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Tasmanian Certificate of Education

PHYSICAL SCIENCES

Senior Secondary

Subject Code: PSC5C

External Assessment

2008

Part 1

Time: approximately 45 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criteria taken from the syllabus statement:

- Criterion 6** Demonstrate knowledge and understanding of the impact of science on society and the environment.
- Criterion 7** Demonstrate knowledge and understanding of the principles of forces and motion.

Pages: 16
Questions: 8

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CANDIDATE INSTRUCTIONS

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Answer **ALL** questions. Answers must be written in the spaces provided on the examination paper.

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Each part includes a question that is used in the assessment of Criterion 6.

All written responses must be in English.

A spare diagram has been provided in the back of the answer booklet for you to use if required.

If you use the spare diagram, you MUST indicate you have done so in your answer to that question.

**For
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Question 1

This question assesses Criterion 7.

A rock is thrown **upwards** from the top of a cliff with an initial velocity of 4.90 m s^{-1} **upwards**.

- (a) Determine the **velocity** of the rock after 3.00 seconds. (2 marks)

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- (b) Determine the **final velocity** of the rock if the cliff is 66.0 m high. (2 marks)

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- (c) Without any calculations, **briefly** state what is happening to the **magnitude** of the following quantities during the period indicated. (Ignore air resistance.) (2 marks)

Quantity	after rock leaves hand until maximum height reached	from maximum height until just before it hits the ground
momentum		
acceleration		

Question 2

This question assesses Criterion 7.

A cyclist travels for 2.00 hours north at an average speed of 25.0 km h^{-1} . She then travels for 1.50 hours west at 30.0 km h^{-1} .

Determine the:

- (a) distance covered in this time. (1 mark)

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- (b) average speed. (1 mark)

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- (c) average velocity of the cyclist. (3 marks)

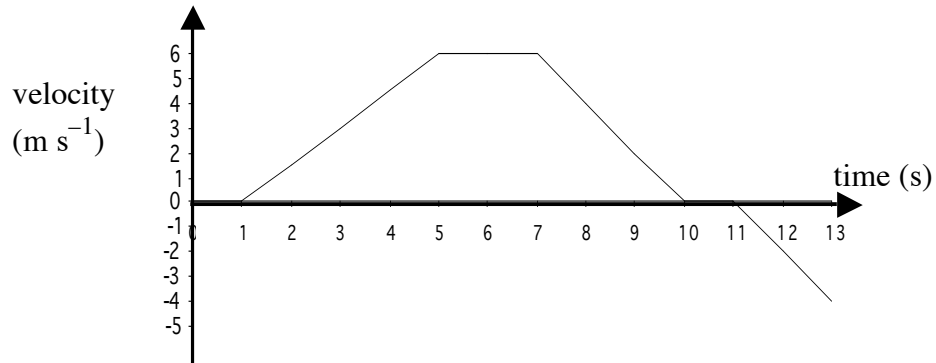
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Question 3

This question assesses Criterion 7.

A Physical Sciences student prepares a velocity-time graph showing the velocity of his toy car during a toy car race.



- (a) Suggest why his toy car had no velocity for the first second. (1 mark)

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Question 3 continues opposite.

Question 3 (continued)

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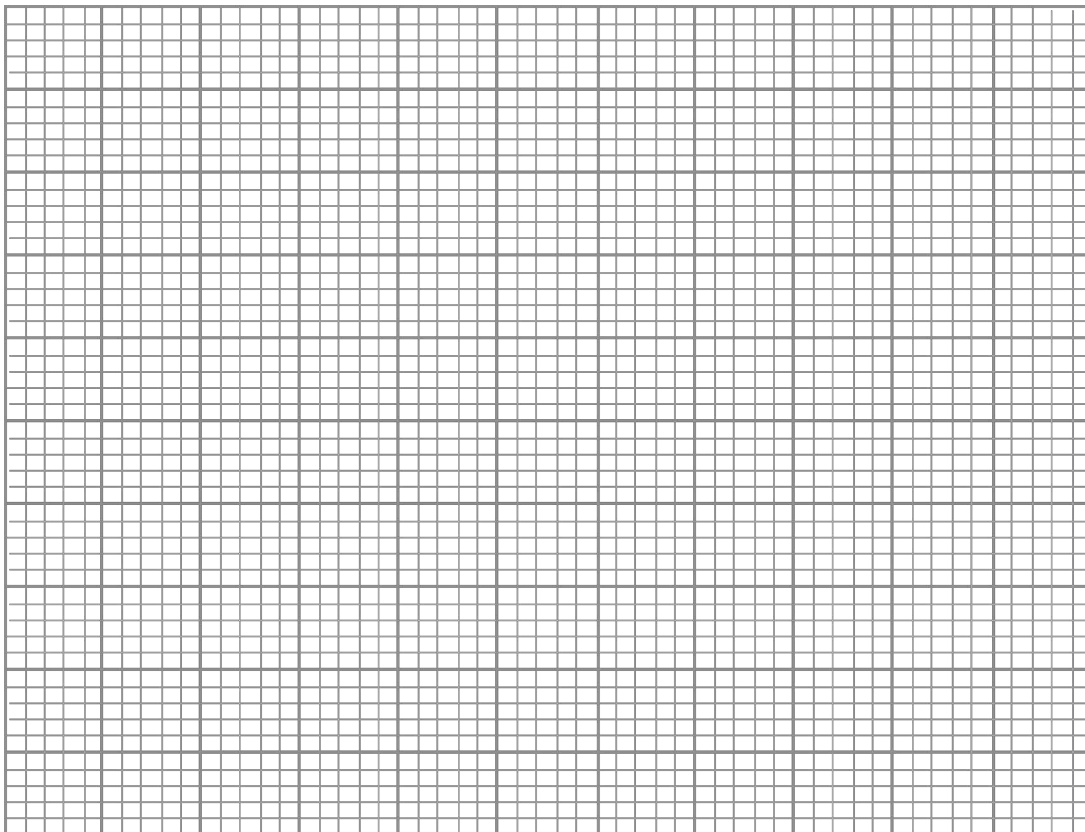
- (b) Showing appropriate calculations, sketch an acceleration versus time graph for the first **10 seconds** of motion. (3 marks)

