OFFICE OF TASMANIAN ASSESSMENT, STANDARDS & CERTIFICATION

Tasmanian Certificate of Education
External Assessment 2016

PLACE YOUR CANDIDATE LABEL HERE

PHYSICAL SCIENCES

(PSC315114)

PART 1

Time: 45 minutes

Pages:	12
Questions:	6
Attachments:	Information Sheet

Candidate Instructions

1. You **MUST** make sure that your responses to the questions in this examination paper will show your achievement in the criteria being assessed.
2. Answer **ALL** questions. Answers must be written in the spaces provided on the examination paper.
3. You should make sure you answer all parts within each question so that the criterion can be assessed.
4. This examination is 3 hours in length. It is recommended that you spend approximately 45 minutes in total answering the questions in this booklet.
5. The 2016 External Examination Information Sheet for Physical Sciences can be used throughout the examination.
6. All written responses must be in English.

On the basis of your performance in this examination, the examiners will provide results on each of the following criteria taken from the course statement:

Criterion 5 Demonstrate knowledge and understanding of principles of motion and force.

Criterion 5 Total:	/40

Additional Instructions for candidates

Show all working in your answers to numerical questions. Some credit will be given for unsimplified answers. Credit cannot be given for an incorrect answer, unless it is accompanied by details of the working. Appropriate units must be included.

Note:

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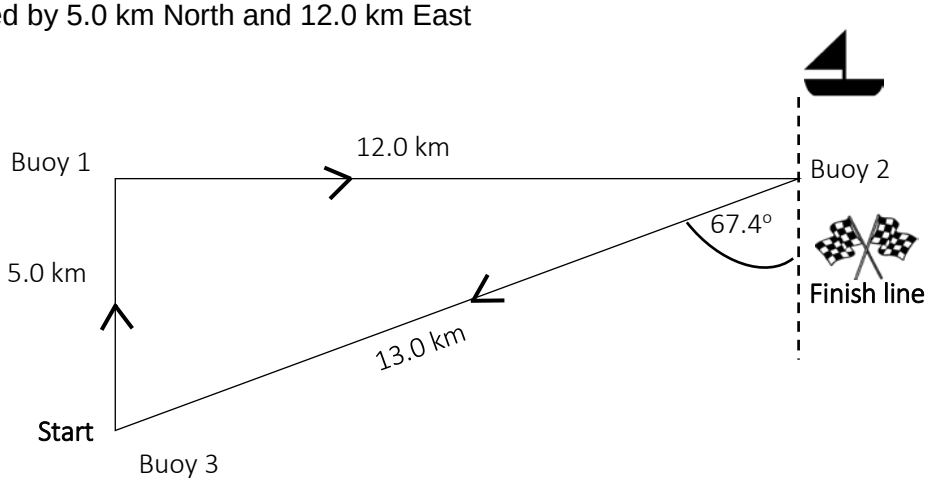
Question 1

For Marker Use Only

A yacht race features a triangular course as shown below.

The 77.0 km race consists of:

- two complete circuits of 5.0 km North, 12.0 km East and 13.0 km S67.4ºW
- followed by 5.0 km North and 12.0 km East



The winning yacht took 2 hours and 30 minutes to complete the race.

(a) Calculate the average speed of the winner. (1 mark)

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(b) Calculate the average velocity of the winner. (2 marks)

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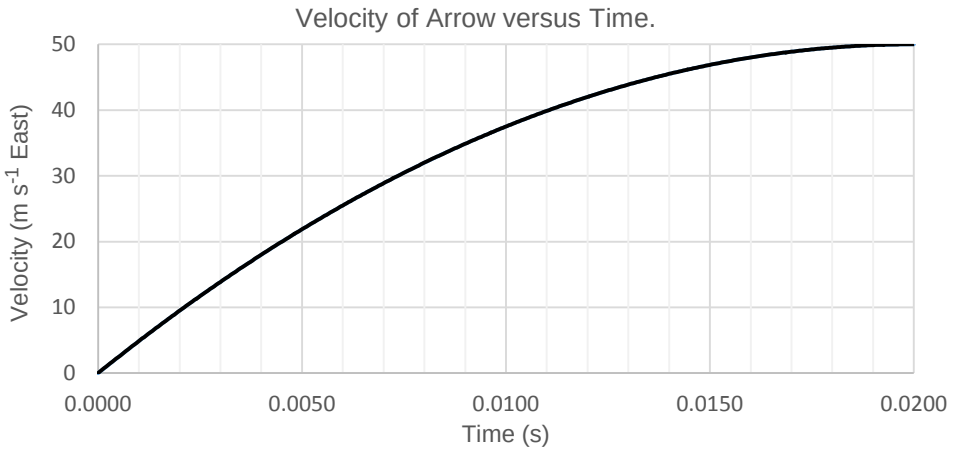
Question 2

