TASMANIAN ASSESSMENT, STANDARDS & CERTIFICATION

External Assessment 2026

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PHYSICAL SCIENCES

PSC315118

Section A

Pages: 12
Questions: 5
Information Sheet: 1

Preparation time for this exam: 15 minutes

Suggested working time: 36 minutes

Instructions:

- Answer **all** questions and **all** items 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 this section. Indicate in the box provided if you have used the spare diagrams.
- The exam is **three (3) hours** in length. The suggested working time for this section is **approximately 36 minutes**.
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- The Physical Sciences Information Sheet can be used throughout the exam.
- All answers must be written in **English**.
- You **must** make sure your answers address the listed criterion.

Marker use	
C4	/ 36

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Additional Instructions

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Section E	6	6	36 minutes	36 marks
Totals	**28**	**28**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 4 apply concepts and processes of atomic properties and nuclear reactions.

Question 1

Marker use

In a nuclear reactor, a nucleus of uranium-235 absorbs a neutron and undergoes **nuclear fission**. One (1) possible fission reaction is shown:

Uranium-235 + n → Strontium-95 + Xenon-139 + x n

a) Describe what happens when an atom undergoes **nuclear fission**.

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/1

b) If x represents the number of neutrons released, find the value of x by writing the **completed balanced nuclear equation** using the correct symbol notation.

/2

$$^{235}_{92}U \; + \; ^{1}_{0}n \; \rightarrow$$

Spare diagram used (X) ☐

c) Identify why releasing neutrons is important in a nuclear reactor.

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/1

Total Q1

/4

Question 2

Marker use

A sample of argon extracted by the Mars Curiosity Rover in 2013 was analysed by mass spectroscopy. The mass spectrum is displayed in Figure 1.

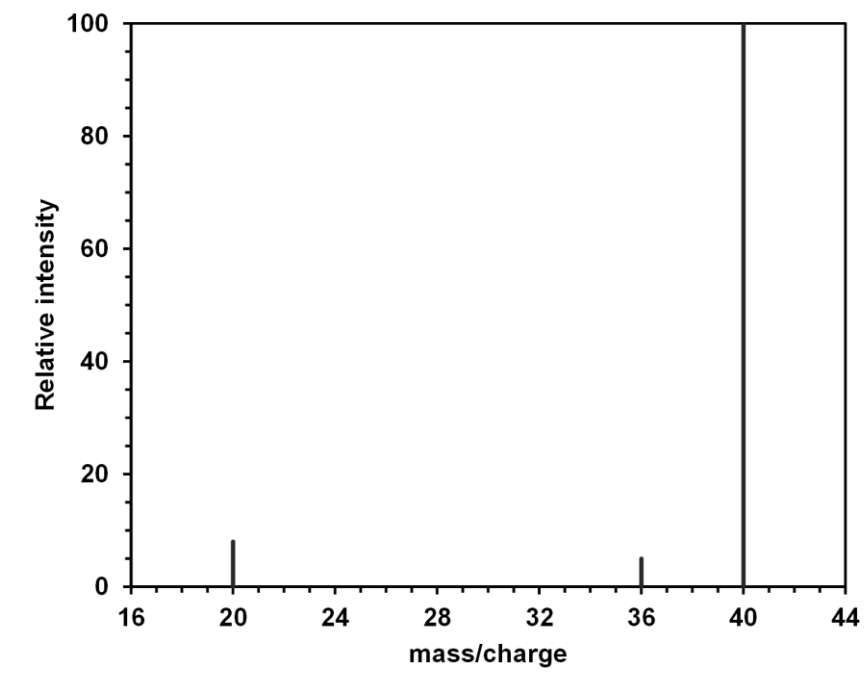


Figure 1: Mass spectrum of argon.

The strong peak at m/z = 40 would indicate the species $^{40}_{18}Ar^{+}$

a) State the number of protons, neutrons and electrons:

i. Protons ..... /1

ii. Neutrons .....

iii. Electrons .....

b) What does the peak on the mass spectrum at m/z = 36 indicate? /1

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c) The relative intensities of Ar-36 and Ar-40 are 5.00 and 100.0 respectively. Calculate the relative atomic mass of the argon sample from Mars. /2

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Total Q2 /4

Question 3

Marker use

Table 1 shows four (4) elements with consecutive atomic numbers from 17 to 20.

Element	Symbol	Atomic number	Atomic mass (amu)	Electron configuration
Chlorine	Cl	17	35.45	
Argon	Ar	18	39.95	
Potassium	K	19	39.10	
Calcium	Ca	20	40.08	

Table 1

Spare diagram used (X) ☐

a) What **period** and **group** does calcium belong to?

i. Period ..... /1

ii. Group .....

b)

i. In the space provided in Table 1, write the electron configuration of **Cl** and **K.** /1

ii. Use these electron configurations to explain why **Cl** and **K** have a valency of 1. /1

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c) Explain in terms of **electron shells** and **electrostatic attraction**, why argon has the smallest radius of the four (4) elements listed in Table 1. /3

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Question 3 continues

Marker use

Table 1 also displays the atomic mass of the four (4) elements. The atomic mass of potassium is less than argon, despite potassium having a higher atomic number.

d) By considering isotopic composition, explain why potassium has a lower atomic mass. /2

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e) The unit for atomic mass in Table 1 is atomic mass units (amu). Define the term 'atomic mass unit' (amu). /2

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Total Q3

/10

Question 4

Marker use

Terms used to describe the properties of alpha, beta and gamma radiation are **ionising** and **penetrating**.

In regard to **ionising**, alpha is more ionising than beta, and beta is more ionising than gamma.

a) Explain this trend in ionisation.

/3

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The first smoke detector developed used radium-226, an alpha producer. It decays to **radon-222 gas**.

b) Write a decay equation for radium-226.

/1

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Radon-222, with a half-life of 3.8 days, is also an alpha producer.

c) Outline the dangers of using Ra-226 in smoke alarms.

/2

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Question 4 continues

Marker use

In regard to **penetrating**, alpha, beta and gamma behave very differently.

The penetrating ability of the three (3) radiation types are tested using different thicknesses of aluminium. Table 2 gives a summary of the test.

