James Ruse Agricultural High School

Theory Exam

Chemistry Assessment
Term 4 2016

General Instructions

- **Reading Time**: 5 minutes
- **Working Time**: 95 minutes
- **Complete both Theory and Data Processing Tasks**

- Write using black or blue pen
- Draw diagrams using pencil
- Board approved calculators may be used
- Write your Student Number on the answer booklets
- A Periodic Table and Data Sheet are provided.

Total Marks 80

Theory Test
Total marks: 37
Take about 40 minutes to do this section

Data Processing
Total marks: 43
Take about 55 minutes to do this section

Part A

Multiple Choice: 9 marks
Attempt Questions 1-9

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

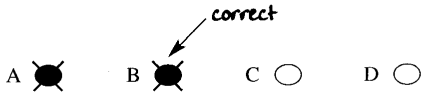
Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ⊗ C ○ D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.



▸ Mark your answers for Questions 1 – 9 in the Answer Box on page 7

Part A: Multiple Choice

1. Which of the following is **NOT** a fossil fuel?

   (A) Coal

   (B) Manure

   (C) Crude oil

   (D) Natural gas

2. Which of the following sources could be another possible alternative resource used to build petrochemicals?

   (A) Soil

   (B) Wind

   (C) Blood

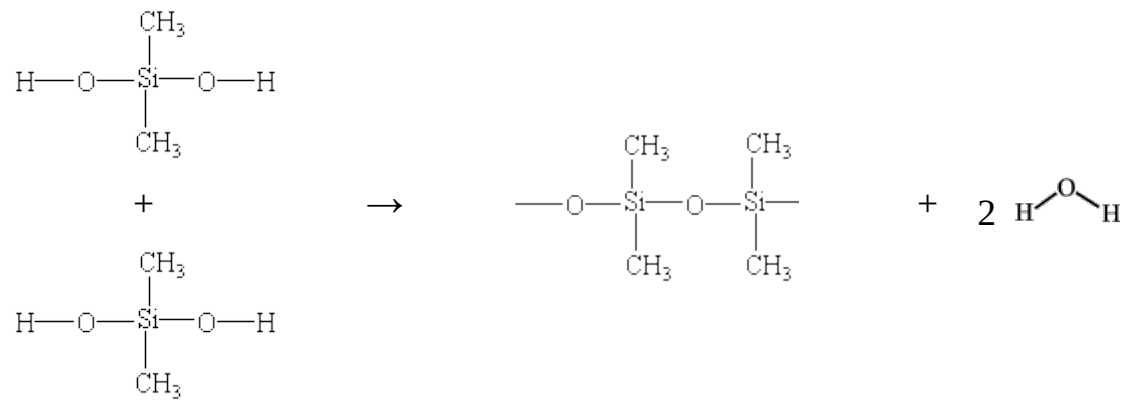
   (D) Biomass

3. With reference to a first-hand investigation conducted to compare the reactivities of cyclohexene and cyclohexane in bromine water in a school laboratory, which of the following observations are correct?

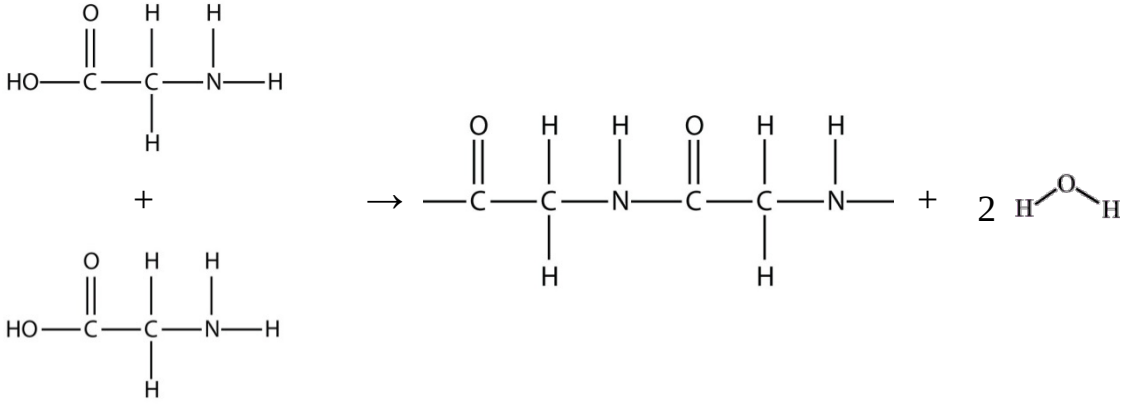
	Before the reaction		*After the reaction*	
	Colour of the aqueous layer	*Chemicals in the aqueous layer*	*Colour of the aqueous layer*	*Chemicals in the non-aqueous layer*
(A)	Orange	Bromine	Colourless	Water
(B)	Colourless	Cyclohexene	Brown	2,1-dibromocyclohexane
(C)	Orange	Bromine	Colourless	1,2-dibromocyclohexane
(D)	Colourless	Cyclohexene	Brown	2,2-bromocyclohexane