For Marker Use Only

The graph below shows how the velocity of an arrow changes as the string was released. The time interval was while the arrow was still in contact with the bowstring.



(a) (i) Describe how the velocity of the arrow changed during the time interval 0.0000 to 0.0200 s. (1 mark)

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(ii) Use the velocity time graph to describe when the acceleration of the arrow was a maximum during the time interval 0.0000 to 0.0200 s. Explain your answer. (1 mark)

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(b) If the mass of the arrow is 100 g, calculate the average total force acting on the arrow during the time interval 0.0000 to 0.0200 s. (2 marks)

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Question 3

For Marker Use Only

Two builders working on the roof of a high-rise building were 200 m above the ground. One of the builders threw a bottle of water to their co-worker. The co-worker missed the bottle, which then went over the edge of the building, moving horizontally at 5.00 m s^{-1}.

The bottle landed in the garden below 6.40 s later.

(a) How far from the base of the building did the bottle land? (1 mark)

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(b) Show that in the absence of friction the vertical velocity of the bottle was about 63 m s^{-1} down when it hit the ground. (1 mark)

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(c) Calculate the velocity of the bottle just before it hit the ground. Include a vector diagram as part of your answer. (3 marks)

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(d) The bottle sank 20.0 cm into the ground. Calculate the average acceleration of the bottle as it came to a stop. (2 marks)

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Question 4

For Marker Use Only

In a baseball match, a pitcher threw the ball (mass = 0.145 kg) so that it reached the batter with a velocity of 50.0 m s^{-1} East. The batter struck the ball with a bat of mass 1.000 kg moving at 18.00 m s^{-1} West.

(a) Calculate the initial momentum of: (2 marks)

(i) the ball.

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(ii) the baseball bat.

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After the collision the baseball bat was moving at 5.82 m s^{-1} West.

(b) Calculate the change in momentum of the bat. (2 marks)

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(c) Calculate the velocity of the ball **immediately after** it hit the bat. (3 marks)

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Question 4 continues.

Question 4 (continued)

For Marker Use Only

The duration of impact between the bat and ball was 7.10×10^{-4} s.

(d) Calculate the force with which the bat struck the ball. (2 marks)

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(e) Determine the force that the ball applied on the bat. (1 mark)

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(f) State the law illustrated by your answers to (d) and (e). (1 mark)

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Question 5

For Marker Use Only

A road engineer drove a car on a straight section of track.

(a) From rest, the car took 30.0 s to travel 1.000 km. Assume the car had a constant acceleration throughout the journey.

(i) Show that the acceleration of the car was about 2.2 m s^{-2}. (2 marks)

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(ii) Calculate the speed of the car after travelling 500 m. (2 marks)

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(b) To test the brakes, the driver made an emergency stop from an initial speed of 100 km h^{-1}. The mass of the vehicle including the driver was 1500 kg. It came to a complete stop over a distance of 42.0 m.

Calculate the average braking force that was applied on the car. (3 marks)

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Question 6

For Marker Use Only

An 80.0 kg passenger entered a stationary lift.