Aluminium thickness	Count rate Source X	Count rate Source Y	Count rate Source Z
0 mm	820 counts per minute	750 counts per minute	260 counts per minute
1 mm	260 counts per minute	20 counts per minute	240 counts per minute
3 mm	25 counts per minute	19 counts per minute	230 counts per minute
10 mm	20 counts per minute	20 counts per minute	210 counts per minute

Table 2

d)

i. Using the results in Table 2, identify the **most** penetrating radioactive source. /1

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ii. Suggest the background radioactive count. /1

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iii. **Identify** the type of radiation from each source. /1

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e) Explain why a difference in penetrating ability exists between alpha, beta and gamma radiation. /3

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Total Q4 /12

Question 5

Marker use

Carbon-14 is a naturally occurring, weakly radioactive isotope of carbon.

a) Carbon-14 decays via **beta decay**. Write the decay equation for carbon-14. /1

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b) **Explain** why the release of a beta particle leads to a change in atomic number not mass number. /2

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With a half-life of 5,730 years, carbon-14 can be used to determine the age of once living matter (radiocarbon dating).

c) In an ancient wooden artefact, the ratio of carbon-14 to non-radioactive carbon was 12.5% compared to that of a newly harvested piece of wood. Calculate the age of the wooden artefact. /2

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A sceptic claimed that radiocarbon dating is inaccurate since the present level of carbon-14 has been altered by radiation emitted from mobile phones.

d) Explain why this sceptic's claims are incorrect. /1

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Total Q5 /6

Spare Diagrams

Question 1 b)

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow$$

Question 3 b)

Element	Symbol	Atomic number	Atomic mass (amu)	Electron configuration
Chlorine	Cl	17	35.45	
Argon	Ar	18	39.95	
Potassium	K	19	39.10	
Calcium	Ca	20	40.08	

Table 1

End of Section A



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PHYSICAL SCIENCES

PSC315118

Section B

Pages: 16
Questions: 6
Information Sheet: 1

Suggested working time: 36 minutes

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Marker use	
C5	/ 36

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Section D	6	6	36 minutes	36 marks
Section E	6	6	36 minutes	36 marks
Totals	**28**	**28**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 5 apply concepts and processes of motion and force.

Question 6

Marker use

This year NASA launched its SLS rocket to undertake the Artemis II flyby of the moon. This enormous rocket has a mass 2.610 x 10^6 kg and produces an upwards thrust of 34.0 MN.

a) Calculate the **weight** of the rocket. Provide your answer to the correct number of significant figures. /2

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b) Add **labelled** force vectors to the **centre** of the rocket as it lifts off the platform. /2

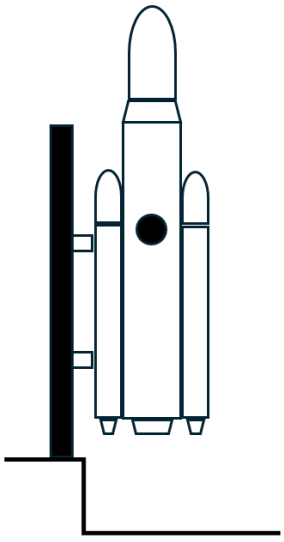


Figure 2: Diagram of a rocket as it lifts off the platform at full thrust upwards.

Spare diagram used (X) ☐

c) Calculate the **net force** on the rocket as it lifts off the platform at maximum thrust. /1

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Question 6 continues

Marker use

d) Calculate the rocket's **acceleration** as it lifts off the platform. /1

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Figure 3 illustrates a possible graph of the acceleration of the rocket for the first 300 seconds.

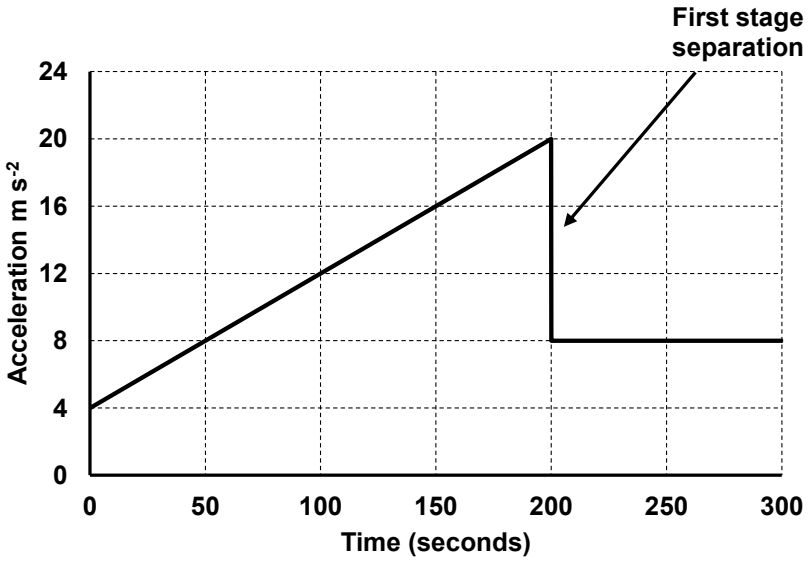


Figure 3: Acceleration vs time graph for rocket launch.

The rocket burns about 4 tonne of propellant every second for the first 200 seconds.

e) With the aid of **one (1)** of **Newton's laws**, explain why the acceleration increases over the first 200 seconds, despite maximum thrust being maintained during this time. /2

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f) What **change in speed** would occur from 200 to 300 seconds? /1

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Total Q6 /9

Question 7

Marker use

A student walks at a **steady** pace 6.0 m **north** in 6.0 s, then 8.0 m **south** in 4.0 s and finally 5.0 m **north** in 10.0 s.

a) Calculate the total **distance** travelled by the student. /1

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b) On the axis provided in Figure 4, sketch a **displacement vs time** graph of the student's walk. /1

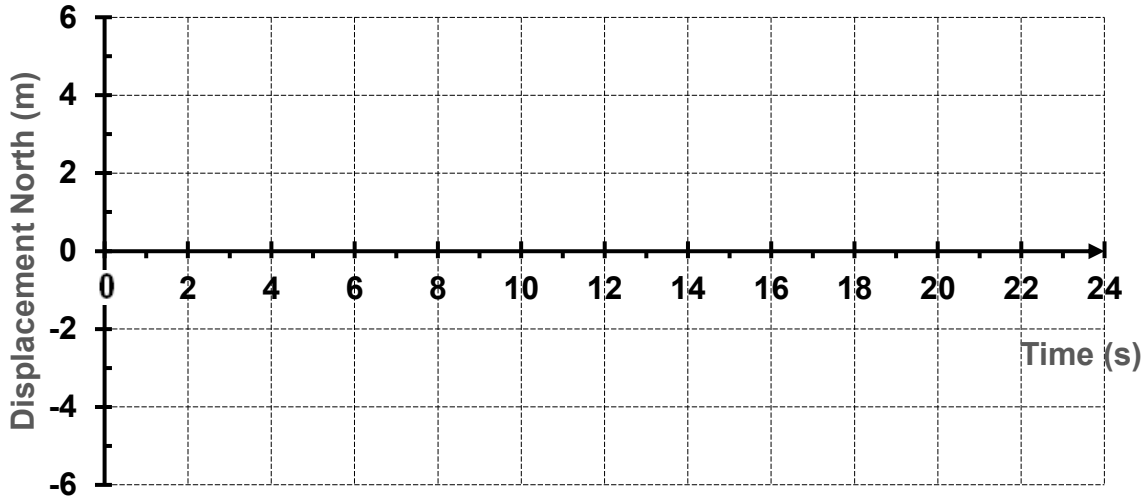


Figure 4: Displacement vs time graph of the student's walk.