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- (c) Determine the **final displacement** of the toy car at the end of the 13.0 seconds. (2 marks)

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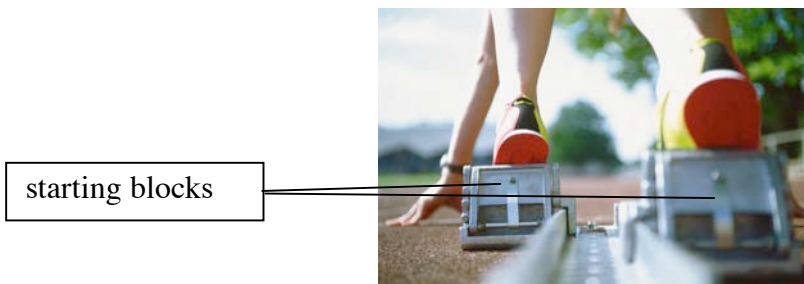
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Question 4

This question assesses Criterion 7.

Sarah uses starting blocks at the beginning of a 100 m sprint race.



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(a) Sarah, who has a mass of 58.0 kg, exerts a force of 820 N against her starting blocks for a time of 0.150 seconds.

(i) Determine the **magnitude** of her acceleration during this time. (1 mark)

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(ii) Starting from rest, with what **velocity** did Sarah leave the starting blocks? (2 marks)

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(b) With reference to Newton’s third law, explain the advantage that Sarah gets from using starting blocks compared to her starting the race on flat ground. (2 marks)

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Question 5

This question assesses Criterion 7.

Use your knowledge of physical principles to explain why a full shopping trolley is much harder to move from rest than an empty shopping trolley is. (2 marks)



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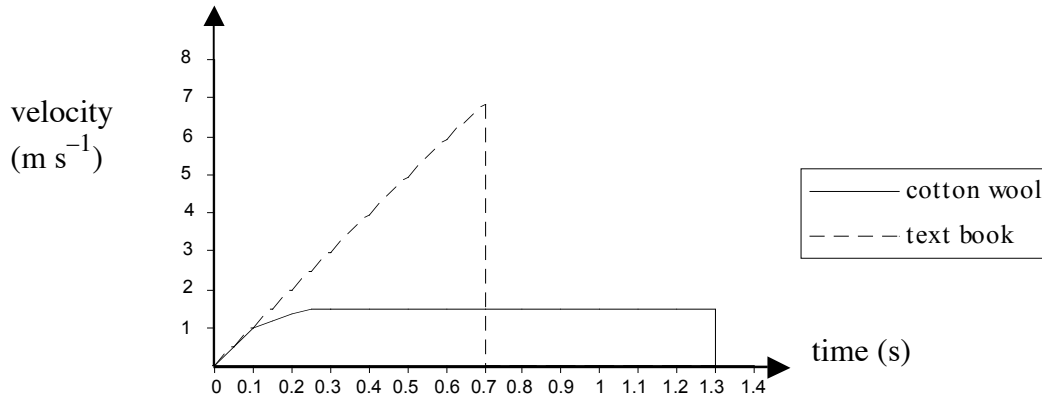
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Question 6

This question assesses Criterion 7.

Chris drops his large text book and a ball of cotton wool at the same time from the top of a ladder.

He records the velocity-time graph for their motion.



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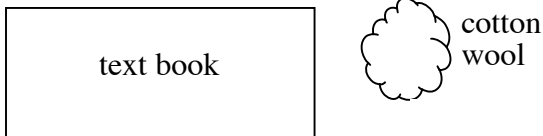
- (a) Using the graph, which of the two items reaches the ground first? (1 mark)

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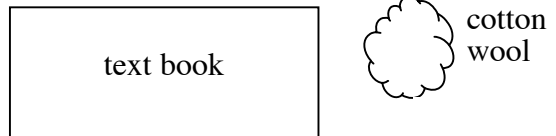
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- (b) On the diagrams below draw vectors to scale showing **all forces** and the **resultant force** acting on each at $t = 0.050$ seconds and at $t = 0.30$ seconds. (3 marks)

t = 0.050 seconds



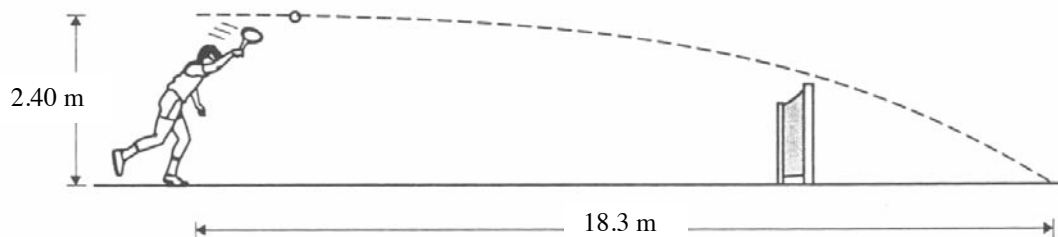
t = 0.30 seconds



Question 7

This question assesses Criterion 7.

**For
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A tennis player serves the ball horizontally from a height of 2.40 m above his head. The ball lands 18.3 m horizontally from him.

- (a) Show that the ball is in the air for 0.700 s. (2 marks)

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- (b) Calculate the initial (serve) speed of the ball in km h^{-1} . (2 marks)

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A ‘top class’ serve is considered to be in the 150 to 200 km h^{-1} speed range. Is this serve in that category?