(a) Calculate the weight of the passenger. (1 mark)

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(b) Determine the normal force acting on the passenger (the force applied by the floor of the stationary lift on the passenger). (1 mark)

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(c) After the door closed the lift accelerated upwards at 2.50 m s^{-2}. Calculate the normal force on the passenger while the lift accelerated. (2 marks)

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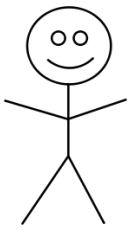
(d) After 4 s the lift stopped accelerating. Draw vector(s) on the diagram showing the force(s) on the passenger while the lift moved upwards with a constant velocity. Justify your answer. (2 marks)



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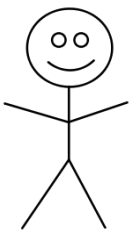
(e) The lift slowed as it approached the next floor. Draw vector(s) on the diagram showing the force(s) on the passenger while the lift slowed. Justify your answer. (2 marks)



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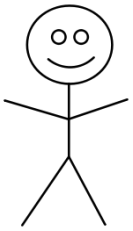
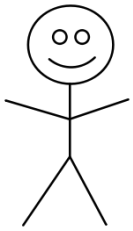
SPARE DIAGRAMS

Question 6 (d)



Question 6 (e)



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Tasmanian Certificate of Education
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PHYSICAL SCIENCES

(PSC315114)

PART 2

Time: 45 minutes

Pages:	12
Questions:	6
Attachments:	Information Sheet

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On the basis of your performance in this examination, the examiners will provide results on each of the following criteria taken from the course statement:

Criterion 6 Demonstrate knowledge and understanding of principles of sources and properties of energy.

Criterion 6 Total: /40

Additional Instructions for candidates

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For Marker Use Only

Question 7

An 80.0 kg athlete ran up a steep hill at a constant speed. If the athlete's elevation increased by 10.0 m over 10.0 s, calculate the average power produced by the athlete. (2 marks)

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Question 8

Three friends had to 'roll start' a car. One steered while two pushed the car along a flat section of road.

The two people pushing the car applied a combined force of 600 N against a frictional force of 475 N over a distance of 100 m.
The car reached a speed of 5.00 m s^{-1}.

(a) (i) Calculate the work done by the two friends pushing the car. (1 mark)

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(ii) If the car including the driver had a combined mass of 1000 kg, find the kinetic energy of the car as it reached a speed of 5.00 m s^{-1}. (1 mark)

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(iii) Explain why the work done by the two pushing the car is so much greater than the kinetic energy of the car. (2 marks)

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Question 9

For Marker Use Only

A kayaker went over a waterfall in a fast moving river.

At the top of the fall the kayaker was moving at 5.00 m s^{-1}. The waterfall was 10.0 m high.

The combined mass of the paddler and the kayak was 100 kg.

(a) Calculate the potential energy at the top of the fall. (1 mark)

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(b) Use the conservation of energy to calculate the expected speed at which the kayak hit the water at the base of the waterfall. (3 marks)

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(c) Would the actual speed of the kayak as it hit the water be more or less than that calculated? Provide a reason for the difference. (1 mark)

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Question 10

For Marker Use Only

A bouncy rubber ball and a ball of clay, of the same mass and volume, were dropped from a height of 1 m.

In terms of energy use these examples to explain the difference between elastic and inelastic collisions. (2 marks)

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Question 11

Technetium-99^m is prepared in a 'Molybdenum Cow' and is used as a tracer for bone scans.

(a) Complete the table by identifying the number of protons and neutrons in each of the following isotopes. (2 marks)

Isotope	Number of protons	Number of neutrons
$^{99}_{42}\mathrm{Mo}$		
$^{99}_{43}\mathrm{Tc}^{m}$		

(b) When a $^{235}_{92}\mathrm{U}$ target is placed in a nuclear reactor, some of the nuclei undergo fission to produce $^{99}_{42}\mathrm{Mo}$.

(i) Balance the nuclear equation by filling in the details for the missing isotope. (1 mark)

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}n \xrightarrow{\textit{fission}} {}^{99}_{42}\mathrm{Mo} + \qquad\qquad + 3\ {}^{1}_{0}n + {}^{0}_{0}\gamma + \text{Energy}$$

The radioisotope $^{99}_{42}\mathrm{Mo}$ decays to produce $^{99}_{43}\mathrm{Tc}^{m}$.

(ii) Write a balanced nuclear equation for this decay process. (1 mark)

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(iii) What is the significance of the *m* in $^{99}_{43}\mathrm{Tc}^{m}$? (1 mark)

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Question 11 continues.

(c) The half-lives of the radioisotope $^{99}_{42}Mo$ and $^{99}_{43}Tc^{m}$ are 67 hours and 6 hours respectively. ANSTO, the nuclear facility based at Lucas Heights, exports $^{99}_{42}Mo$ for medical imaging all over the world.