Spare diagram used (X) ☐

c) Determine the final **displacement** of the student. /1

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Question 7 continues

Marker use

d) Calculate the student's average **speed** for the walk.

/1

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e) On the axis provided in Figure 5 sketch a **velocity vs time** graph of the student's walk, ensuring all axes are labelled (space has been left for calculations).

/3

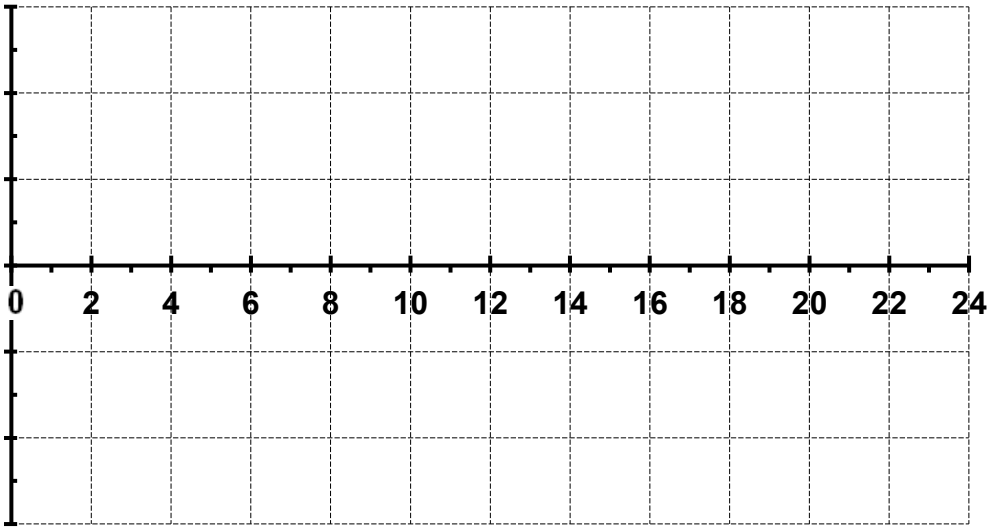


Figure 5: Velocity vs time graph of the student's walk.

Spare diagram used (X) ☐

Total Q7

/7

Question 8

Marker use

A car buyer was only interested in two (2) aspects of the car they wanted to purchase. Firstly, they decided to test how fast it could accelerate.

In this test, the car started at **2.80 m s^{-1}** and accelerated to **22.0 m s^{-1}** in **6.31 seconds**.

a) Convert 22.0 m s^{-1} into km hr^{-1}. /1

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b) Calculate the average acceleration of the car over the 6.31 s. /2

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c) Calculate the distance travelled over the 6.31 s. /1

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The car buyer then viewed a collision test, with a crash test dummy in the driver's seat of the car. The car was driven into a solid barrier at 14.0 m s^{-1}. The front of the car crumpled as the car came to a stop. The situation is displayed in Figure 6.

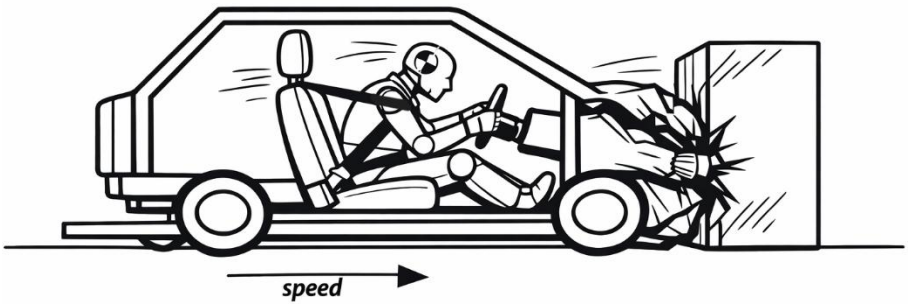


Figure 6: Diagram of a car with a barrier, and a crash test dummy in the driver's seat.

Question 8 continues

Marker use

d) Calculate the change in momentum of the 75.0 kg crash test dummy during the collision.

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e) If the impact took 0.175 seconds, calculate the horizontal force experienced by the **seatbelt wearing dummy.**

/1

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f) When reviewing the footage of the collision (Figure 6) the buyer noticed the dummy appeared to be pushed forward during the collision. Use **one (1)** of **Newton's laws** to explain this apparent movement forward when the car suddenly stops.

/2

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Total Q8

/8

Question 9

Marker use

A pilot is flying a small plane at a velocity relative to the ground of **55 m s^{-1}** directly north on a calm day. The wind suddenly changes to be **15 m s^{-1}** directed from the west towards the east. Figure 7 displays the situation.

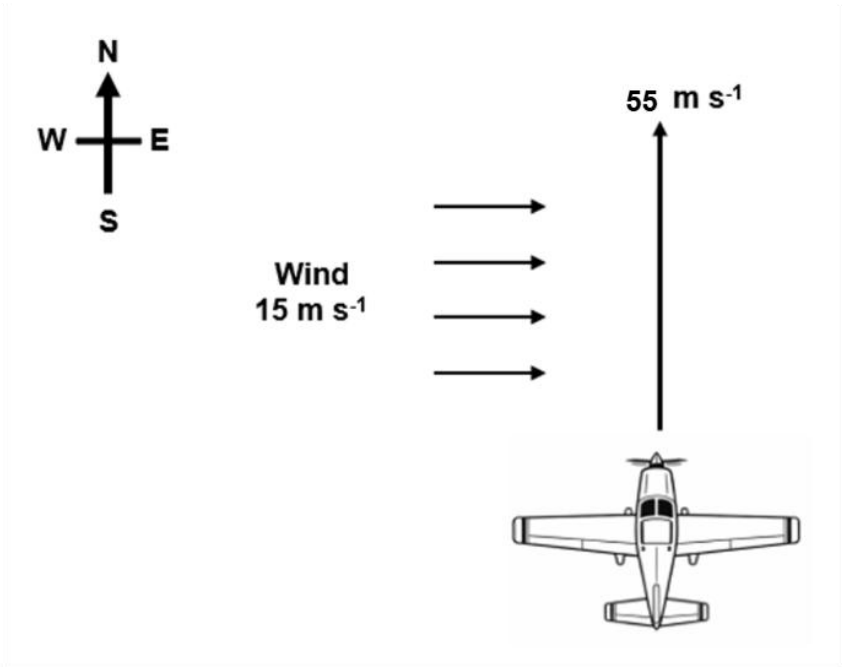


Figure 7: Diagram of a top-down view of a plane flying.

a) Construct a **labelled velocity vector diagram** of the situation. /2

b) From the vector diagram constructed in item a), calculate the new velocity of the plane (relative to the ground) in these windy conditions. /2

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Total Q9 /4

Question 10

Marker use

Ignore air resistance when answering this question.

