting on the helicopter when operating at full power.

1



Spare diagram used (✓)

☐

c) Calculate the net force on the helicopter when operating at full power.

1

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d) **Show that** the maximum acceleration of the helicopter is approximately 0.7 m s^{-2}.

1

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Question 10 continues

Question 10 continued

e) Engineers needed to determine how the helicopter would deal with various flight scenarios on Mars. A Mars flight scenario they analysed was as follows:

- Initially, the helicopter is hovering stationary 0.500 m above the ground.
- The helicopter then accelerates vertically upwards for 2.50 m at full power.
- The engine fails and the helicopter falls.

i. Calculate the expected velocity reached by the helicopter just before the engine fails.

1

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ii. The engineers knew that the helicopter could survive a fall to Mars' surface if the impact speed was less than 4.8 m s^{-1}. Determine whether the helicopter could survive the fall in this scenario.

2

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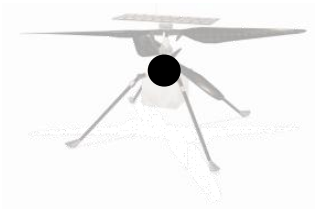
Total Q10

7

Spare Diagram

Question 10b)



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End of Part 2

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PHYSICAL SCIENCES

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Part 3

Pages	12
Questions	5
Information Sheet	1

Suggested working time: 36 minutes

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Marker use	
C6	32

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Question 11

Marker use

At a building site, a crane lifts a 3100 kg steel beam vertically at a constant speed. In **one second**, the beam moves up 0.75 m.

a) Calculate the change in gravitational potential energy in ten seconds.

1

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b) Hence, **show that** the power required to lift the beam is approximately 20 kW.

1

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c) The crane driver sees that the motor is actually providing a power of 55 kW. Account for the difference between this value and the answer to part b).

1

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Total Q11

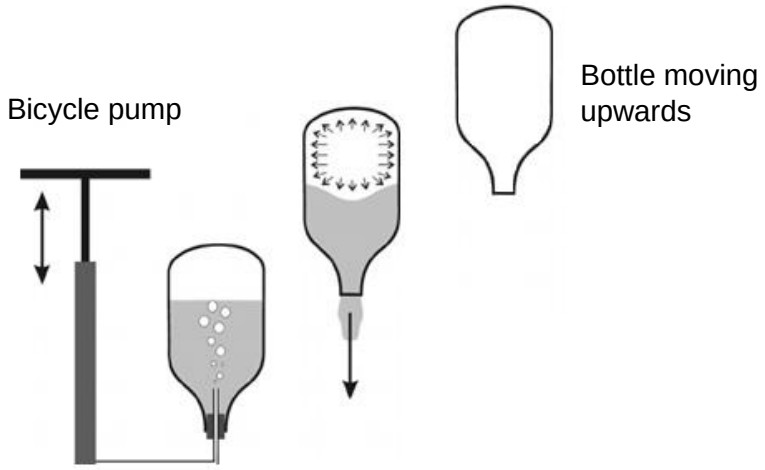
3

Question 12

Marker use

A student sets up a bottle rocket which is filled with a volume of water, fitted with a cork, and then pumped with air using a bicycle pump.

When there is enough pressure in the bottle, the cork and water is blasted downwards and the bottle is launched upwards.



After all the water has left the bottle, the bottle is travelling upwards at 10.0 m s^{-1}, rising to a maximum height before falling back to earth.

a) After all the water has left the bottle, describe the energy transformations of the bottle during its flight. **2**

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b) Using conservation of energy, **show that** the bottle reaches a height of 5.1 m above the point when all the water has left the bottle. **2**

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Question 12 continues

Marker use

c) During launch, the 85 g bottle moves upwards and the water and cork, with a combined mass of 200 g, move vertically down.

i. What was the momentum of the bottle, cork and water prior to launch?

1

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ii. Calculate the momentum of the bottle just after launch.

1

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iii. Calculate the velocity of the water and cork just after launch assuming they move off together.