4. Which of the following chemical reactions is **NOT** condensation polymerization?

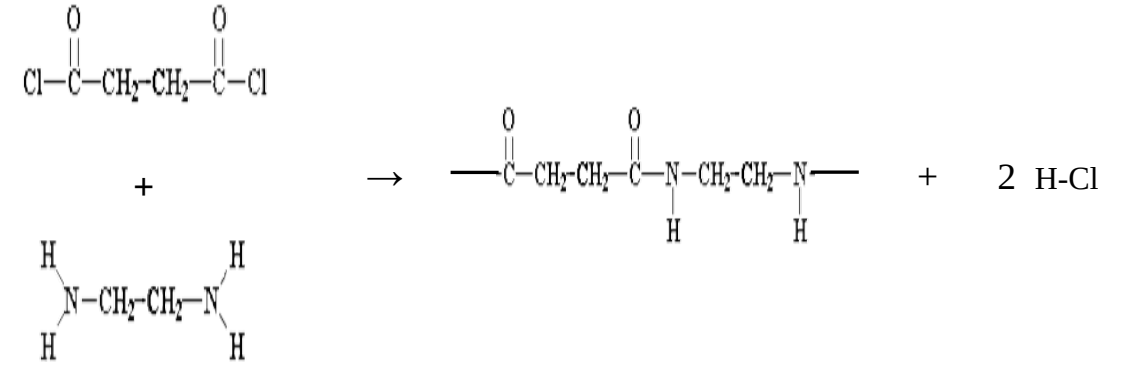
(A)



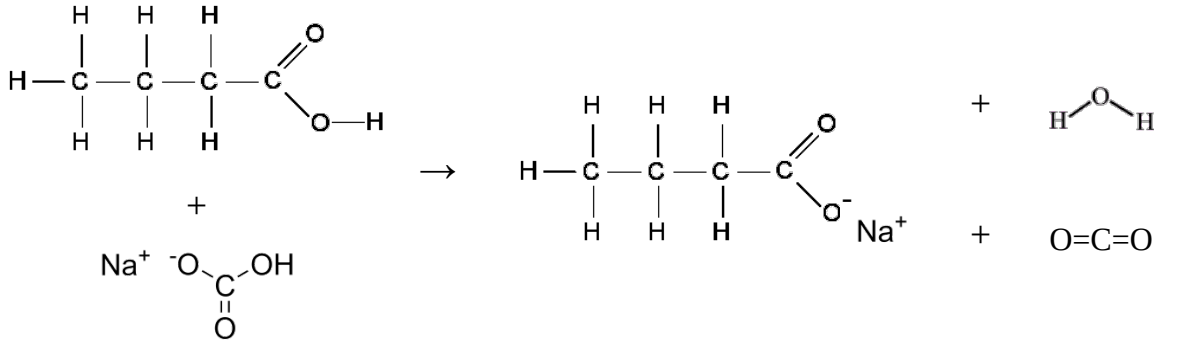
(B)



(C)



(D)



5. Which is the chosen reference electrode used in the table of standard potentials?

(A) Carbon

(B) Hydrogen

(C) Oxygen

(D) Sodium

6. What is the oxidation state of chromium in potassium chromate, K_2CrO_4 ?

(A) +3

(B) +5

(C) +6

(D) +7

7. Ethanol is widely used as a solvent in the preparation of perfumes, food flavourings and pharmaceuticals.

What types of intermolecular forces are exerted by ethanol on hexane?