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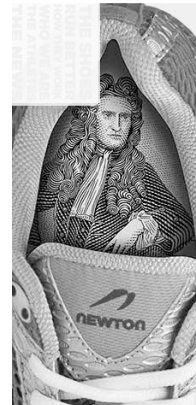
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Question 8

This question assesses Criterion 6.

The *Newton Running Shoe Company* makes a running shoe called the *Newton Runner*.

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- (a) Suggest why the company has chosen to use Newton’s name. (1 mark)

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Running shoes possess a ‘shock absorbing layer’ in the sole of the shoe. The effectiveness of this relies on the basic principle that by **increasing the time of impact of the shoe on the ground** it is more comfortable for a runner.

- (b) Using your knowledge of physical principles, explain why increasing the time of impact of the shoe on the ground makes it more comfortable for a runner. (3 marks)

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Question 8 continues opposite.

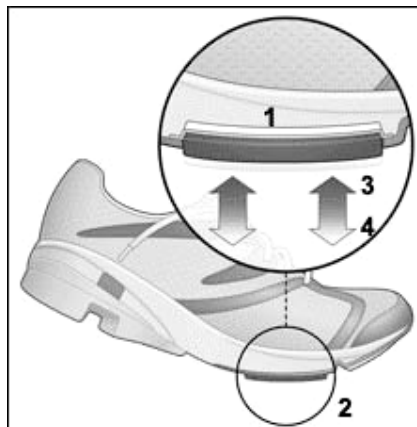
Question 8 (continued)

The *Newton Runner* running shoe makes use of four air chambers to produce an ‘**action equal to reaction force sequence**’ which provides a forward thrust force to help propel a runner forward.

- (c) Which of Newton’s laws is referred to above? (1 mark)

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When the air chambers (1) strike the ground (2), they are **compressed**. When the runner pushes off from the ground (4), the chambers return to their original shape resulting in a force applied to the foot (3).



- (d) Complete the following, identifying the **reaction force** for the given **action force**. (2 marks)

(i) **Action force:** The *Newton Runner* lands on the ground.

Reaction force:

(ii) **Action force:** The air chambers are compressed by the foot.

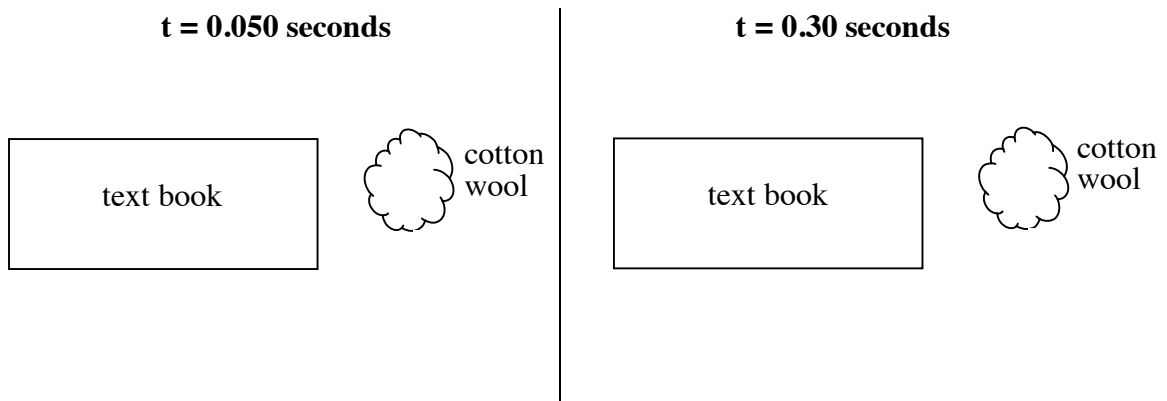
Reaction force:

- (e) Using your knowledge of physics, name or describe one other **physical** feature that would be useful for the sole of any running shoe. Explain. (1 mark)

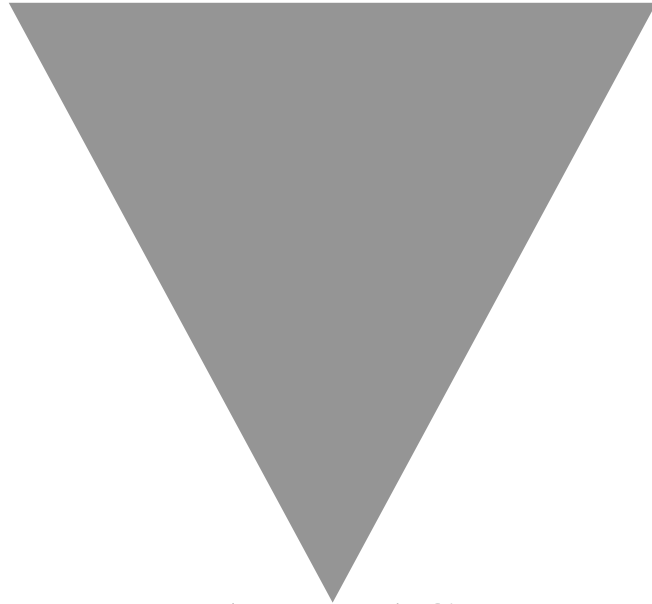
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SPARE DIAGRAM

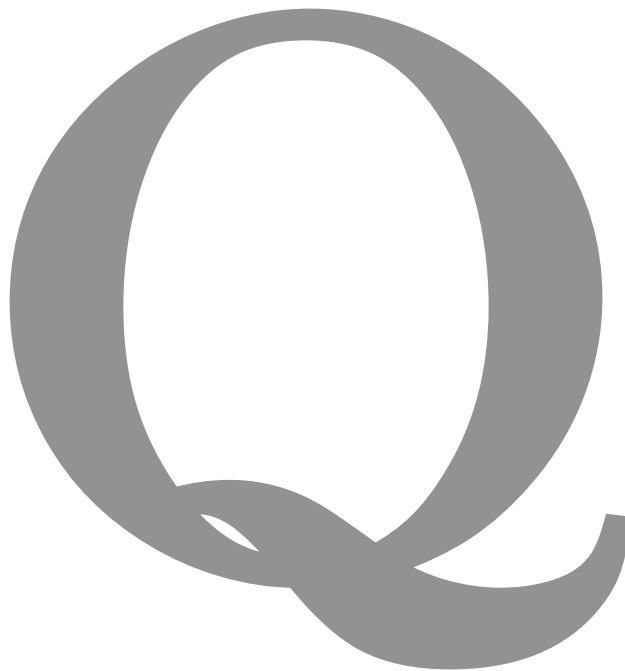
Please indicate on page 10 if you have used this diagram!