(i) Suggest two reasons why ANSTO does not export $^{99}_{43}Tc^{m}$. (2 marks)

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The radioisotope $^{99}_{43}Tc^{m}$ undergoes γ-decay.

(ii) Write a nuclear equation to show this process. (1 mark)

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(d) A patient is injected with serum containing $^{99}_{43}Tc^{m}$ with an activity of 10.0 MBq.

(i) What does an activity of 10.0 MBq actually mean? (1 mark)

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(ii) Use the grid provided (opposite) to plot a graph of activity versus time for up to 30.0 hours after the injection. $T_{1/2}$ = 6.00 h for $^{99}_{43}Tc^{m}$. (3 marks)

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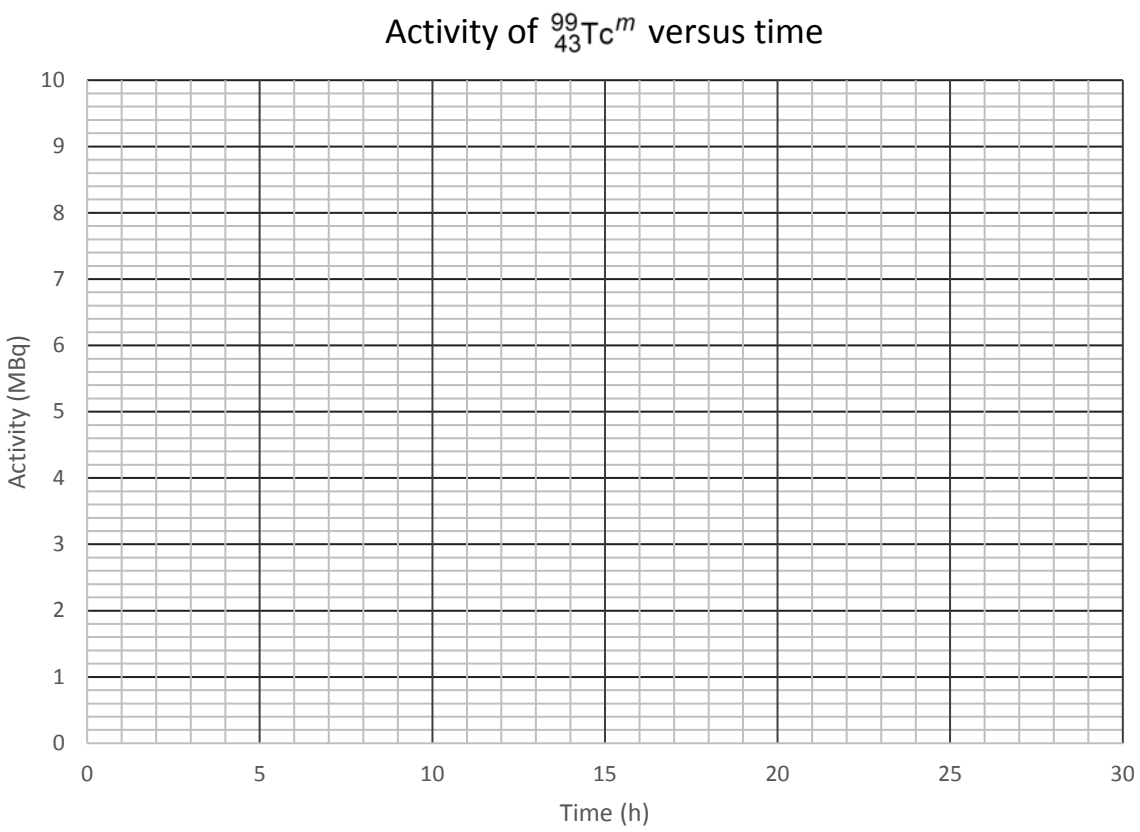
Question 11 (continued)

For Marker Use Only



(iii) Use the graph to determine the activity after 15 hours. (1 mark)

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Patients treated with radioisotopes are advised to avoid close contact with children or pregnant women for a 24-hour period.

