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Tasmanian Certificate of Education

PHYSICAL SCIENCES

Senior Secondary 5C

Subject Code: PSC5C

External Assessment

2004

Part 1

Time: approximately 45 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion 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: 11
Questions: 6

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CANDIDATE INSTRUCTIONS

Candidates **MUST** ensure that they have addressed **ALL** of the externally assessed criteria on this examination paper.

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

The 2004 Physical Sciences Information Sheet can be used throughout the examination.

No other printed material is allowed into the examination.

Spend about 45 minutes answering the questions in this booklet.

No credit can be given for incorrect answers unless they are accompanied by details of the working. Some credit will be given for unsimplified answers. Appropriate units must be included.

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

Question 1

This question assesses Criterion 7.

Newton’s Third Law of Motion states:

‘Forces exist in pairs. These action and reaction forces are equal in magnitude and opposite in direction.’

If each of the following forces is labelled ‘action’, state the corresponding ‘reaction’ force:

- (a) **Action Force:** The 100 N force (north) of a softball bat on a ball originally moving southwards. (1 mark)

Reaction Force:

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- (b) **Action Force:** The 50 N pull (vertically down) of the Earth on a falling rock. (1 mark)

Reaction Force:

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- (c) The boy pictured in the drawing is attempting to step off a canoe that has not been securely tied to the jetty. How does this situation illustrate Newton’s Third Law?



(2 marks)

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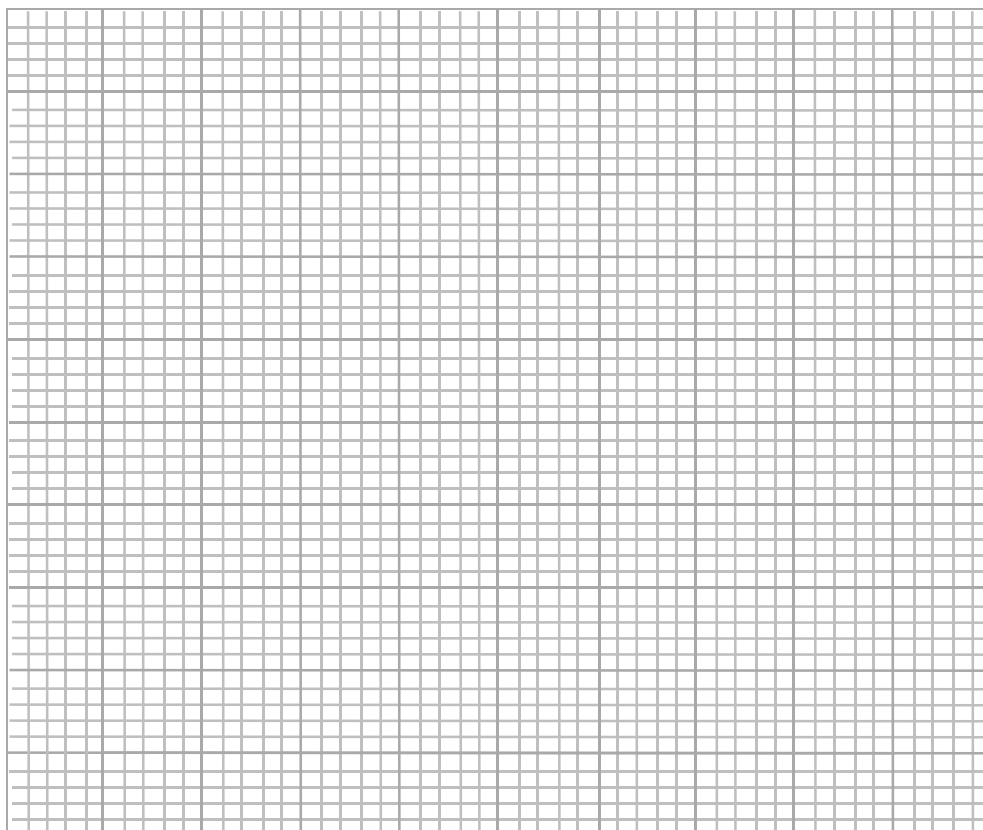
Question 2

This question assesses Criterion 7.