Question 6 (b)

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Part 2

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- Criterion 6** Demonstrate knowledge and understanding of the impact of science on society and the environment.
- Criterion 8** Demonstrate knowledge and understanding of the principles of structures and properties of materials.

Pages: 12
Questions: 7

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**For
Marker
Use
Only****Question 9**

This question assesses Criterion 8.

Complete the following table. The first row has been completed as an example. (3 marks)

Name	Formula	Type of Compound
strontium sulfide	SrS	ionic
iron (III) oxide		
	CH ₃ Cl	
silicon carbide		

Question 10

**For
Marker
Use
Only**

This question assesses Criterion 8.

You will need to refer to the Periodic Table when answering these questions.

- (a) What **atomic feature** dictates which period of the periodic table an element is in? (1 mark)

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- (b) What is the formula for the compound formed between the two elements that have **atomic numbers** 56 and 9? (1 mark)

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- (c) Explain why neon has a **relative atomic mass** of 20.18 rather than a whole number, such as 20. (2 marks)

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- (d) Referring to atomic and/or electronic structure, list two similarities and two differences between the ions:
 ${}_{11}^{23}\text{Na}^+$ and ${}_{12}^{23}\text{Mg}^{2+}$. (2 marks)

two similarities:

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two differences:

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Question 11

**For
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This question assesses Criterion 8.

- (a) The halogens (Group VII or 17) are quite a reactive group of elements. By referring to their electronic structure, give the reason for this reactivity. (2 marks)

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- (b) Iodine is able to bond with a variety of elements to form compounds. Two such compounds are iodine chloride (ICl) and lead (II) iodide.

- (i) Draw an electron dot (Lewis) diagram of iodine chloride (ICl). (1 mark)

- (ii) Explain how the bonding in the compounds, iodine chloride (ICl) and lead (II) iodide (PbI₂) is different. (3 marks)

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Question 12

**For
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This question assesses Criterion 8.

- (a) Household electrical wiring consists of copper wire surrounded by plastic (a polymer). Write down the properties of copper and plastic that are made use of in electrical wiring. (2 marks)

Copper:

Plastic:

Use your knowledge of bonding models to explain the following.

- (b) Lithium fluoride (LiF) doesn't conduct electricity in the solid form but does when dissolved in water. (2 marks)

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- (c) The structures of silicon dioxide (SiO₂) and carbon dioxide (CO₂) both involve covalent bonding yet silicon dioxide is a high-melting-point solid, whereas carbon dioxide is a gas at room temperature. (4 marks)

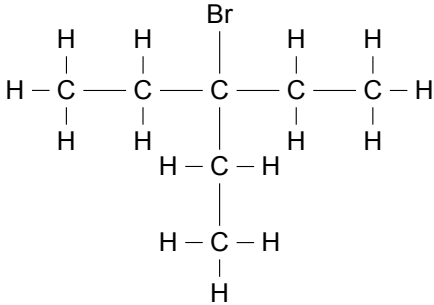
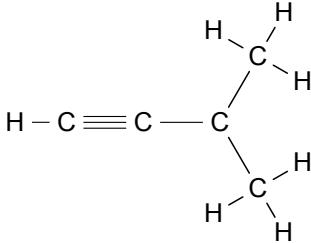
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Question 13

This question assesses Criterion 8.

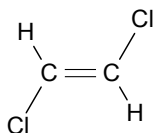
Draw the structure or give systematic names for each of the following organic compounds.
(4 marks)

Name	Structural formula
1-chloro-3-methylhexane	
	
4-bromopent-2-ene	
	

Question 14

This question assesses Criterion 8.

The polymer, polyvinylidene chloride, used to make car seat covers, is formed when a molecule of 1, 2-dichloroethene reacts with many more molecules of itself under suitable conditions.



1, 2-dichloroethene

- (a) Show how polyvinylidene chloride is formed. Include **three units** of the polymer in your answer. (2 marks)

- (b) Which of the two compounds, 1, 2-dichloroethene or polyvinylidene chloride will undergo an addition reaction with bromine? Explain. (1 mark)

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- (c) Using **structural formulae**, write an appropriate equation to represent the reaction that occurs in (b). (2 marks)

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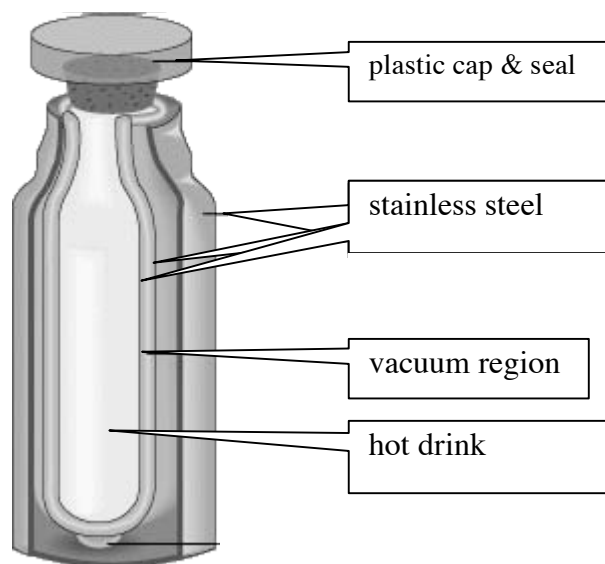
Question 15

This question assesses Criterion 6.