(iv) Explain the basis for this precaution. (2 marks)

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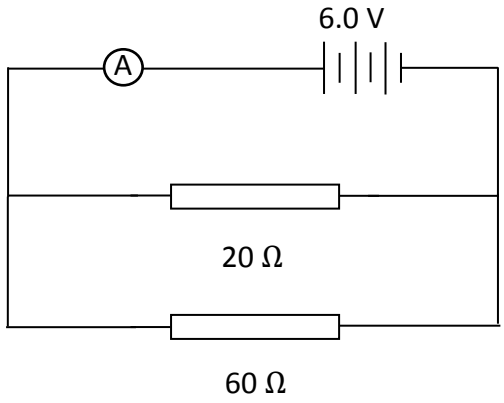
Question 12

For Marker Use Only

A student set up the following circuit using a 6.0 V car battery and resistances of 20 Ω and 60 Ω connected in parallel as shown.



(a) (i) Find the total resistance of the circuit. Assume that the resistance of the ammeter is negligible. (1 mark)

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(ii) Calculate the current that flowed through each resistor. (2 marks)

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The resistors were both rated at 1.0 W maximum.

(iii) Which of the two resistors is most likely to burn out? Justify your answer. (2 marks)

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(iv) Find the new current through the ammeter after the predicted resistor burnt out. (1 mark)

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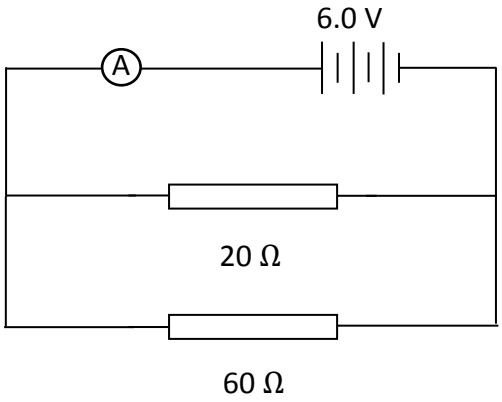
Question 12 continues.

The student tested the prediction by connecting a voltmeter across the burnt out resistor.

(v) Using the diagram below, show the placement of the voltmeter that would enable the voltage across the burnt out resistor to be measured.

(1 mark)



(vi) Predict the reading of the voltmeter. Explain your reasoning. (2 marks)

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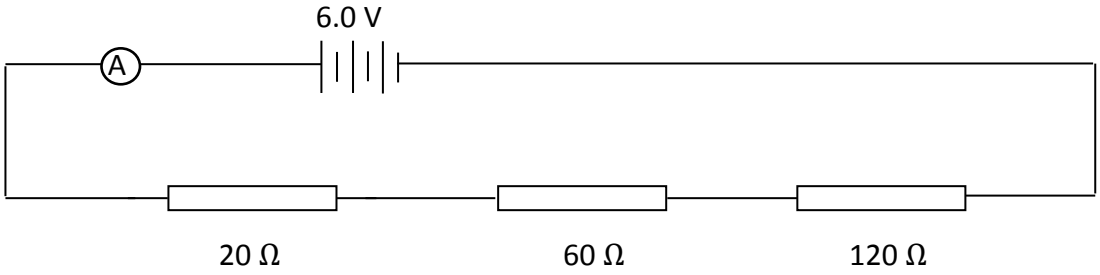
(b) The student then built a series circuit using three new resistors as shown.



Calculate the voltage across each resistor. (3 marks)