The motion of an object is described in the table below.

Time interval	Description of motion of object
At $t = 0$ seconds	Object is at rest.
From $t = 0$ to 5 seconds	Object uniformly accelerates at 2.0 m s^{-2} south.
From $t = 5$ to 10 seconds	Object travels with constant velocity.
From $t = 10$ to 20 seconds	Object uniformly accelerates at 2.0 m s^{-2} north.
From $t = 20$ to 25 seconds	Object uniformly decelerates to rest.

- (a) Use the information given in the table to draw a *velocity-time* graph for the object's motion from time 0 to 25 seconds. Show time on the horizontal axis of your graph. Carefully label your graph showing the points where the velocity has changed. (5 marks)



Question 2 continues opposite.

Question 2 (continued)

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Where necessary, specify a direction of motion when answering the following questions.

(b) What is the object's *velocity* at time 5.0 seconds? (1 mark)

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(c) What is the object's *acceleration* at time 22.0 seconds? (2 marks)

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(d) What is the *displacement* of the object over the 25.0 seconds of motion? (3 marks)

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Question 3

This question assesses Criterion 7.

A small plane is flying at a height of 250 m above ground level. The pilot is on course to pass over a group of starving bush walkers waiting on the clear level ground below. Her task is to drop a food package to the bush walkers. The velocity of the plane is a constant 60.0 m s^{-1} south. *In the questions that follow, ignore the effects of air resistance and where appropriate, take directions into account when giving answers.*

- (a) What will be the *acceleration* of the food package as it falls to the ground? (1 mark)

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- (b) How long (in time) will it take the food package to reach the ground after its release from the plane? (2 marks)

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- (c) What *horizontal distance* from the bush walkers should the food package be released so that it lands where the bush walkers are standing? (2 marks)

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- (d) What will be the *velocity* of the food package just before it lands? (3 marks)

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Question 4

This question assesses Criterion 7.

A car has a total *weight* of 1.80×10^4 N vertically downwards and is travelling with a velocity of 5.00 m s^{-1} east. The car is uniformly accelerated by an unbalanced (resultant) force of 5.00×10^3 N east for 6.00 s.

Calculate each of the following for the car. *Where necessary, take the direction of motion into account when giving your answer.*

- (a) The *mass* of the car. (1 mark)

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- (b) The *acceleration* of the car. (2 marks)

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- (c) The *displacement* of the car in the 6.00 s that the unbalanced force acts. (2 marks)

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Question 5

This question assesses Criterion 7.

A girl is standing on a skateboard which is moving with a velocity of 2.50 m s^{-1} north. The total mass of the girl and skateboard is 57.0 kg .

The girl catches a ball of mass 750 g travelling with a velocity of 15.0 m s^{-1} south that is thrown to her. *Neglect friction and where necessary take directions of motion into account when giving answers.*

- (a) What is the *total momentum of the girl, skateboard and ball* just before the girl catches the ball? (2 marks)

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- (b) Calculate the *velocity* of the girl and skateboard just after she catches the ball. (2 marks)

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Question 6

This question assesses Criterion 6.

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A Physics principle that can be applied to road accidents is simply stated: *'It is not how fast you are going that matters, but how quickly you come to a stop.'*

- (a) Explain why *increasing* the time to come to rest in the event of a road accident greatly decreases the risk of injury to the car's occupants. In your answer refer to any relevant equation. (4 marks)

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- (b) In the photograph below the road barriers are made from rigid steel. Using your knowledge of Physics principles, give some recommendations for constructing barriers and median strips to improve their safety. (4 marks)



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Tasmanian Certificate of Education

PHYSICAL SCIENCES

Senior Secondary 5C

Subject Code: PSC5C

External Assessment

2004

Part 2

Time: approximately 45 minutes

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

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: 11
Questions: 9

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CANDIDATE INSTRUCTIONS

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Question 7

This question assesses Criterion 8.

Complete the following table in the spaces provided:

(2 marks)

Chemical name	Formula of compound
	$\text{Na}_2\text{S}_2\text{O}_3$
chromium (III) oxide	
	$(\text{NH}_4)_2\text{Cr}_2\text{O}_7$
calcium hydrogen phosphate	

Question 8

This question assesses Criterion 8.