A stone is thrown vertically into the air at a speed of **16.0 m s^{-1}**. The stone left the person's hand **1.90 m** above the ground.

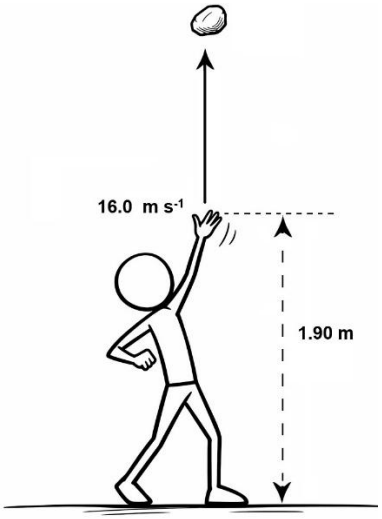


Figure 8: Diagram of a person launching a rock vertically.

a) Show that the stone's impact speed when it hits the ground is about 17 m s^{-1}. /2

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b) What time elapses between throwing the stone and the stone hitting the ground? /2

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Total Q10 /4

Question 11

Marker use

This tennis ball machine always shoots balls at the **same speed horizontally**. The machine can be raised or lowered to adjust the distance the ball travels horizontally before it bounces.

When shot from a height of **0.710 m** the tennis balls hit the ground **15.0 m** from the machine, as shown in Figure 9.

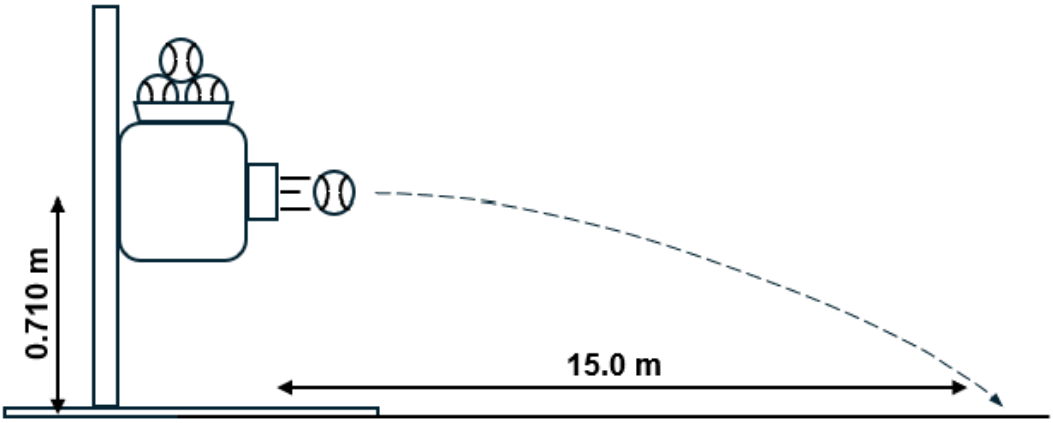


Figure 9: Diagram showing tennis ball machine ball trajectory.

a) Show that the ball is in the air for **0.38 seconds**.

/1

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b) Calculate the height needed for the tennis ball machine to land the balls **23.0 m** horizontally from the machine.

/3

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Total Q11

/4

Spare Diagrams

Question 6 b)

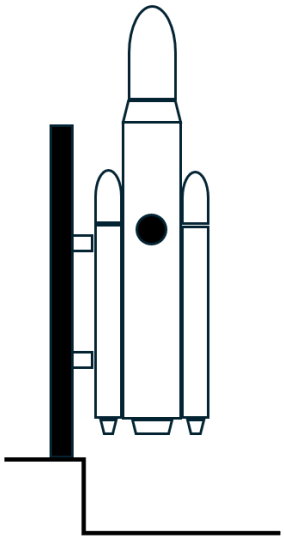


Figure 2: Diagram of a rocket as it lifts off the platform at full thrust upwards.

Question 7 b)

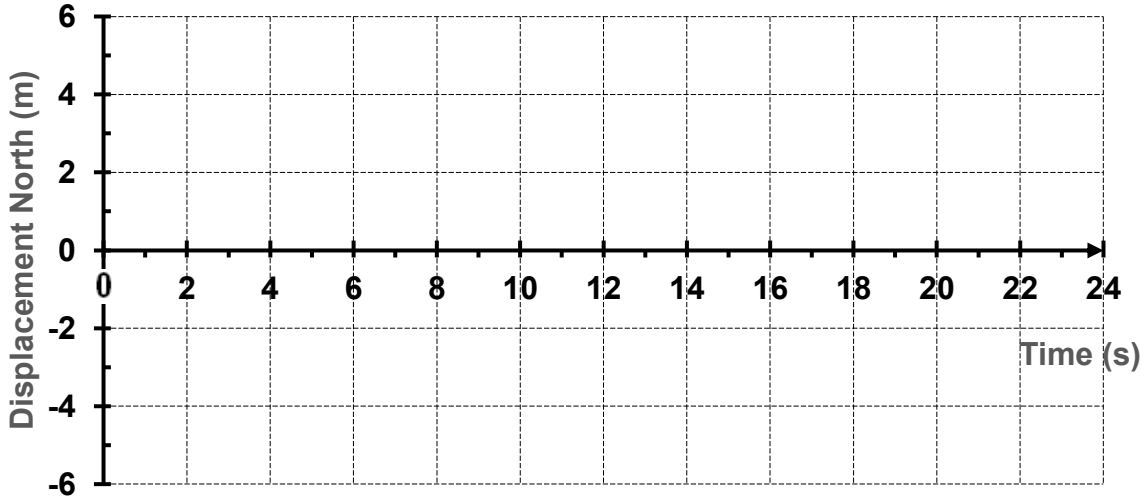


Figure 4: Displacement vs time graph of the student's walk.