A vacuum ‘thermos’ is a sealed drink container designed to keep hot drinks hot.

A hot drink is poured into the vacuum ‘thermos’ which is then sealed.

A recent advertisement described a stainless steel (mainly iron) vacuum ‘thermos’, shown opposite, as being **‘durable, made to last and guaranteed to keep your hot drinks hot’!**



(a) Use your knowledge of chemical structural models and properties to answer the following questions.

- (i) The advertisement stated that it is ‘durable’ and ‘made to last’. Explain why stainless steel is used for the outside layer. (3 marks)

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- (ii) Explain why the cap is made out of plastic (a polymer) and not stainless steel. (2 marks)

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Question 15 continues opposite.

Question 15 (continued)

**For
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- (iii) Explain how the vacuum region, between two stainless steel layers, helps to reduce heat loss. (1 mark)

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- (b) Dentists can use a variety of filling materials for teeth. Most fillings are either made of a mixture of silver and mercury or (white) polymer.

Examples of each, for the same tooth, are shown below.



silver and mercury filling



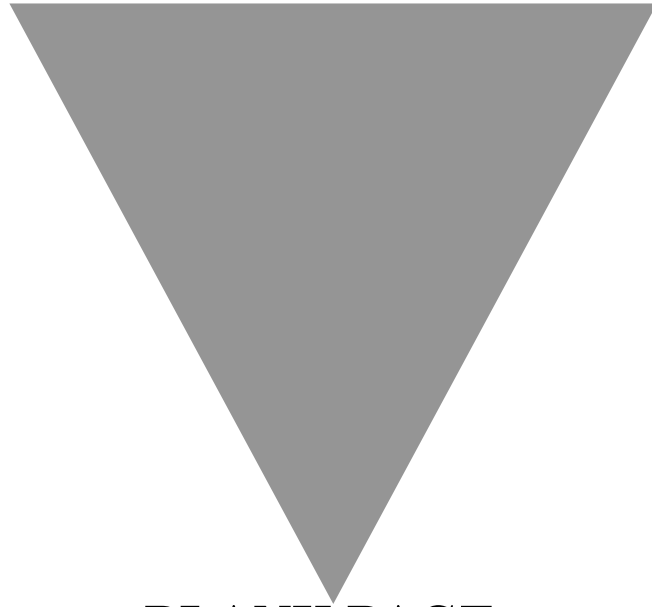
polymer filling

- (i) Over the past twenty years some people have decided to have polymer fillings rather than metal fillings. Suggest a reason why this might be occurring. (1 mark)

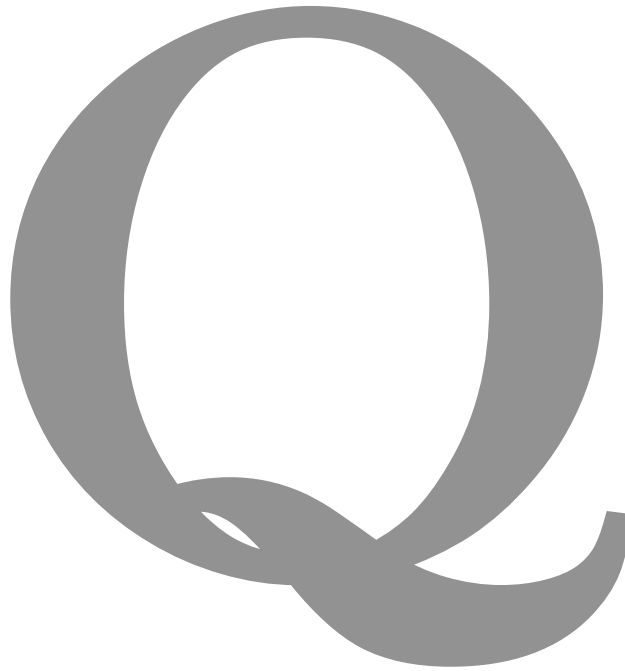
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- (ii) On the basis of your **chemical knowledge**, which of these two filling materials appears to be the **least desirable**? Give a reason for your answer. (1 mark)

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PHYSICAL SCIENCES

Senior Secondary

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External Assessment

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Part 3

Time: approximately 45 minutes

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- Criterion 6** Demonstrate knowledge and understanding of the impact of science on society and the environment.
- Criterion 9** Demonstrate knowledge and understanding of the principles of sources and properties of energy.

Pages: 16
Questions: 7

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Question 16

**For
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This question assesses Criterion 9.

Targeted alpha therapy (TAT) can be used to treat skin cancers.

A patient is injected with a solution containing bismuth-213, a radioisotope with a half life of only 45.0 minutes. This very quickly accumulates in the patient’s skin cancer.

- (a) Write the alpha decay equation for bismuth-213. (1 mark)

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- (b) Briefly discuss how TAT treatment with bismuth-213 can be so effective in treating a skin cancer. (3 marks)

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- (c) The initial activity of the bismuth-213 was 220 kBq per gram. If the patient has to remain in isolation until the activity is reduced to less than 6.0 kBq per gram, **approximately** how long will this be? (2 marks)

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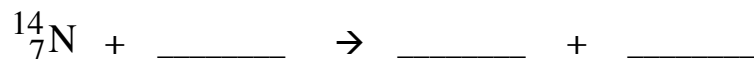
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Question 17

This question assesses Criterion 9.

Carbon-14 is formed in the upper atmosphere as a result of neutron bombardment of nitrogen-14 atoms. A proton is also produced.

- (a) Complete the nuclear equation for the formation of carbon-14. (1 mark)



Carbon-14 dating was used recently to determine the approximate age of stone tools found in an ancient aboriginal campfire in Western Australia.