1

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Total Q12

7

Question 13

Marker use

A 1560 kg car is travelling at 100.0 km h^{-1}.

a) **Show that** the kinetic energy of the car is approximately 600 kJ.

2

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b) When the brakes are applied, the car's tyres provide a constant braking force of 7500.0 N. Calculate the distance required for the car to stop on a level road. Ignore the reaction time of the driver.

1

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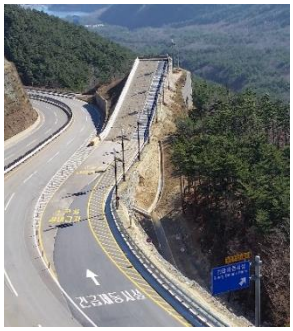

c) On steep roads, road designers sometimes include an "emergency escape ramp" to stop vehicles without brakes.

What is the kinetic energy of the car 10 m vertically up the emergency escape ramp if it was travelling at 100.0 km h^{-1} at the bottom and did not apply the brakes?

2

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d) A heavily laden car has an increased mass and uses its brakes to stop. How would the temperature of the brakes of this car compare with the temperature of the brakes of an unladen car if stopping from the same speed? Justify your answer.

2

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Total Q13

7

Question 14

Marker use

Some flashing school zone signs installed in Tasmania are powered by a solar panel, as shown in the picture.

When the sign is in use an average current of 500 mA flows.

a) Calculate the charge passing through the circuit in 5 minutes.

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1

b) Calculate the number of electrons that this charge corresponds to.

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1

c) The LEDs in the sign are an example of **non-ohmic** resistors. Define this term.

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1

d) When operating at 500 mA, the sign components have a total equivalent resistance of 200 Ω. Calculate the power used by the sign.

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1

e) The sign is operating for 2 hours each day, 5 days a week, for 40 weeks of the year. How much money does the council save in a year by having this sign solar powered, given that electrical energy from the grid costs 26.587 cents per kWh? Give your answer to the nearest cent.

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2

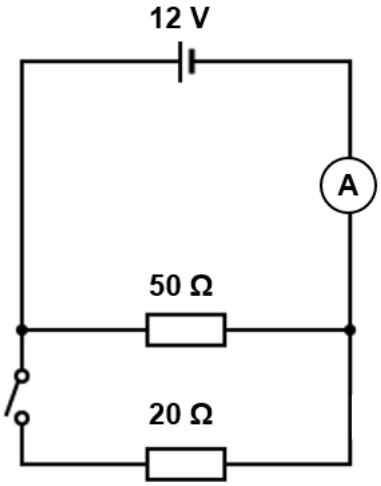
Total Q14

6

Question 15

Marker use

A student sets up the circuit shown.



Spare diagram used (✓)

☐

a) Calculate the current through the ammeter when the switch is **open**.

1

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The switch is then closed.

b) Calculate the new current through the ammeter.

2

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With the switch still closed, a voltmeter is added to measure the potential difference across the 20 Ω resistor.

c) Draw this voltmeter on the circuit **diagram above.**

1

d) What value will be given by this voltmeter?

1

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Question 15 continues

Marker use

e) Meters are designed to measure without significantly affecting the current in the circuit.

i. Given how it is connected, would the voltmeter in **part c)** need to have **much greater, equal,** or **much less** resistance than 20 Ω so that the current through the 20 Ω resistor is not significantly affected? Explain your answer.

2

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ii. The ammeter used in this circuit has a resistance of 0.05 Ω. **Show that** this resistance has a negligible effect on the current in the circuit when the switch is open.