U-235 and **U-238** are well-known uranium *isotopes*.

- (a) Using your Periodic Table, compare the numbers of protons, electrons and neutrons in atoms of these two isotopes of uranium, and complete the following table. (3 marks)

	U-235	U-238
Number of protons		
Number of electrons		
Number of neutrons		

- (b) Would you expect the *chemical* properties of these two uranium isotopes to differ from one another? Give a reason for your answer. (2 marks)

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Question 9

This question assesses Criterion 8.

- (a) In the space provided below, draw electron dot diagrams for each of *nitrogen gas* and *phosphorus trichloride*. (2 marks)

- (b) You may need to refer to your Periodic Table when answering these questions. (3 marks)

- (i) Predict the empirical formula for the compound formed between the two elements that have atomic numbers 3 and 8.

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- (ii) How many electrons are present in the *outer shell* of the atom with atomic number 15?

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- (iii) The atomic number of nitrogen is 7. How many electrons are present in a nitride ion, N^{3-} ?

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- (iv) The atomic number of rubidium is 37. Predict the type of bonding likely to be found in rubidium chloride. (*No reason needs to be given.*)

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- (c) The *noble gases* (Group VIII, or 18) are almost completely unreactive. By referring to their electronic structure, give the reason for this lack of reactivity. (2 marks)

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Question 12

This question assesses Criterion 8.

Complete the following table by giving the missing structural formula or chemical name of the compound involved. (3 marks)

Chemical name of compound	Structural formula of compound
1,2-dichlorocyclobutane	
	$\begin{array}{c} \text{CH}_2=\text{C} - \text{CH}_2 - \text{CH}_3 \\ \\ \text{CH}_2 \\ \\ \text{CH}_3 \end{array}$
3-methylpent-1-yne	

Question 13

This question assesses Criterion 8.

The table below contains information about the physical properties of five substances, **A, B, C, D and E**. *These substances are either elements or compounds.*

Physical Property	Substance A	Substance B	Substance C	Substance D	Substance E
Melting point (°C)	119	770	-101	1 713	-39
Boiling point (°C)	445	1 407	-35	2 230	356
Solubility in water	Insoluble	Moderately soluble without a reaction taking place	Insoluble	Insoluble	Insoluble
Electrical conductivity of solid	Very poor	Very poor	Very poor	Very poor	High conductivity
Electrical conductivity of molten substance	Very poor	High conductivity	Very poor	Very poor	High conductivity

(a) From the table above, choose **one** substance which is most likely to be: *(There may be more than one possibility.)* (3 marks)

(i) A metallic element:

(ii) An ionic compound:

(iii) A non-metallic element:

(iv) A covalent molecular element:

(v) A covalent network compound:

(vi) A gas at room temperature:

(b) Explain the reasoning you used in answering part (v) above. (2 marks)

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Question 14

This question assesses Criterion 8.

- (a) Many properties of metals can be explained using the idea of '*delocalised electrons*'. Explain the meaning of the term, '*delocalised electrons*'. (2 marks)

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- (b) *Annealing* is a method of using heat treatment to change the physical properties of metals. Explain how heat treatment can affect the physical properties of a metal such as iron. (2 marks)

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Question 15

This question assesses Criterion 6.

The picture shows an unlit Olympic Torch. A cartridge in the body of the torch contains the fuel for the flame. The fuel is a mixture of hydrocarbons, one of which is the gas propane.



- (a) Imagine you have been selected to run with the torch for a 500 m section of its journey. State **two** *physical* properties you consider highly desirable for choosing the material used for constructing the torch. *Give reasons with each of your answers.* (4 marks)

Property 1:

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Property 2:

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- (b) The technologists who developed the torch deliberately did not choose an *alkene* fuel such as *propene* because it would burn with a sooty flame leaving an unsightly sooty residue on the torch.

- (i) What is this sooty residue? (1 mark)

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- (ii) Sooty flames are common when alkenes such as propene are used as fuels. Suggest a possible explanation for this and give an appropriate equation. (3 marks)

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Tasmanian Certificate of Education

PHYSICAL SCIENCES

Senior Secondary 5C

Subject Code: PSC5C

External Assessment

2004

Part 3

Time: approximately 45 minutes

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

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: 11
Questions: 6

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CANDIDATE INSTRUCTIONS

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

NOTE:

Candidates have a choice between questions 19 and 20. (ie, Answer either Question 19 OR Question 20.)