- (b) A sample of carbon-14 found in the campfire has an activity of 1.8 kBq per kg.

If the activity of carbon-14 in a living organism is 230 kBq per kg and carbon-14 has a half life of 5 700 years, determine the age of the sample. (2 marks)

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- (c) Carbon-14 can only be used to date materials up to 50 000 years old. Discuss why this is the case. (2 marks)

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Question 18**For
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This question assesses Criterion 9.

A student models an electric kettle. She does this by forming a wire length into a coil (resistor) and then connects it to a power pack set at 12.0 V.

She also decides to monitor the current flow and the voltage across the coil.

- (a) Draw a circuit diagram showing this. On your diagram show how the current and voltage can be measured. (2 marks)

- (b) What is the power of this circuit if it draws a current of 10.0 A? (1 mark)

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- (c) What is the resistance of the wire coil? (1 mark)

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The student then uses the coil to boil some water.

- (d) If it takes 8.00 minutes to boil the water, what quantity of charge has flowed through the coil during this time? (1 mark)

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Question 18 continues opposite.

Question 18 (continued)

The student decides that she can more safely model the workings of an electric kettle if she includes a **fuse** in this circuit.

**For
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- (e) Briefly describe how a **fuse** (or a **circuit breaker**) works in an electric circuit. (2 marks)

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- (f) Describe how the student could model and use a ‘fuse’ in this experiment. (2 marks)

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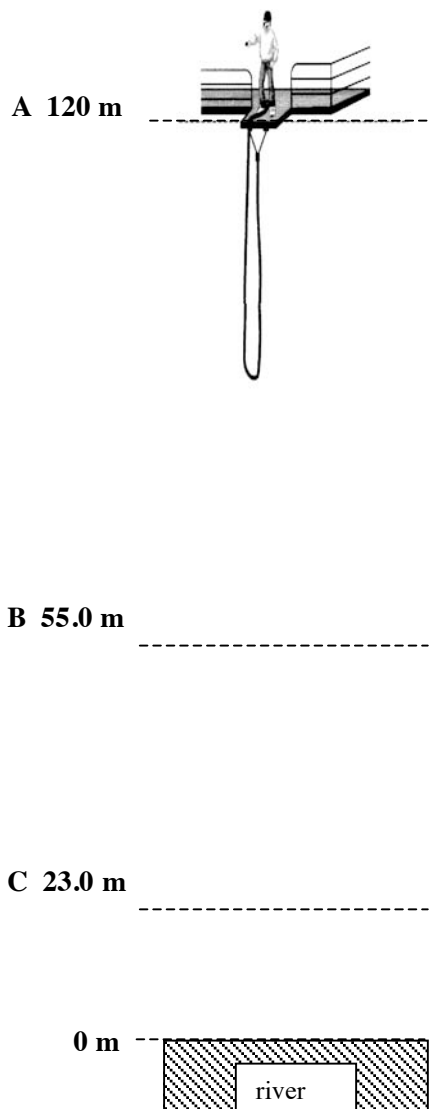
Question 19

This question assesses Criterion 9.

A bungee jumper of mass 85.0 kg jumps from a height of 120 m (point A) above a river.

He free-falls to point B, 55.0 m above the water, before the bungee (elastic) cord starts to stretch. He then comes to rest momentarily at point C, 23.0 m above the water.

After this he then moves up and down on the bungee elastic.



**For
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- (a) Determine the gravitational potential energy of the bungee jumper at point A. (1 mark)

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Question 19 continues opposite.

Question 19 (continued)**For
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- (b) Calculate the speed of bungee jumper at point B.

(2 marks)

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- (c) If the bungee jumper is slowed down to a (momentary) stop at point C, determine the average force required to do this.

(3 marks)

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The actual speed of the bungee jumper at point B was found to be **less** than that calculated in part (b).

- (d) Explain this with reference to the **Law of Conservation of Energy**.

(2 marks)

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Question 20

**For
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Use
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This question assesses criterion 9.

A desk of mass 70.0 kg has to be shifted a distance of 2.90 m across a section of carpet.

- (a) If when dragging the desk, the carpet provides an average frictional force of 75.0 N, how much **work** will need to be done by you? (1 mark)

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- (b) If you could lift the desk instead of dragging it, would you do more **work** than in part (a)? Explain, using a calculation to assist. (3 marks)

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Question 21

**For
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This question assesses Criterion 6.

A 26 W compact fluorescent light bulb produces the same amount of light as a 100 W incandescent light bulb.



26 W compact fluorescent light bulb



100 W incandescent light bulb

- (a) Consider a room to be lit for an average of 45 hours per week. If current electrical energy costs are \$0.185 per kilowatt hour (kW h), determine the savings to be made by using the compact fluorescent light bulb over the light bulb. (2 marks)

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By the end of 2010, Australia is due to have replaced the use of incandescent light bulbs with the use of compact fluorescent light bulbs.

- (b) Apart from saving money, give TWO other benefits to society brought about by using compact fluorescent light bulbs instead of incandescent light bulbs. (2 marks)

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Question 22

This question assesses Criterion 6.

Radioisotopes can be used as tracers in environmental studies.

A water authority proposes to use a radioisotope to determine where water losses are occurring due to leaking water pipes in a small town. Most of these water pipes are buried under ground.