2

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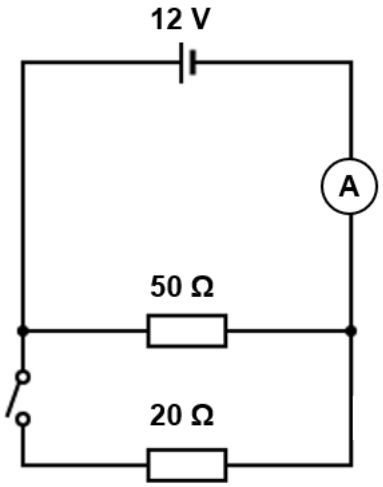
Total Q15

9

Spare Diagram

Question 15



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End of Part 3

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Part 4

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Marker use	
C7	32

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Part 5	5	5	36 minutes	32
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Question 16

Marker use

a) Give the systematic name for each of the following compounds:

- $NiSO_4$ .....

- $Na_2S_2O_3$ .....

1

b) Give the chemical formula for each of the following compounds:

- dinitrogen pentoxide .....

- ammonium carbonate .....

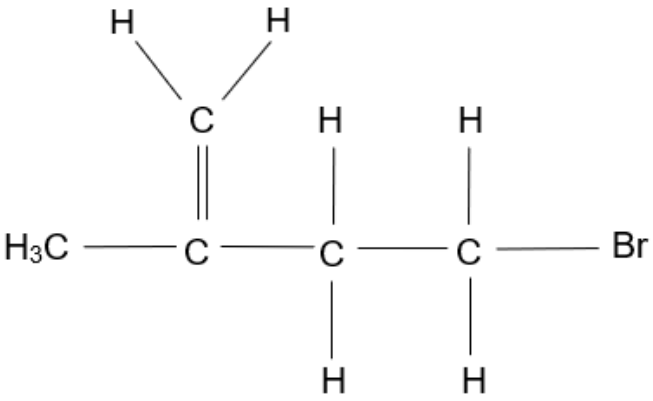
1

c) Draw the structure of cyclopentene.

1

d) Give the systematic name for the following organic compound:

2



Name: .....

Total Q16

5

Question 17

Marker use

a) Draw an electron dot diagram for methane, CH_4.

1

b) Methane and water are molecules of similar size, however, at room temperature methane is a gas and water is a liquid. Explain this difference with reference to their structure and bonding, using a diagram of the water molecule to support your answer.

3

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Total Q17

4

Marker use

Question 18

Use information in the table below to identify the organic compounds, labelled **X**, **Y** and **Z**.

Compound	Molecular formula	Empirical formula	Reaction with bromine, Br_2, solution	Other information
X		CH_2	Reacts quickly	1 mole of X burns to give 3 mole of CO_2 and 3 mole of H_2O
Y	C_3H_6		No immediate reaction	
Z	C_3H_8		No immediate reaction	Under UV light, compound Z reacts with bromine solution

a) Identify compounds **X** and **Y**, giving reasons for your choices.

4

Compound X: .....

Explanation: .....

.....

.....

Compound Y: .....

Explanation: .....

.....

.....

b) Write a chemical equation, using **structural formulae** for any organic compounds, to show the reaction of compound **Z** and bromine solution.

2

c) Are any of the three compounds isomers? Justify.

1

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Total Q18

7

Question 19

a) Part of the periodic table is reproduced below. **Only use these elements** to answer the following questions.

2

H							He
Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar

- Identify the **most** reactive metal.

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- Give the **formula** of a common ion of a group 2 element.

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- Identify an **element** with a similar reactivity to chlorine.

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- Identify the **least** reactive element in period 3.

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b) Lithium reacts with hydrogen to form an ionic compound called lithium hydride, LiH.

Explain how an ionic bond is formed between the two reactant atoms.

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Question 19 continues

Marker use

c) Complete the following table to show that the very different melting points of lithium, lithium hydride and hydrogen are due to different forces between the particles in their structures:

2

	Lithium	Lithium hydride	Hydrogen
Melting point (°C)	181	692	–259
Force or bond overcome on melting		ionic bond	
Particles present	Li^+ and e^-		

Spare diagram used (✓) ☐

d) Lithium can be made into thin sheets. Refer to the structure of lithium to explain this property.