Candidates also have a choice within Question 21, by answering EITHER part (a) OR part (b).

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Question 16

This question assesses Criterion 9.

Fred's mass is 65.0 kg. He moves from rest on his roller blades down a sloping concrete path towards the flat ground at the bottom of the path.

Fred's speed is 7.50 m s⁻¹ when he arrives at the flat ground.



- (a) Calculate Fred's *gain* in kinetic energy by the time he reaches the flat ground. (3 marks)

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- (b) What is Fred's *change* in gravitational potential energy when he has reached the flat ground? (1 mark)

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- (c) How would Fred's *kinetic energy* and *momentum* be affected if he doubled his speed? Give a reason with each of your answers. (4 marks)

Kinetic Energy:

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Momentum:

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Question 17

This question assesses Criterion 9.

Car skid marks are seen frequently on our roads and highways. For a particular road surface, the friction force on tyres is 80.0% of the car's *weight*. A car of total mass 950 kg left a skid mark 30.0 m long when the driver suddenly applied the brakes.

- (a) What is the magnitude of the frictional force acting on the tyres? (2 marks)

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- (b) What *work* is done by the frictional force acting on the tyres? (2 marks)

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- (c) What is the *loss* in the car's kinetic energy as a result of the skid? (1 mark)

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- (d) Using the *Law of Conservation of Energy*, account for the car's loss in kinetic energy. (1 mark)

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- (e) If the car's speed was 25.0 m s^{-1} just before braking commenced, what was its speed at the end of the skid? (4 marks)

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Question 18

This question assesses Criterion 9.

- (a) 1.00×10^6 kg of water per minute flows through the turbines of a large hydroelectric power station after falling a vertical distance of 50.0 m.

- (i) What theoretical power should be available due to this mass of water falling 50.0 m vertically? (2 marks)

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- (ii) When measured, the turbines in this power station develop a maximum power of only 5.00×10^6 W (5.00 MW). Why is there this significant difference between the theoretical and measured power of the power station? (2 marks)

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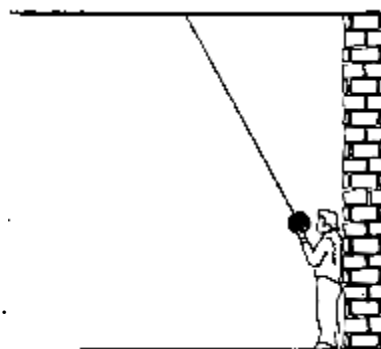
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- (b) A heavy bowling ball is attached to an end of a strong, thin, metal wire. The other end of the wire is firmly attached to the ceiling as shown in the diagram. A boy stands against the wall, raises the ball to his nose and releases the ball. He remains stationary as the ball swings back towards him. Is the boy in danger of being hit by the ball? Give reasons with your answer. (2 marks)



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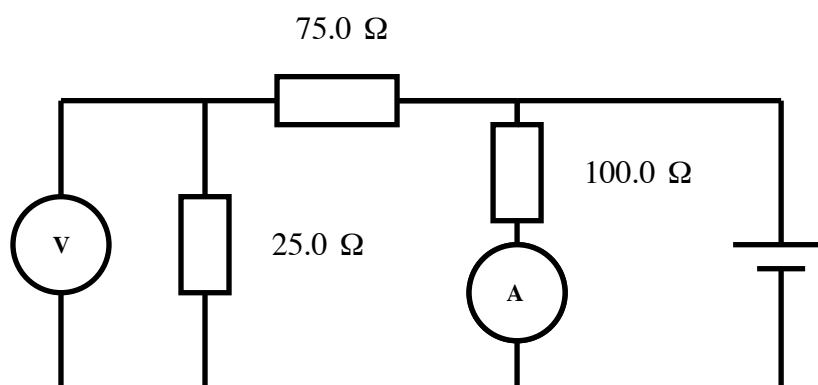
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Answer: EITHER Question 19
OR Question 20

Question 19 – (Current Electricity)

This question assesses Criterion 9.