Spare Diagrams

Question 7 e)

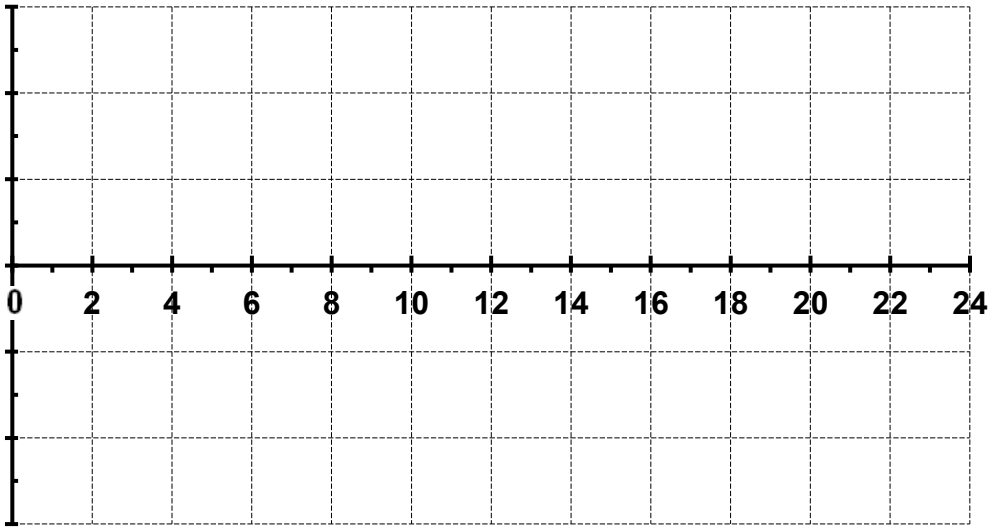


Figure 5: Velocity vs time graph of the student's walk.

End of Section B

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PHYSICAL SCIENCES

PSC315118

Section C

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Information Sheet: 1

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Marker use	
C6	/ 36

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Totals	**28**	**28**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 6 apply concepts and processes of conservation in physics.

Question 12

Marker use

The track of a roller coaster is displayed in Figure 10.

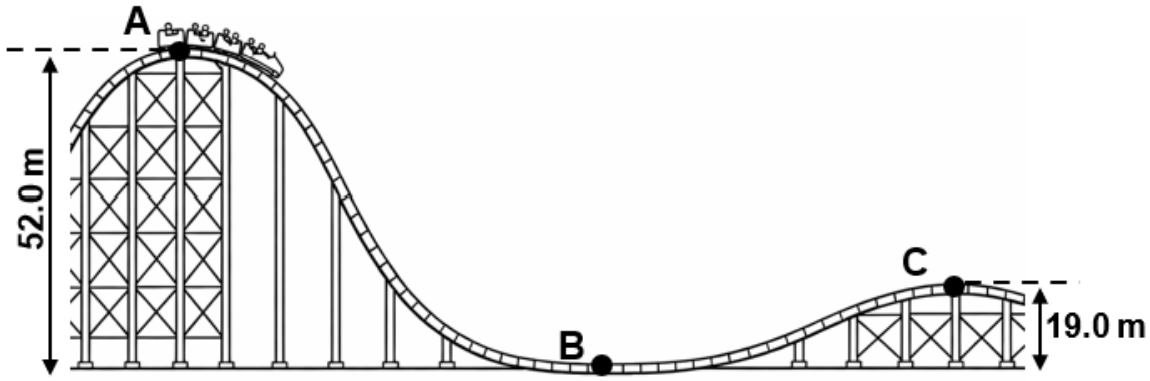


Figure 10: Diagram of a roller coaster.

The roller coaster has a mass of **395 kg** and a velocity of **2.85 m s^{-1}** at the top of the track at **point A**. Assume there is **no friction**.

a) Calculate the **kinetic** energy of the roller coaster at **point A**. /1

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/1

b) Point A is **52.0 m** above point B. Calculate the gravitational **potential** energy of the roller coaster at **point A** relative to **point B**.

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c) Calculate the **total** energy of the roller coaster midway between **points A** and **B**. /1

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Question 12 continues

Marker use

d) Point C is **19.0 m** above point B. Calculate the speed of the roller coaster at the end of the track at **point C**.

/3

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In a real situation there is some friction. The frictional force is, on average, equal to **490 N**.

e) If the track length from **A** to **B** is **73.0 m**, calculate the speed of the roller coaster at **point B.**

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Total Q12

/9

Question 13

Marker use

As part of their Winter Olympics ice dance, two (2) ice skaters approach each other from opposite directions with one of the skaters then lifting the other. **Skater A** has a mass of **78.2 kg** and is travelling at a speed of **4.55 m s^{-1}** to the right. **Skater B** has a mass of **51.6 kg** and travels at **3.75 m s^{-1}** to the left.

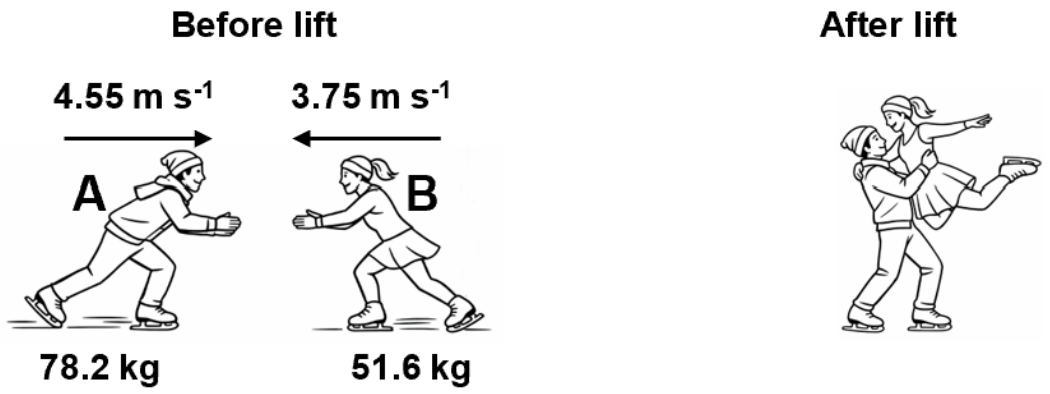


Figure 11: Diagram of skaters before and after lift.

a) Calculate the initial momentum of each skater prior to the lift. /2

i. Skater A: .....

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ii. Skater B: .....

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b) Calculate the total momentum prior to the lift. /1

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c) Assuming the ice is frictionless, calculate the final velocity of the pair once the lift has occurred. /2

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Total Q13 /5

Question 14

Marker use

A student investigated the I – V characteristics of two (2) electrical components, a filament globe and a diode.

After constructing a simple circuit, the student measured the current passing through the components as the potential difference was varied.