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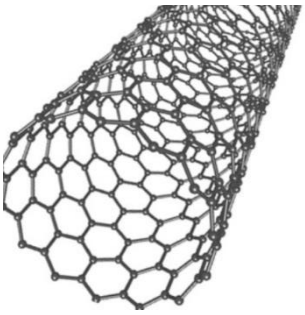
e) A fullerene is an allotrope of carbon. One example is a nanotube, which consists of a tube of carbon atoms, as shown in the diagram.



i. Define the term **allotrope**.

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ii. Explain why these tubes have high electrical conductivity.

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Total Q19

11

Question 20

Two groups of students, A and B, are provided with unlabelled solid samples of three sodium salts: sodium sulfate, sodium carbonate and sodium chloride. Each group suggests two chemical tests to enable the salts to be correctly identified. The suggested tests are given below:

	Group A	Group B
Test 1	Dissolve each salt in water and add silver nitrate solution, $AgNO_{3(aq)}$.	Add hydrochloric acid solution to solid samples of the salts and test any gas evolved.
Test 2	Dissolve each salt in water and add barium chloride solution, $BaCl_{2(aq)}$.	Dissolve each salt in water and add barium chloride solution, $BaCl_{2(aq)}$.

a) Complete the table below, giving the expected results for each of the remaining two suggested tests.

1

Group A:

Test	Na_2SO_4	Na_2CO_3	NaCl
Adding $AgNO_{3(aq)}$ to solutions of the sodium salts		Precipitate forms	Precipitate forms
Adding $BaCl_{2(aq)}$ to solutions of the sodium salts	Precipitate forms	Precipitate forms	No reaction

Spare diagram used (✓) ☐

Group B:

Test	Na_2SO_4	Na_2CO_3	NaCl
Adding $HCl_{(aq)}$ to the solid sodium salts		CO_2 evolved	No reaction
Adding $BaCl_{2(aq)}$ to solutions of the sodium salts	Precipitate forms	Precipitate forms	No reaction

Question 20 continues

Marker use

b) Outline the laboratory technique that Group B can use to identify that carbon dioxide was produced.

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c) Write a net ionic equation to represent the reaction between silver nitrate and sodium carbonate.

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d) Explain why **only** Group B can successfully identify each of the sodium salts.

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Total Q20

5

Spare Diagrams

Question 19 c)

	Lithium	Lithium hydride	Hydrogen
Melting point (°C)	181	692	–259
Force or bond overcome on melting		ionic bond	
Particles present	Li^+ and e^-		

Question 20 a)

Group A:

Test	Na_2SO_4	Na_2CO_3	NaCl
Adding $AgNO_{3(aq)}$ to solutions of the sodium salts		Precipitate forms	Precipitate forms
Adding $BaCl_{2(aq)}$ to solutions of the sodium salts	Precipitate forms	Precipitate forms	No reaction

Group B:

Test	Na_2SO_4	Na_2CO_3	NaCl
Adding $HCl_{(aq)}$ to the solid sodium salts		CO_2 evolved	No reaction
Adding $BaCl_{2(aq)}$ to solutions of the sodium salts	Precipitate forms	Precipitate forms	No reaction

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End of Part 4

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PHYSICAL SCIENCES

PSC315118

Part 5

Pages	12
Questions	5
Information Sheet	1

Suggested working time: 36 minutes

Instructions

- Attempt **all** questions and **all** parts within each question.
- Write your answers in the spaces provided in this exam paper.
  - Show working in answers to numerical questions and use appropriate units. Marks may not be given to answers without working.
  - Spare diagrams have been provided at the end of the exam booklet.
    Indicate in the box provided if you have used the spare diagrams.
- When asked to 'show that':
  - Calculate answers to the correct number of significant figures. Use this value to answer the remaining part(s) of the question.
  - If unsure, use the value given by the examiner.
- A TASC approved scientific calculator is allowed throughout the exam.
- All answers must be written in **English**.
- You **must** make sure your answers address:
  - Criterion 8 apply concepts and processes of chemical reactions and reacting quantities.