List and explain at least **four** things the water authority should take into consideration when doing this. (4 marks)

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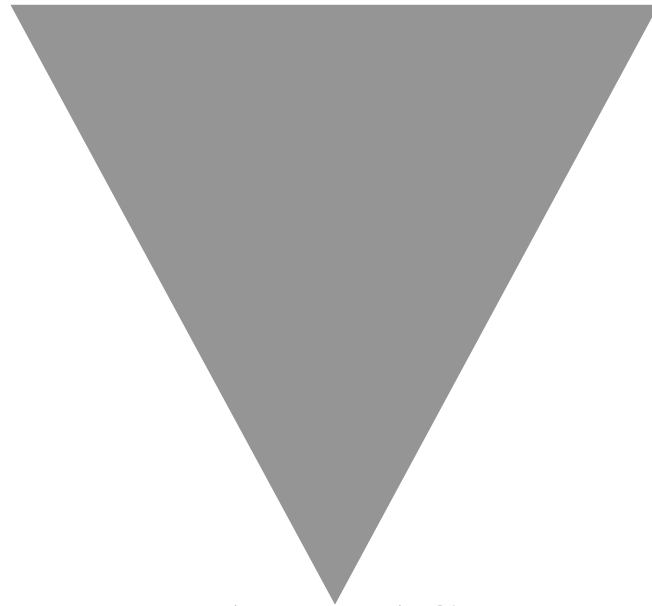
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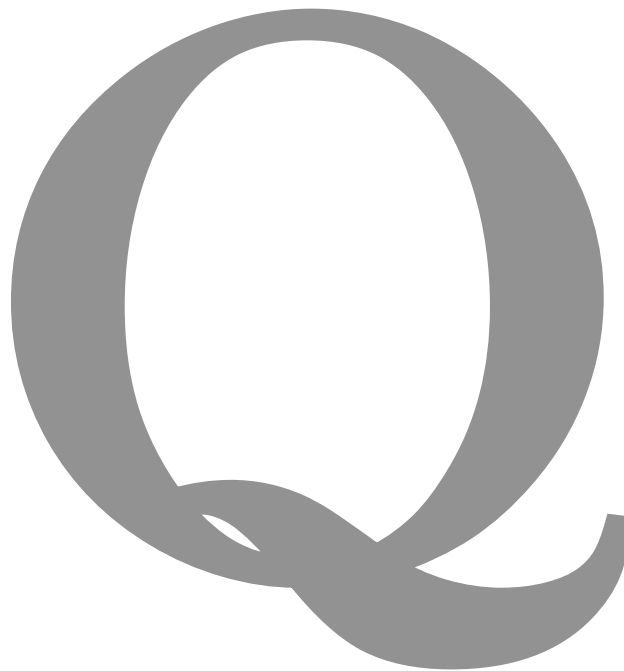
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Part 4

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Criterion 6 Demonstrate knowledge and understanding of the impact of science on society and the environment.

Criterion 10 Demonstrate knowledge and understanding of the principles of chemical reactions and change.

Pages: 12
Questions: 9

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No other printed material is allowed into the examination.

This examination is 3 hours in length. It is recommended that you spend approximately 45 minutes in total answering the questions in this booklet.

Show all working in your answers to numerical questions. Some credit will be given for unsimplified answers but no credit will be given for an incorrect answer, unless it is accompanied by details of the working. Appropriate units must be included.

Each part includes a question that is used in the assessment of Criterion 6.

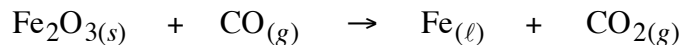
All written responses must be in English.

Question 23

This question assesses Criterion 10.

**For
Marker
Use
Only**

- (a) Balance the following chemical equation: (1 mark)



- (b) Name the **reactants** in part (a). (1 mark)

.....

Question 24

This question assesses Criterion 10.

- (a) Calculate the molar mass of ethanoic acid (CH₃COOH). (1 mark)

.....

- (b) Calculate the mass of 1.56 mol of zinc sulfate (ZnSO₄). (2 marks)

.....

- (c) Calculate which has the greater mass:

0.350 moles of potassium hydroxide (KOH)

or

3.45×10^{23} molecules of oxygen gas (O₂) (3 marks)

.....

Question 25

This question assesses Criterion 10.

**For
Marker
Use
Only**

Solid zinc oxide is added to hydrochloric acid solution.

- (a) Write a balanced full or ‘molecular’ chemical equation for this reaction. (1 mark)

.....
.....

- (b) Write the ‘net’ ionic equation for this reaction. (1 mark)

.....
.....
.....

- (c) Identify the ion(s) that do not take part in this reaction. (1 mark)

.....
.....

Question 26

This question assesses Criterion 10.

Sophie makes up two 1.00 mol L^{-1} solutions, one of sodium sulfate (Na_2SO_4), and another of copper (II) sulfate (CuSO_4).

Which solution of the two compounds contains the greater concentration of ions? Explain. (2 marks)

.....
.....
.....
.....

Question 27**For
Marker
Use
Only**

This question assesses Criterion 10.

Oxalic acid is found in rhubarb leaves. It consists of 26.7% carbon, 71.1% oxygen and the remainder hydrogen by mass.

- (a) Determine the empirical formula of oxalic acid. (3 marks)

.....

.....

.....

.....

.....

.....

- (b) It was found that 3.50 mol of oxalic acid had a mass of 315 g. Determine the molar mass of oxalic acid. (1 mark)

.....

.....

- (c) Hence determine the molecular formula of oxalic acid. (1 mark)

.....

.....

.....

.....

Question 28

This question assesses Criterion 10.

**For
Marker
Use
Only**

Predict what will happen in both (a) and (b) giving expected observations and write an appropriate equation(s) as part of your answer.

- (a) Giles adds a piece of magnesium to a test tube containing sulfuric acid. (2 marks)

Observations:

.....

Equation:

.....

- (b) Emma adds some 1.0 mol L^{-1} lead nitrate solution to **two** test tubes, one containing sodium sulfate solution and the other containing potassium ethanoate (acetate) solution. (3 marks)

Observations:

- (i) Test tube containing sodium sulfate solution

.....

- (ii) Test tube containing potassium ethanoate (acetate) solution

.....

- (iii) Equation(s) for reaction(s):

.....

.....