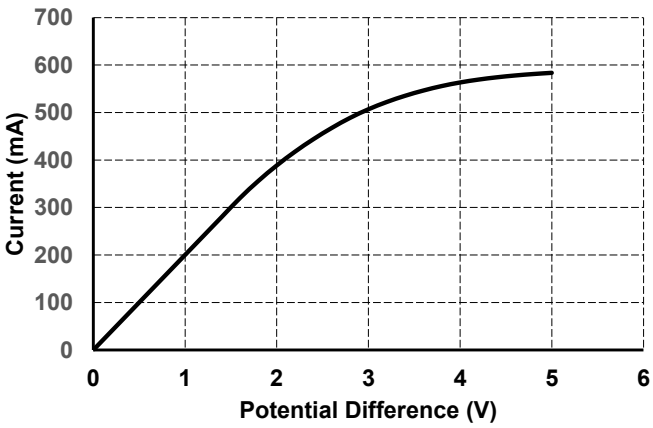


Figure 12: I vs V graph of filament globe.

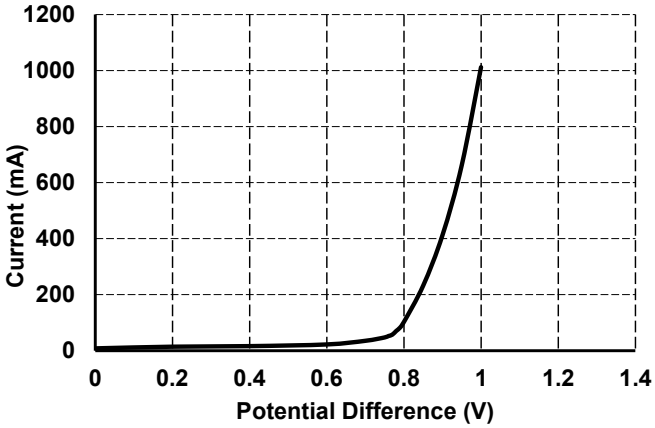


Figure 13: I vs V graph of diode.

a) Both components are **non-ohmic**. What is meant by **non-ohmic**? /1

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b) For the filament light globe in Figure 12, describe how the resistance changes as potential difference increases. /1

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c) For the diode in Figure 13, justify what the shallow slope from 0 to 0.6 V indicates. /1

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Total Q14 /3

Question 15

Marker use

Three (3) **identical** lamps were wired in series and connected to a **24.0 V** power supply. An ammeter was placed in the circuit to measure the current flow.

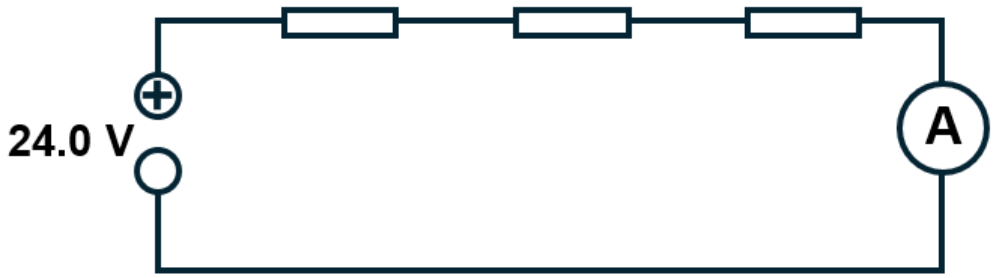


Figure 14: Electrical diagram of series circuit.

When switched on, the ammeter reading was **1.40 A**.

a) Show that the **total** resistance of the circuit is about 17 Ω. /1

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b) Calculate the resistance of **one (1)** lamp in the circuit. /1

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c) Calculate the charge moving through **one (1)** lamp every **minute**. /1

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The light output from the lamps was found to be poor, with each lamp being very dim. One (1) lamp was removed from the circuit, the wires reconnected in series and the power supply switched on. The remaining two (2) lamps became brighter.

d) Explain why the series circuit with only **two (2)** lamps can generate more light than a circuit with **three (3)** lamps. /2

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Question 15 continues

Marker use

An alternate layout of the two (2) remaining lamps was undertaken, such that the lamps were parallel.

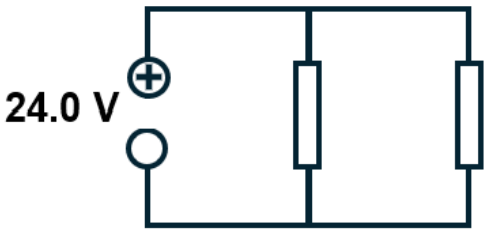


Figure 15: Electrical diagram of parallel circuit.

e) Show that the power output from the parallel circuit displayed in Figure 15 is about 200 W. /3

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f) If this parallel circuit was left running for **3.00 hours** every night for one (1) year, calculaute:

i. the amount of energy used (in kWh) each year. /1

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ii. the cost of running the lamps if electrical energy costs **31.10 c** for every kWh consumed. /1

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Total Q15 /10

Question 16

Marker use

The power output of an athlete can be determined by measuring the speed and duration of a full pace run up a steep incline.

At one (1) high-performance facility, the vertical height difference between the top and bottom was **16.3 m**.

An **83.1 kg** athlete, after a running start, took **14.5 seconds** to run up the incline. Their initial speed was **8.38 m s^{-1}** at the bottom of the incline and by the time they reached the top their speed had dropped to **2.34 m s^{-1}**.

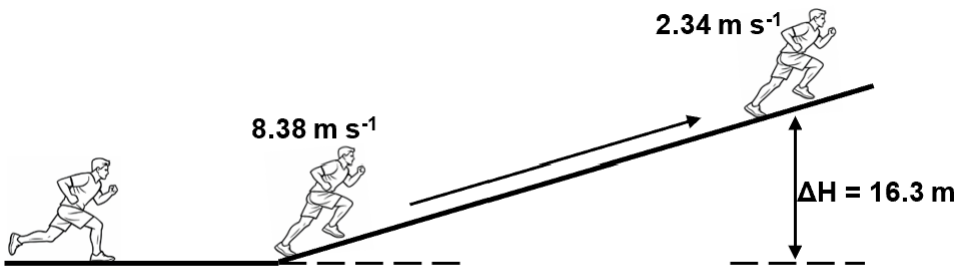


Figure 16: Diagram of an athlete running up an incline.

a) Outline the energy changes occurring in this scenario when an athlete runs up an incline. /4

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Question 16 continues

Marker use

b) By first calculating the change in **both kinetic** and **gravitational potential** energy, show that the **work done** by the athlete running up the incline was about 11 kJ.

/4

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c) Calculate the power output of the athlete.

/1

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Total Q16

/9

End of Section C

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PHYSICAL SCIENCES

PSC315118

Section D

Pages: 12
Questions: 6
Information Sheet: 1

Suggested working time: 36 minutes

Instructions:

- Answer **all** questions and **all** items 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 this section. Indicate in the box provided if you have used the spare diagrams.
- The exam is **three (3) hours** in length. The suggested working time for this section is **approximately 36 minutes**.
- TASC approved scientific calculators can be used throughout the exam.
- The Physical Sciences Information Sheet can be used throughout the exam.
- All answers must be written in **English**.
- You **must** make sure your answers address the listed criterion.