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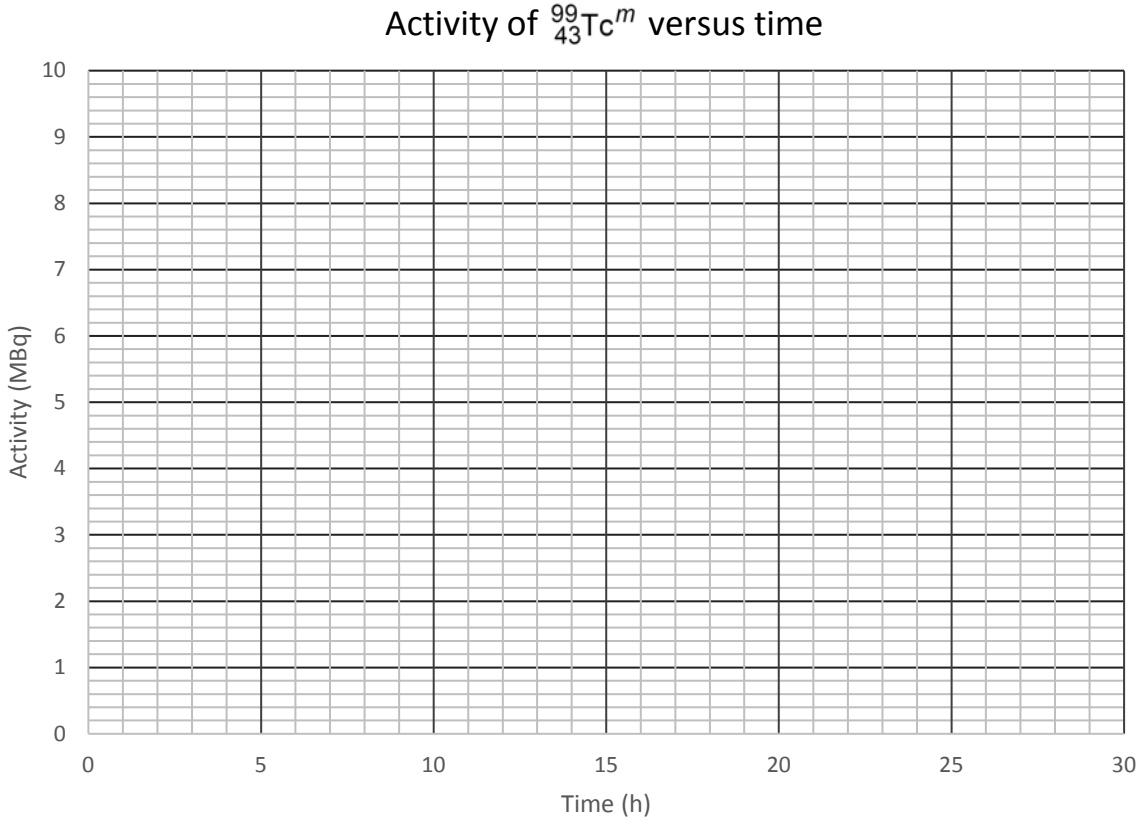
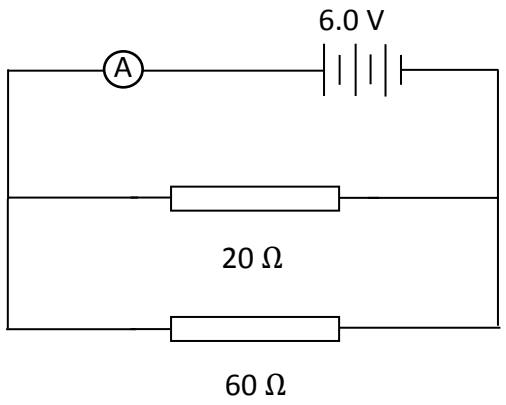
SPARE DIAGRAMS

Question 11 (iii)



Question 12 (a)(v)



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PHYSICAL SCIENCES

(PSC315114)

PART 3

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Questions:	8
Attachments:	Information Sheet

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Criterion 7 Demonstrate knowledge and understanding of the principles of chemical fundamentals: structures and properties.

Criterion 7 Total:	/40

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Question 13

For Marker Use Only

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

Name	Chemical Formula	Structure
boron nitride	BN	covalent network
	$FeCl_3$	
hydrogen chloride		
	Fe	

(b) Match the substances from the table above with the appropriate physical properties in the table below. (4 marks)

Chemical Formula or Name	Melting Point (°C)	Boiling Point (°C)	Conductivity (solid)	Conductivity (liquid)	Conductivity (solution)
	–114	–85	non-conducting	non-conducting	good
	306	315	non-conducting	excellent	good
	1538	2862	excellent	excellent	insoluble
	2973 sublimes	not applicable	non-conducting	not applicable	insoluble

Question 14

(a) Explain what is meant by a covalent bond. (1 mark)

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(b) Identify and compare the forces between molecules and atoms in liquid nitrogen and the type of property these forces influence by completing the table. (3 marks)