In the circuit for which the circuit diagram is shown below, the voltmeter has a very high resistance and the ammeter has negligible resistance. The reading on the ammeter is 250 mA.



Calculate the following:

- (a) The potential difference across the 100 Ω resistor. (1 mark)

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- (b) The current in the 25.0 Ω resistor. (1 mark)

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- (c) The total resistance of the circuit. (2 marks)

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- (d) The reading on the voltmeter. (2 marks)

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Question 19 continues opposite.

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Question 19 (continued)

(e) The charge passing from the battery in 10.0 minutes.

(2 marks)

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Answer: EITHER Question 19
OR Question 20

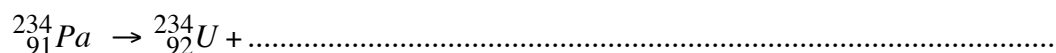
Question 20 – (Nuclear Physics)

This question assesses Criterion 9.

- (a) (i) Berkelium-245 (^{245}Bk) is a radioactive isotope that decays by way of alpha emission. Give the nuclear equation representing this decay and identify the new nucleus formed. (2 marks)

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- (ii) There is a missing product in the following nuclear equation. Using the notation ${}^A_Z\text{X}$, complete the equation and identify the missing product. (1 mark)



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- (b) Ruthenium-103, ${}^{103}\text{Ru}$, is a radioactive isotope. It decays by way of beta particle emission. ${}^{103}\text{Ru}$ has a half-life of 40.0 days. By referring to ${}^{103}\text{Ru}$ explain the meaning of the term 'half life'. (1 mark)

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- (c) A radioisotope sometimes used as a tracer in medical diagnosis is Tc-99 which has a half life of 6.00 hours. If a hospital requires 1.20 g of the tracer but it takes a day to be transported to the hospital, what mass of this isotope should be ordered? (2 marks)

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- (d) What is the relationship between the half life of a radionuclide and its rate of decay? Give the reason for your answer. (2 marks)

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Question 21

This question assesses Criterion 6.

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Answer: EITHER Part (a) OR Part (b), but not both.

- (a) (i) Many parents complain when their children leave lights on in rooms that are not being used. Assuming 1 kW h (kilowatt hour) of electricity costs 12 cents, calculate the cost of leaving a 60 W bedroom light on for 3 hours each night, for each day in a 30 day month. Based on your calculation comment on whether the parents' complaint is justified. (2 marks)

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- (ii) Electricity accounts are based on the number of kilowatt hours used by the consumer. People commonly refer to these accounts as a 'power bill'. Explain why this term is incorrect. (3 marks)

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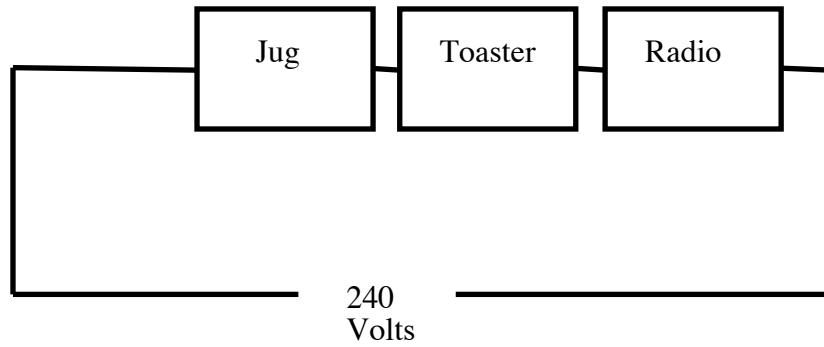
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Question 21 continues over the page.

Question 21 (continued)

- (iii) Over the years many ideas have been suggested to reduce the cost of a consumer's electricity account. One such scheme is as follows. Connect appliances to the mains in *series* rather than in *parallel*. For example, rewire and connect the electric jug, toaster and radio in *series* so that the electricity will pass through the jug, then the toaster and finally the radio. Comment on this scheme. Will it work? Give reasons with your answer. (3 marks)



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Question 21 continues opposite.