Marker use	
C7	/ 36

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Additional Instructions

- Note: When you are asked to **"show that"**:
  - You should calculate your own answer to the appropriate number of significant figures and then use this value to answer the following item(s) of the question.
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Guide to Exam Structure

	Questions available	Questions to answer	Suggested working time	Marks available
Section A	5	5	36 minutes	36 marks
Section B	6	6	36 minutes	36 marks
Section C	5	5	36 minutes	36 marks
Section D	6	6	36 minutes	36 marks
Section E	6	6	36 minutes	36 marks
Totals	**28**	**28**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 7 apply concepts and processes of chemical structures and properties.

Question 17

Marker use

Copper is a strong, malleable, ductile and conductive metal.

a) By providing a **diagram**, outline the structure of copper metal. /2

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b) Explain why copper is strong, yet malleable and ductile. /2

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c) What aspect of copper's structure accounts for its electrical conductivity? /1

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Copper is usually extracted from copper carbonate by heating, which releases water and carbon dioxide.

d) Identify a test that can be used to detect carbon dioxide.

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Total Q17 /6

Question 18

Marker use

The structural outlines of the covalently bonded substances nitrogen, water and diamond are shown in Figure 17.

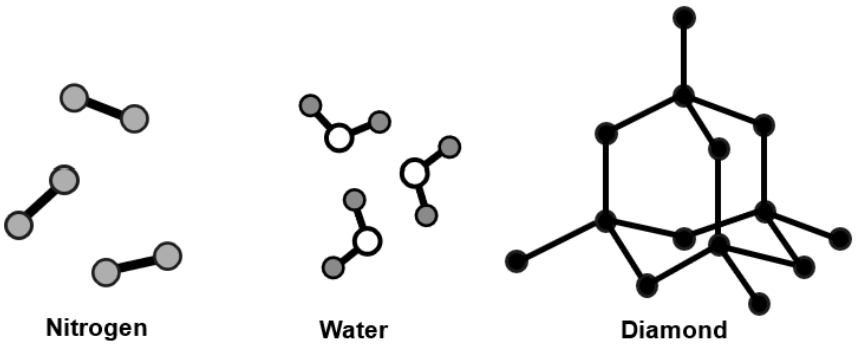


Figure 17: Diagram of the structural outlines of nitrogen, water and diamond.

a) Draw an electron dot diagram of a **nitrogen** (N_2) **molecule.** /1

All three (3) substances contain strong covalent bonds between the atoms, yet at room temperature **nitrogen is a gas**, **water is a liquid** and **diamond is a hard solid**.

b) Explain why nitrogen is a gas and water is a liquid at room temperature. /3

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c) Explain why diamond is a hard solid. /2

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Total Q18 /6

Question 19

Marker use

The alkali metal halide compounds are formed between the group 1 alkali metals and group 17 halogens.

a) With the aid of an electron shell diagram, describe the bonding that forms between sodium and fluorine to form the alkali metal halide **sodium fluoride**. /3

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Sodium fluoride is a brittle, white crystalline solid with a melting point of 993^{o}C.

b) With reference to its structure, explain why sodium fluoride is a **high melting point**, **brittle** solid. Use a diagram to support your explanation. /3

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Total Q19 /6

Question 20

Marker use

a) Complete Table 3 by adding the missing name or empirical formula.

/3

Name	Empirical Formula
	$FeCl_2$
Aluminium oxalate	
	SiO_2

Table 3: Name and empirical formula for given compounds.

Spare diagram used (X) ☐

b) Complete Table 4 by adding the missing name, structure or empirical formula.

/3

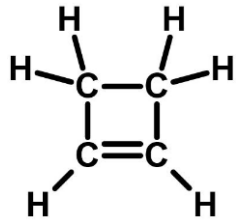
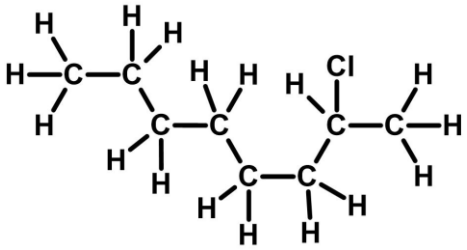
Name	Structure	Empirical Formula
Cyclobutene		
		$C_8H_{17}Cl$
5-bromo-3-methylpent-1-yne		C_6H_9Br

Table 4: Name, structure and empirical formula for given compounds.

Spare diagram used (X) ☐

Total Q20

/6

Question 21

Marker use

Hex-2-ene (C_6H_{12}) is an unsaturated hydrocarbon of the alkene homologous series.

A simple test of unsaturation is by adding bromine.

a) Write a balanced **structural** chemical equation for the addition of bromine to hex-2-ene. /2

b) What aspect of this reaction makes it a useful test for unsaturation? /1

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c) Sketch the structure of an isomer of hex-2-ene that is **saturated**. /1

Hex-2-ene is a highly flammable liquid and burns with a sooty flame when **insufficient** oxygen is provided for the combustion.

d) Write a balanced chemical equation for the **incomplete combustion** of hex-2-ene. /2

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Total Q21 /6

Question 22

Marker use

Two (2) solutions of equal concentrations are made and placed in identical test tubes.
One is **ammonium hydroxide**, the other **barium chloride**.

a) Using the 'solubility table for some ionic compounds', suggest a chemical solution that could be added to both solutions that would form a precipitate in one but not the other. /2

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b) Write a **full balanced chemical equation** and a **net ionic equation** of the precipitation reaction taking place. /3

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c) List any spectator ions in the reaction that forms a precipitate. /1

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Total Q22 /6

Spare Diagrams

Question 20 a)

Name	Empirical Formula
	$FeCl_2$
Aluminium oxalate	
	SiO_2

Table 3: Name and empirical formula for given compounds.

Question 20 b)

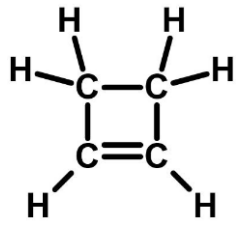
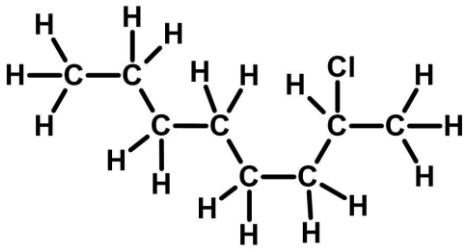
Name	Structure	Empirical Formula
Cyclobutene		
		$C_8H_{17}Cl$
5-bromo-3-methylpent-1-yne		C_6H_9Br

Table 4: Name, structure and empirical formula for given compounds.