	Name of Force/Bond	Relative Strength	Type of Property Physical or Chemical
Between Atoms			
Between Molecules			

Question 15

For Marker Use Only

(a) X and Y are elements that combine to form the ionic compound XY_3. The ions X^{3+} and Y^- both have the same electronic configuration as the neon atom. Use the Periodic Table on the information sheet to identify X and Y. (1 mark)

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(b) (i) The compounds sodium fluoride and magnesium oxide have ions of similar sizes but quite different melting points (993°C and 2852°C respectively). Explain the reason for the difference. (2 marks)

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(ii) The melting points of the alkali metal halides tend to decrease as we descend the Periodic Table despite their having identical charges on their ions. For example sodium fluoride, NaF melts at 993°C and caesium iodide, CsI melts at 621°C.

Explain the melting point trend. (2 marks)

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Question 16

For Marker Use Only

(a) Describe the change in reactivity of metals across the third row of the Periodic Table from Group 1. Include an explanation for this change. (3 marks)

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(b) Considering that the atomic radii decrease across the third row from Group 1 to 17, compare the reactivity of sulfur and chlorine. (1 mark)

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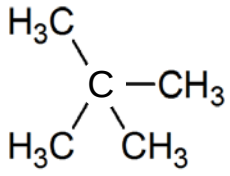
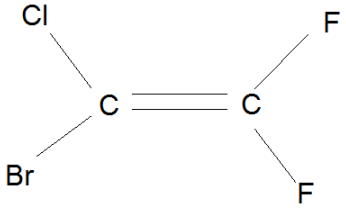
Question 17

Complete the following table. (6 marks)

For Marker Use Only

Structure	Name
	
	1-bromo-3,3-dichlorobut-1-yne
	

Question 18

For Marker Use Only

(a) What is meant by the term isomer? (1 mark)

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(b) In the space below, draw three isomers with the molecular formula, C_4H_8 including one saturated compound. (3 marks)

(i)

(ii)

(iii)

(c) (i) Write a balanced chemical equation for the reaction of one of your unsaturated compounds C_4H_8 reacting with bromine solution. (1 mark)

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(ii) What observation would you make? (1 mark)

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(iii) Write a balanced chemical equation for the reaction of your saturated compound C_4H_8 reacting with bromine solution. (1 mark)

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(iv) What observation would you make? (1 mark)

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Question 19

For Marker Use Only

LPG, liquid petroleum gas, consists of propane gas, $C_3H_{8(g)}$.

(a) Write an equation for its complete combustion in oxygen gas. (1 mark)

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(b) Incomplete combustion produces carbon solid (soot) and other products. Complete the balancing of the equation, showing all products formed. Do not change the coefficient of the reactants. (2 marks)

$C_3H_{8(g)} + 3\ O_{2(g)} \rightarrow$

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Question 20

For Marker Use Only

(a) Draw an electron dot diagram for nitrogen trifluoride, $NF_{3(g)}$. (2 marks)

(b) What sort of bonds would exist between the N and F atoms? (1 mark)

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PHYSICAL SCIENCES

(PSC315114)

PART 4

Time: 45 minutes

Pages:	12
Questions:	7
Attachments:	Information Sheet

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Criterion 8 Demonstrate knowledge and understanding of principles of chemical reactions and reacting quantities.

Criterion 8 Total:	/40

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Question 21

For Marker Use Only

A student dissolved a sample of iron metal in dilute sulfuric acid to form a solution of iron(II) sulfate.

(a) Write a chemical equation for the reaction. (1 mark)

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(b) The student mixed some of the iron(II) sulfate solution with a solution of sodium hydroxide to produce an olive green precipitate.

(i) Identify the precipitate. (1 mark)

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(ii) Write an overall equation for the reaction. (1 mark)

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(iii) Write a net ionic equation for the reaction. (1 mark)

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(iv) Identify any spectator ions. (1 mark)

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Question 22

For Marker Use Only

(a) Calculate the mass of hydrogen chloride gas that would need to be dissolved in water to make 500 mL of 0.100 mol L^{-1} $HCl_{(aq)}$. (2 marks)

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(b) A sample of pure ethanoic acid, $CH_3COOH_{(l)}$, with a mass of 1.501 g was dissolved in deionized water and the volume made up to 250.0 mL using a volumetric flask.