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Question 21 (continued)

Answer: EITHER Part (a) OR Part (b), but not both.

(b) The discovery of radioactivity in 1896 by Henri Becquerel is considered by many to be a 'mixed blessing'.

(i) Give **two** examples of the importance of radioactive applications in *industry* or *agriculture*. Give scientific detail to justify your choice of answers. (4 marks)

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(ii) Disposal of high-level radioactive waste is a difficult problem for governments to resolve. The international scientific community has determined that underground disposal currently is the best option for isolating highly radioactive waste. Using your knowledge of radioactivity, state **four** matters that should be taken into consideration in choosing an underground repository for storing nuclear waste. Give a reason with each of your answers. (4 marks)

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PHYSICAL SCIENCES

Senior Secondary 5C

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External Assessment

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Part 4

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

Pages: 15
Questions: 9

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NOTE:

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Question 22

This question assesses Criterion 10.

Balance this chemical equation. There are no reactants or products apart from those indicated. (1 mark)

**Question 23**

This question assesses Criterion 10.

Zinc metal reacts with silver ions when it is placed in an aqueous solution of silver nitrate. Zinc ions in aqueous solution and silver metal are formed as the only products. Write a balanced chemical *ionic* equation for this reaction. Include in your equation an appropriate state subscript, {(s), (l), (g) or (aq)}, for each reactant and product. (2 marks)

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Question 24

This question assesses Criterion 10.

Analysis of a hydrocarbon revealed that it contained 90.0% carbon by mass. The molar mass of the hydrocarbon was found to be 40.0 g mol^{-1} .

(a) Use this information to determine the *molecular formula* of the hydrocarbon. (2 marks)

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(b) Give a possible chemical name for this hydrocarbon. (1 mark)

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Question 25

This question assesses Criterion 10.

Please note that: $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$

The label on a popular sports drink states that it contains 0.500 g of glucose in every 100 mL of the drink. Glucose has the molecular formula $C_6H_{12}O_6$.

- (a) What is the molar mass of glucose? (1 mark)

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- (b) What *amount* (mol) of glucose is present in 0.500 g of glucose? (1 mark)

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- (c) Calculate the number of *molecules* of glucose present in 0.500 g of glucose. (1 mark)

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- (d) Calculate the total number of *atoms* present in 0.500 g of glucose. (1 mark)

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- (e) What is the concentration of glucose in this sports drink? *Express your answer in mol L^{-1} .* (1 mark)

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Question 26

This question assesses Criterion 10.

For each of the reactions described below indicate the expected observation(s) and write a chemical equation to represent the reaction occurring. Include state subscripts, $\{(s), (l), (aq), \text{ or } (g)\}$ for each of the reactants and products in your equations.

- (a) Potassium sulfate solution is mixed with barium nitrate solution. (3 marks)

Observation:

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Equation:

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- (b) Sodium sulfite solution is added to dilute nitric acid. (3 marks)

Observation:

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Equation:

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- (c) Whilst stirring, potassium hydroxide solution is slowly added to dilute sulfuric acid. The pH of the resulting solution is continuously measured. (3 marks)

Observation:

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Equation:

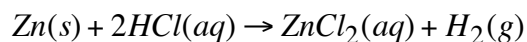
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Question 27

This question assesses Criterion 10.

The balanced equation for the reaction between zinc and dilute hydrochloric acid is shown below:



7.54 g of zinc is reacted with 0.250 M (0.250 mol L⁻¹) hydrochloric acid.

- (a) What *amount* (mol) of zinc is present in 7.54 g of zinc? (1 mark)

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- (b) What is the minimum *amount* (mol) of hydrochloric acid that will be required for a complete reaction with 7.54 g of zinc? (1 mark)

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- (c) What is the minimum volume of 0.250 M hydrochloric acid required for a complete reaction with 7.54 g of zinc? (2 marks)

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Answer: EITHER Question 28
OR Question 29

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Question 28 – (Qualitative Analysis)

This question assesses Criterion 10.

When filtered sea water was slowly evaporated, different crystals were formed at different stages of the evaporation. These crystals were labelled **P**, **Q**, **R** and **S**. (*P*, *Q*, *R* and *S* do not represent the chemical symbols of any elements that are present in the crystals.)