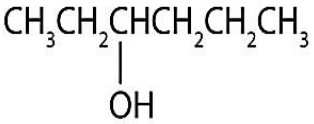
(A) hydrogen bonding

(B) dipole–dipole and dispersion

(C) dispersion forces

(D) dipole-dipole and hydrogen

8. Name the following compound.



(A) 3-heptanol

(B) 3-hexanol

(C) 4- hexanol

(D) 4- heptanol

9. Iron-58 is bombarded with neutrons in a nuclear fission reactor. A single neutron is captured by the Iron-58 nucleus to form a new isotope. This isotope then undergoes β decay, producing a daughter nucleus.

What is the identity of the daughter nucleus?

(A) $^{59}_{27}\mathrm{Co}$

(B) $^{59}_{26}\mathrm{Fe}$

(C) $^{57}_{26}\mathrm{Fe}$

(D) $^{59}_{25}\mathrm{Fe}$

Student Number.....…….

Theory Mark ……..

Part A: Answer grid for multiple choice questions

1.	A O	B O	C O	D O
2.	A O	B O	C O	D O
3.	A O	B O	C O	D O
4.	A O	B O	C O	D O
5.	A O	B O	C O	D O
6.	A O	B O	C O	D O
7.	A O	B O	C O	D O
8.	A O	B O	C O	D O
9.	A O	B O	C O	D O

Part B: 28 marks

Attempt questions 10- 14

- *Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response*
- *Show all relevant working in questions involving calculations*

Question 10 (5 marks)

Ethylene is used to produce vinyl chloride and styrene monomers. Ethylene is the basis of many polymers.

Account for the uses of these polymers in terms of their structure and properties. **5**

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Question 11(4 marks)

Ethanol can be produced industrially by the acid-catalysed addition of water to ethene.

A mixture of ethene and steam is pumped into a reaction vessel containing phosphoric acid catalyst. This reaction is carried out at 300^oC.

(a) Write the balanced chemical equation for this reaction. **2**

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(b) What is the purpose of the catalyst in this chemical reaction? **1**

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(c) The yield of ethanol is favoured by low temperatures yet this reaction is carried out at 300^oC.

Suggest a reason for the use of higher temperatures. **1**

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Question 12 (5 marks**)**

Measurements of the heat of combustion of fuels can be made in the school laboratory.

Describe a procedure that would allow you to compare the molar heats of combustion of ethanol and 1-butanol. **5**

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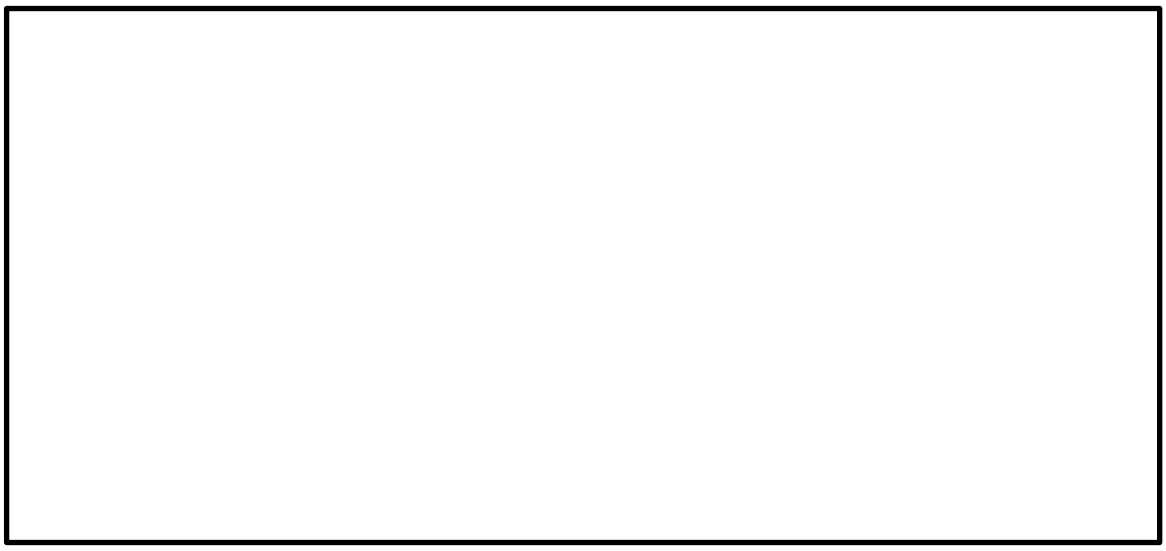
Question 13 (8 marks)