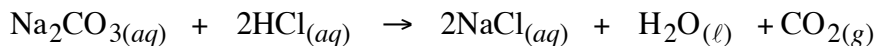
Question 29

This question assesses Criterion 10.

**For
Marker
Use
Only**

In a titration Gary finds that, on average, 38.50 mL of hydrochloric acid solution is required to completely react with 25.00 mL of 0.516 mol L⁻¹ sodium carbonate solution.

The equation for this reaction is:



- (a) Explain what the term ‘on average’ means with respect to the hydrochloric acid volume measurement. (1 mark)

.....

- (b) Calculate the number of moles of sodium carbonate used. (1 mark)

.....

- (c) Hence determine the concentration of hydrochloric acid. (3 marks)

.....

- (d) If Gary had, by mistake, left some water in his burette (the apparatus delivering the HCl) before doing this experiment: (2 marks)

Would the actual concentration of HCl be *higher* or *lower* than that calculated in part (c)? Explain.

.....

**For
Marker
Use
Only****Question 30**

This question assesses Criterion 10.

The pH of four solutions are measured. All are known to be either 0.10 mol L^{-1} solutions or water samples.

In the table below, identify the four solutions (or water samples) from the following list of six possibilities. (2 marks)

ethanoic (acetic) acid

tap water

deionised (or distilled) water

hydrochloric acid

ammonium hydroxide

potassium hydroxide

pH	Solution
1.0	
6.5	
11.0	
13.0	

**For
Marker
Use
Only**

Question 31

This question assesses Criterion 6.

‘Hard’ water is the term used to describe water which contains large amounts of ions such as calcium (Ca^{2+}) ions.

In some parts of Australia, ‘hard’ water presents a problem as deposits of calcium carbonate can block up water pipes.



cross sections of pipes showing extensive calcium carbonate deposition

- (a) What is one possible consequence of having blocked water pipes? (1 mark)

.....
.....

Hard water also prevents washing powders from working efficiently. In order to remove calcium ions many washing powders contain **sodium carbonate**.

- (b) Using an appropriate chemical equation, show how a sodium carbonate solution can remove calcium ions from **solution**. (2 marks)

.....
.....

- (c) Write a ‘net’ ionic equation showing for part (b). (1 mark)

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.....

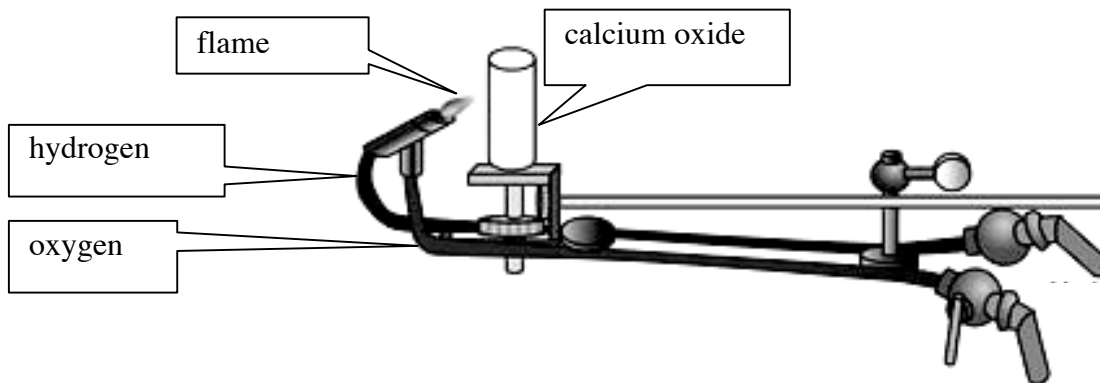
Question 31 continues opposite.

Question 31 (continued)

**For
Marker
Use
Only**

Famous people are often said to be ‘in the limelight’. This refers to the time in the past when actors on stage were lit by ‘limelight’.

When lime (calcium oxide) was heated with a high temperature **oxyhydrogen** flame, it gave off a bright light, known as ‘limelight’.



An **oxyhydrogen** flame is produced by burning a 2 to 1 mole ratio mix of hydrogen gas to oxygen gas.

- (d) Considering the **product** formed by the combustion of hydrogen and oxygen, what is the significance of the 2:1 mole ratio of hydrogen to oxygen in the oxyhydrogen flame? (1 mark)

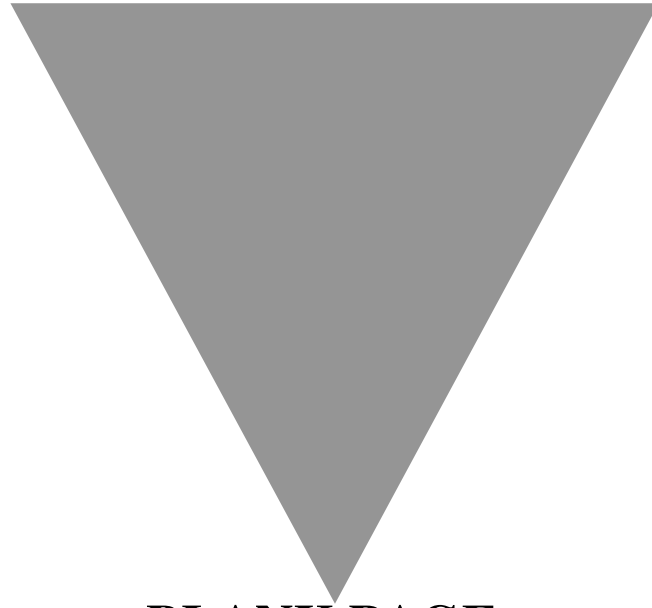
.....

- (e) Explain, using a chemical equation to assist, why explosions involving oxyhydrogen flames were not uncommon when limelight was used. (2 marks)

.....

- (f) Lime (calcium oxide) is often produced by heating calcium carbonate. Write a balanced equation for this reaction. (1 mark)

.....



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