Crystals recovered	% of sea water evaporated	Flame test on recovered crystals	Anion test on recovered crystals
P	0 - 60%	Red-orange (brick red) flame.	P produced a colourless, odourless gas that turned limewater "milky" when added to dilute HCl(aq).
Q	80 - 85%	Red-orange (brick red) flame.	A solution of Q produced a white precipitate when mixed with barium chloride solution.
R	90 - 95%	Intense yellow flame.	A solution of R produced a white precipitate when mixed with silver nitrate solution.
S	98 - 99%	No detectable flame colour.	A solution of S produced a white precipitate when mixed with silver nitrate solution.

- (a) Which of the four solids **P**, **Q**, **R** and **S** is the *least* soluble in water and which is the *most* soluble? (1 mark)

Least soluble solid:

Most soluble solid:

- (b) Give the likely chemical names for each of the solids **P**, **Q** and **R**. (3 marks)

P:

Q:

R:

- (c) Using the chemical name you have chosen for **R**, give a balanced chemical equation for the reaction of a solution of **R** with silver nitrate solution. Include subscripts in your equation to indicate the state of each reactant and product. (2 marks)

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Question 28 continues opposite.

**For
Marker
Use
Only****Question 28 (continued)**

- (d) When part of the small volume of solution left after 99% of the evaporation was completed was mixed with silver nitrate solution, a white precipitate resulted. A flame test on the crystals recovered by evaporating the remainder of the solution produced a lilac (pale violet) flame. What can be concluded from these observations? (1 mark)

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- (e) Explain why **S** cannot be barium chloride. (1 mark)

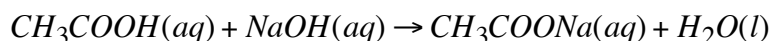
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Answer: EITHER Question 28
OR Question 29

Question 29 – (Volumetric Analysis)

This question assesses Criterion 10.

Acetic (ethanoic) acid, CH_3COOH , is present in vinegar as the principal component other than water. The balanced equation for the reaction between acetic acid in solution and sodium hydroxide solution is:



In preparation for finding the concentration of acetic acid in a particular brand of vinegar, a solution of sodium hydroxide was made by dissolving 5.00 g of sodium hydroxide in 250.0 mL of water.

- (a) Find the concentration of the sodium hydroxide solution in mol L^{-1} . (1 mark)

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- (b) Using phenolphthalein as the indicator, three titrations gave an average volume of 42.25 mL of the sodium hydroxide solution being required for neutralising 25.00 mL of the vinegar.

Calculate:

- (i) The average *amount* (mol) of sodium hydroxide used. (2 marks)

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- (ii) The average *mass* of acetic acid present in 25.0 mL of vinegar. (3 marks)

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Question 29 continues opposite.

**For
Marker
Use
Only****Question 29 (continued)**

- (iii) The average *percentage by mass* of acetic acid in 100 mL of vinegar. 1.00 mL of this vinegar has a mass of 1.010 g. (2 marks)

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Question 30

This question assesses Criterion 6.

- (a) Acid rain is caused by gaseous pollutants such as nitrogen oxides and sulfur dioxide being released into the atmosphere. These gases react with water vapour to form very dilute solutions that may contain any or all of sulphurous, sulfuric, nitrous, and nitric acids. Over many years acid rain slowly damages buildings, monuments and unprotected metal, as well as having other very undesirable environmental effects.

Explain why a marble monument is susceptible to acid rain attack. (Calcium carbonate is a major constituent of marble.) Include a relevant equation with your answer.

(3 marks)

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- (b) Acid rain is responsible for poor crop yields. What effect is acid rain likely to have on the pH of the soil, and how best could this be remedied? (2 marks)

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- (c) Some people suffer from an ‘over acid stomach’ caused by the presence of excess hydrochloric acid in their stomach. Aluminium hydroxide and sodium hydrogen carbonate are constituents of popular antacid remedies. People who use an antacid containing sodium hydrogen carbonate often find the need to noisily ‘burp’ releasing stomach gas from their mouth. This does not happen if only aluminium hydroxide is present in the antacid. Give an explanation. *An equation will help you to answer the question.* (3 marks)

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