(a) Draw a fully-labelled diagram of a galvanic cell consisting of nickel, nickel nitrate solution, silver and silver nitrate solution. **4**



(b) Write the anode and cathode half-equations for the above galvanic cell. **2**

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(c) Write the net equation and calculate the net E^0 value for the cell in part (a). **2**

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Question 14 (6 marks)

Radioisotopes are widely used in medicine.

For a named radioisotope describe how it is produced and the benefits and problems associated with its use in medicine. **6**

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End of Theory Exam……..Continue with Data Processing

Student Number	
Data Processing Mark	

JAMES RUSE AGRICULTURAL HIGH SCHOOL

2016 YEAR 12 CHEMISTRY

TERM 4 ASSESSMENT TASK

DATA PROCESSING

Total: 43 marks

Attempt questions 1 to 5

Allow about 55 minutes for this part

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Show all relevant working in questions involving calculations.

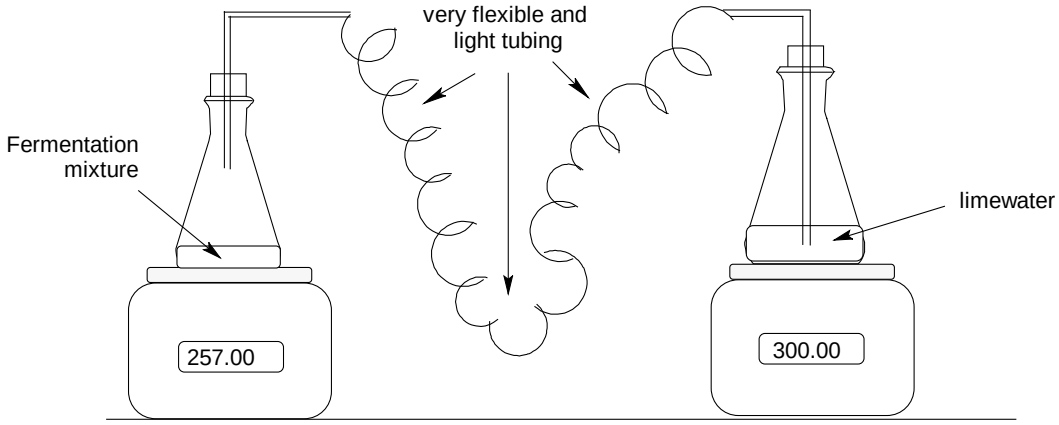
Question 1 (10 marks)

A group of students was asked to design an experiment to monitor the progress of fermentation of glucose to ethanol (C_2H_5OH).

To prepare the fermentation mixture, they dissolved 10 g glucose ($C_6H_{12}O_6$) in 100 g of warm water (37^0) and then added 2.0 g of yeast. They immediately stoppered the flask (flask 1) and weighed it. Gas emission from flask 1 was monitored by channeling the gas into flask 2 containing 150 g of limewater. The flasks were kept on the balances for the duration of the experiment.
Flask 1 had an empty mass of 145.00 g and flask 2 had an empty mass of 150.00 g.
They monitored the fermentation for 100 minutes.

Diagram

The experimental set-up is shown below.