Marker use	
C8	32

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Guide to Exam Structure

	Questions available	How many questions to answer	Suggested working time	Marks available
Part 1	5	5	36 minutes	32
Part 2	5	5	36 minutes	32
Part 3	5	5	36 minutes	32
Part 4	5	5	36 minutes	32
Part 5	5	5	36 minutes	32
Total	**25**	**25**	**180 minutes (3 hours)**	**160**

Marker use

Question 21

This question involves two different compounds containing potassium, sulfur and oxygen.

a) Determine the concentration of each of the following ions in a 0.13 mol L^{-1} solution of potassium sulfate, $K_2SO_{4(aq)}$.

1

- $K^+_{(aq)}$ .....
- $SO_4{}^{2-}_{(aq)}$.....

b) A sample contains 49.4% potassium, 20.3% sulfur and 30.3% oxygen by mass. Determine the empirical formula of this compound.

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Total Q21

3

Question 22

Marker use

Consider the following chemical reactions involving carbon dioxide gas, $CO_{2(g)}$.

a) Balance the following chemical equation: 1

$$Fe_2O_{3\,(s)} \quad + \quad CO_{(g)} \quad \longrightarrow \quad Fe_{(l)} \quad + \quad CO_{2\,(g)}$$

b) Write a balanced chemical equation to represent the reaction between solid calcium carbonate and nitric acid solution. 2

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A soda stream enables carbon dioxide gas to be bubbled into water, producing 'fizzy water', also called carbonic acid, $H_2CO_{3\,(aq)}$.

$$CO_{2\,(g)} + H_2O_{(l)} \longrightarrow H_2CO_{3\,(aq)}$$

c) If 2.50 g of carbon dioxide gas is absorbed into 750 mL of water, calculate the concentration of the carbonic acid solution produced, in mol L^{-1}. Assume all the carbon dioxide forms carbonic acid. 3

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d) 'Fizzy water' is described as a dilute, weak acid. Explain the meaning of dilute and weak in this context. 2

Dilute: .....

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Weak: .....

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Total Q22 8

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Exam continues on the next page

Question 23

Marker use

a) Write a balanced chemical equation to represent the formation of solid aluminium chloride, $AlCl_3$, from solid aluminium and gaseous chlorine.

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Aluminium chloride, with **empirical formula** $AlCl_3$, (M_r = 133.3) exists in various forms.

b) Aluminium chloride exists in a hydrated form, $AlCl_3 \cdot 6H_2O$. Determine the percentage of water by mass in the hydrated form.

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c) The **gaseous** form of aluminium chloride has a molar mass of 267 g mol^{-1}.

i. Deduce the formula of this form of the compound.

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ii. Aluminium chloride is a hazardous material. The recommended exposure limit is 2.00 x 10^{-3} g in one cubic metre. How many molecules of the **gaseous** form of aluminium chloride, does this exposure limit represent?

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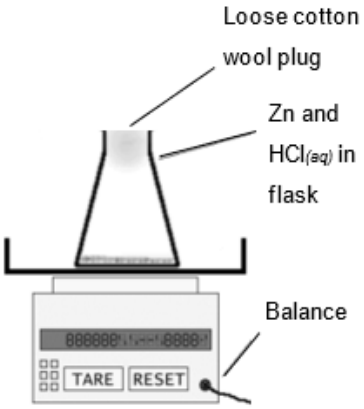
Total Q23

7

Question 24

A conical flask containing 200 mL of hydrochloric acid solution is placed on a precision balance.



0.01 mol of zinc powder is added to the flask and a loose plug of cotton wool is inserted into the top of the flask to prevent any liquid escaping.

The following chemical reaction occurs:

$$\mathrm{Zn}_{(s)} + 2\mathrm{HCl}_{(aq)} \longrightarrow \mathrm{ZnCl}_{2\,(\mathrm{aq})} + \mathrm{H}_{2\,(g)}$$

a) What measurement(s) must be made so that the mass of hydrogen produced can be determined?