If $M_r(CH_3COOH) = 60.05$, show that the concentration of the acid was about 0.10 mol L^{-1}. (2 marks)

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(c) A sensitive pH meter was used to find the pH of the 0.1 mol L^{-1} solutions of the two acids. The $HCl_{(aq)}$ had a pH of 1.0 and the $CH_3COOH_{(aq)}$ had a pH of 2.9.

If both acids had exactly the same concentration, why were their pH values so different? (2 marks)

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Question 23

For Marker Use Only

A retired Chemistry teacher gave a pentillion (10^{18}) gold atoms to each of the Chemistry students they had taught over their career. The gold dust was weighed to the nearest µg and placed in envelopes.

(a) Calculate the mass of gold dust placed in each envelope measured in µg. (3 marks)

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(b) The teacher was able to purchase gold dust from a jeweler at a cost of $50.00 per gram.

Calculate the cost of the gold dust in each envelope to the nearest cent. (1 mark)

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Question 24

For Marker Use Only

A cement manufacturer produced calcium oxide from limestone which contained $CaCO_{3(s)}$.

The equation for the decomposition of calcium carbonate is:

$$CaCO_{3(s)} \xrightarrow{850°C} CaO_{(s)} + CO_{2(g)}$$

$M_r(CaCO_3) = 100.09$
$M_r(CaO) = 56.08$
$M_r(CO_2) = 44.01$

(a) What mass of $CO_{2(g)}$ would be produced with 1 000 kg of $CaO_{(s)}$? (2 marks)

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(b) The limestone was 95% pure $CaCO_{3(s)}$ by mass. What mass of limestone would be required to produce 1 000 kg of $CaO_{(s)}$? (3 marks)

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Question 25

For Marker Use Only

Pale green crystals of hydrated iron(II) sulfate, $FeSO_4 \cdot xH_2O$, contain water of crystallisation. When 2.000 g of the crystals were heated to remove the water of crystallisation, the mass of the dehydrated salt was 1.093 g.

(a) Calculate the molar mass of the dehydrated salt. (1 mark)

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(b) Calculate the amount, in mole, of the dehydrated salt. (1 mark)

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(c) Calculate the amount of water, in mole, removed from the hydrated salt. (1 mark)

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(d) Deduce the formula for the hydrated iron(II) sulfate. (1 mark)

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Question 26

For Marker Use Only

(a) By definition the relative atomic mass of a carbon –12 atom is exactly 12 but the relative atomic mass of carbon on your information sheet is 12.01.

Provide one reason for this apparent discrepancy. (1 mark)

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(b) A white crystalline solid has a molecular mass of 90.04 g mol^{-1} and contains 26.68% carbon, 2.24% hydrogen and 71.08% oxygen by mass.

(i) Determine the empirical formula of the compound. (3 marks)

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(ii) Determine the molecular formula of the compound. (1 mark)

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Question 27

For Marker Use Only

Cider vinegar contains ethanoic acid, CH_3COOH.

(a) The mass of 250.0 mL cider vinegar is 252.5 g. If cider vinegar is 5.00% by mass CH_3COOH, calculate the concentration of CH_3COOH expressed in mol L^{-1}. (3 marks)

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(b) Write an equation for the reaction of $CH_3COOH_{(aq)}$ with sodium hydroxide solution. (1 mark)

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(c) To determine the concentration of CH_3COOH in wine vinegar, 5.00 mL samples of vinegar were titrated with 0.1086 mol L^{-1} NaOH using phenolphthalein as an acid-base indicator. The average volume used was 42.65 mL.

(i) Calculate the average amount, in mole, of NaOH added to each sample. (1 mark)

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(ii) Show that the concentration of $CH_3COOH_{(aq)}$ in the wine vinegar is about 0.9 mol L^{-1}. (2 marks)

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Question 27 continues.

Question 27 (continued)

For Marker Use Only

(iii) Calculate the mass of CH_3COOH in a 250 mL sample of wine vinegar. (2 marks)

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The mass of 250.0 mL of wine vinegar is 252.5 g.

(iv) Calculate the percentage by mass of CH_3COOH in the wine vinegar. (2 marks)

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