End of Section D

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PHYSICAL SCIENCES

PSC315118

Section E

Pages: 12
Questions: 6
Information Sheet: 1

Suggested working time: 36 minutes

Instructions:

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Marker use	
C8	/ 36

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Section D	6	6	36 minutes	36 marks
Section E	6	6	36 minutes	36 marks
Totals	**28**	**28**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 8 apply concepts and processes of chemical reactions and reacting quantities.

Question 23

Marker use

A common laboratory chemical is 2.00 mol L^{-1} hydrochloric acid, $HCl_{(aq)}$.

a) Calculate the amount in moles of $HCl_{(aq)}$ in **225 mL** of **2.00 mol L^{-1}** $HCl_{(aq)}$. /1

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b) How many **ions** are present in 225 mL of 2.00 mol L^{-1} $HCl_{(aq)}$? /1

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c) 2.00 mol L^{-1} $HCl_{(aq)}$ is usually made by diluting 10.4 mol L^{-1} concentrated hydrochloric acid. What volume of **10.4 mol L^{-1}** HCl would be required to make **225 mL** of **2.00 mol L^{-1}** $HCl_{(aq)}$? /1

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HCl can be used to react with substances. As shown in the following chemical equation, HCl reacts with aluminium hydroxide.

$$Al(OH)_{3(s)} + 3\ HCl_{(aq)} \rightarrow AlCl_{3(aq)} + 3\ H_2O_{(l)}$$

d) **Explain** the behaviour of $HCl_{(aq)}$ **and** $Al(OH)_{3(s)}$ in terms of the Brønsted-Lowry acid-base theory. /2

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e) $HCl_{(aq)}$ also dissolves aluminium metal. Write a balanced **ionic chemical equation** for the reaction of $HCl_{(aq)}$ with aluminium. /2

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Total Q23 /7

Question 24

Marker use

The labels of three (3) 1 mol L^{-1} solutions known to be either ammonia, ethanoic acid or nitric acid, have fallen off. The technician carried out three (3) quick tests to identify them. The test results are in Table 5.

Test	Solution 1	Solution 2	Solution 3
Added ($CaCO_{3(s)}$) marble chips	Solution fizzed	Solution fizzed	No observed reaction
Added zinc pieces	No visible reaction	Bubbles formed	No observed reaction
Tested pH	2.5	0	12

Table 5

Identify the **three (3)** solutions, providing **reasoning** as necessary. /4

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Total Q24 /4

Question 25

Marker use

This question is related to the reaction between sulfuric acid ($H_2SO_{4(aq)}$) and sodium hydrogen carbonate ($NaHCO_{3(aq)}$).

a) Write a balanced **full chemical equation** for the reaction. /2

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b) By referring to the equation, calculate the **volume** of an **0.650 mol L^{-1}** $NaHCO_{3(aq)}$ solution needed to exactly neutralise **50.0 mL** of **1.50 mol L^{-1}** $H_2SO_{4(aq)}$. /3

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c) Ignoring the water produced during the reaction, show that the concentration of **the salt** produced from the reaction is about 0.25 mol L^{-1}. /2

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d) Calculate the **salt concentration** in g L^{-1}. /2

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Total Q25 /9

Question 26

Marker use

NPK is the standard acronym for nitrogen (N), phosphorus (P) and potassium (K) percentage content in fertilisers.

a) Calculate the NPK percentages by mass in the general-purpose fertiliser ammonium potassium phosphate $NH_4K_2PO_4$ (M($NH_4K_2PO_4$) = 191.2 g mol^{-1}).

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Many fertilisers are highly explosive. One (1) such fertiliser has the elemental composition listed in Table 6.

Element	Percentage (by mass)
Nitrogen	35.00
Hydrogen	5.04
Oxygen	59.96

Table 6

b) Determine the empirical formula of the compound.

/4

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Total Q26

/7

Question 27

Marker use

Zinc occurs naturally as the sulfide ore sphalerite, mostly as ZnS. Reacting the sphalerite with oxygen and water in acid conditions using a range of catalysts, acid and purifying techniques, produces zinc metal and sulfuric acid. A very simplified reaction is outlined in Figure 18.

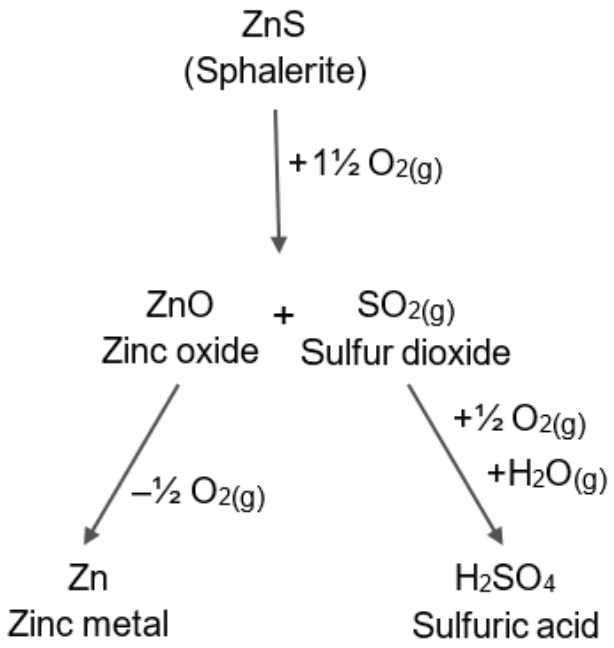


Figure 18: Diagram of a simplified reaction of ZnS to produce Zn and H_2SO4.

What **mass of H_2SO_4** will form from 470 kg of ZnS? /3

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Total Q27 /3

Question 28

Marker use

Biodiesel is derived from sources such as vegetable oils. A crucial pretreatment step for biodiesel production is determining the quantity of free fatty acid (FFA) present in the oil. This is determined by titration.

If the FFA is represented by oleic acid $HC_{18}H_{33}O_2$, the equation is

$$\underset{\text{(FFA)}}{HC_{18}H_{33}O_2} + NaOH \rightarrow H_2O + NaC_{18}H_{33}O_2$$

In a titration **16.3 mL** of **0.119 mol L^{-1}** NaOH was found to neutralise the FFA in **20.00 mL** of the oil.

a) Show that the concentration of FFA in the oil is about 0.10 mol L^{-1}. /3

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b) If the mass of **20.0 mL** of oil is **17.9 g**, calculate the **percentage by mass** of oleic acid in the oil (M($HC_{18}H_{33}O_2$) = **282.5 g mol^{-1}**). /2

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c) FFA is considered a weak acid. Explain what is meant by a 'weak acid'. /1

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Total Q28 /6

End of Section E

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