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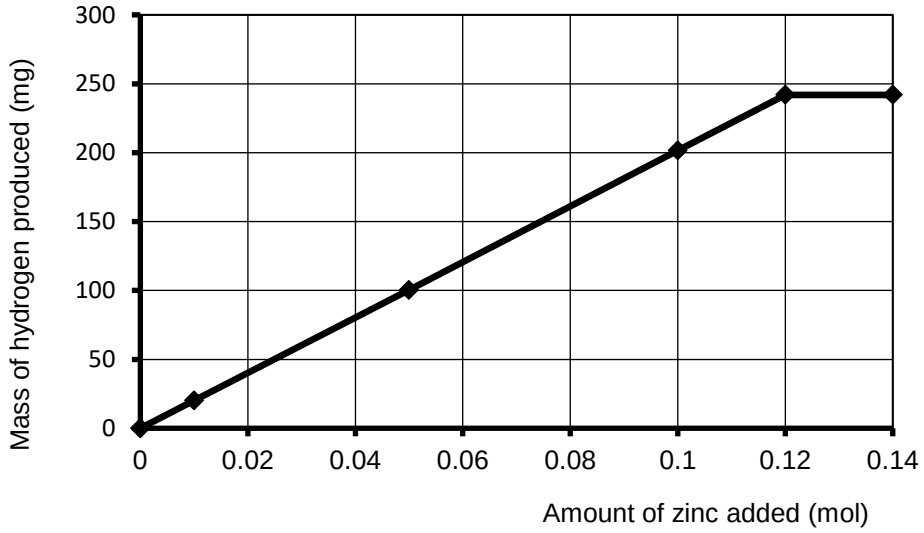
The experiment is repeated four more times by placing different known amounts of zinc in 200 mL of hydrochloric acid and determining the mass of hydrogen produced in each case. A graph of the results is shown below.



b) Calculate the expected mass of hydrogen produced when 0.075 mol of zinc is added.

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Question 24 continues

Marker use

c) At the start of each experiment the flask contains 200.0 mL of 1.20 mol L^{-1} hydrochloric acid solution. How many moles of hydrochloric acid is this?

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d) Refer to the balanced equation, reproduced below, when answering this question:

$$Zn_{(s)} + 2HCl_{(aq)} \longrightarrow ZnCl_{2\,(aq)} + H_{2\,(g)}$$

Why is there no change in the amount of hydrogen produced when adding more than 0.12 mol of zinc?

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e) As the reaction proceeds, will the pH of the contents of the flask **increase**, **stay the same** or **decrease**? Justify your choice.

1

The pH will .....

Justification: .....

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Total Q24

7

Marker use

Question 25

A laboratory technician diluted a 1.42 mol L^{-1} solution of sulfuric acid solution to prepare 2.00 L of dilute acid. The concentration of the diluted acid was found to be 0.103 mol L^{-1}.

a) Determine the volume of the more concentrated acid used for the preparation. 1

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This diluted acid was then used in a titration to identify the cation (X) in a compound with the formula, $XHCO_3$.

An average of 20.2 mL of 0.103 mol L^{-1} sulfuric acid solution was needed to reach the end-point in the titration.

The chemical reaction occurring during the titration is:

$$2XHCO_{3\,(aq)} + H_2SO_{4\,(aq)} \longrightarrow X_2SO_{4\,(aq)} + 2H_2O_{(l)} + 2CO_{2\,(g)}$$

b) **Show that** 4.16 x 10^{-3} mol of $XHCO_3$ was reacted in **each** titration. 2

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3.49 g of $XHCO_3$ was initially dissolved in water and made up to **250.0 mL** of solution; **25.0 mL** samples of the hydrogen carbonate solution were used in **each** titration.

c) **Show that** the molar mass of $XHCO_3$ is approximately 84 g mol^{-1}. 2

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d) Hence determine the identity of X. 2

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Total Q25 7

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End of Part 5

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