Flask 1 Flask 2

Data Results Table

Time (minutes)	***Mass of flask 1 + contents (g)***	***Mass of flask 2 + contents (g)***	***Cumulative Loss in mass (flask 1)***	***Cumulative Gain in mass (flask 2)***
0	257.00	300.00		
10	256.00	300.65		
30	253.85	301.90		
50	252.85	302.80		
70	252.25	303.30		
90	252.15	303.20		

(a) Complete the columns in the data results table. **2**

(b) Identify the gas released from the reaction in flask 1 and describe the observation of the reaction in flask 2 that confirms this identification. **2**

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(c) Write a balanced equation for the fermentation of glucose. **2**

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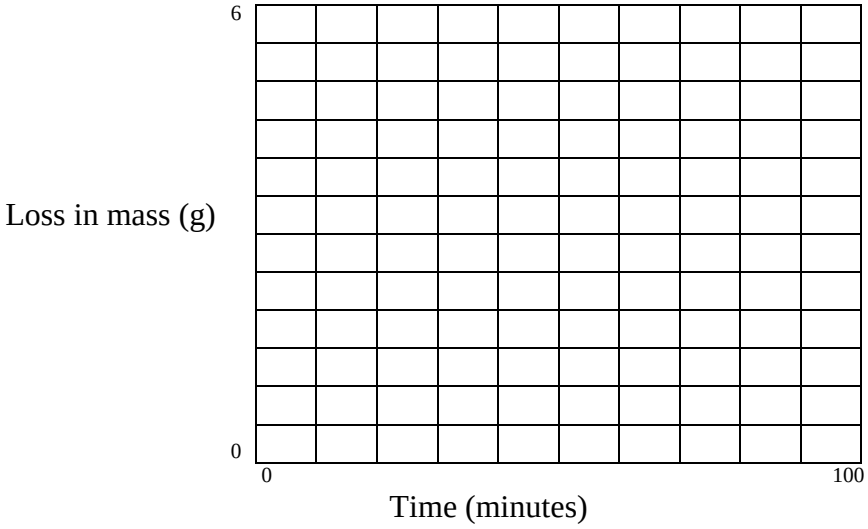
(d) Graph the results of the loss in mass in flask 1 on the grid provided. **2**



(e) Compare the mass lost from flask 1with the mass gain in flask 2 and suggest a reason for this difference. **2**

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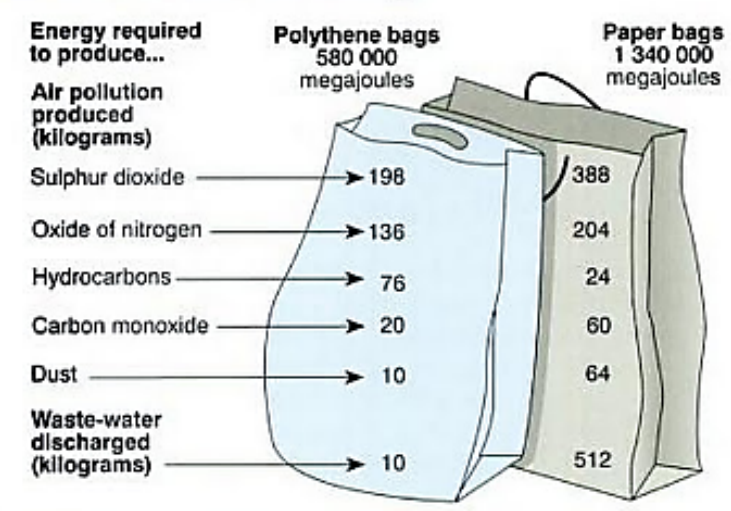
Question 2 (9 marks)

In a letter to the editor of a newspaper, a reader suggests that all supermarkets replace polythene bags made from petrochemicals (non-renewable) to paper bags made from wood (renewable).

(a) The data given below is for the production of 1 million of each type of bag.

Present it in a table **3**



http://politicalcalculations.blogspot.com.au/2012/06/paper-plastic-or-cloth-which-bag-is.html#.WA_mgGe_muk

(b) Compare the energy required to produce 1 of each type of bag. **2**

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(c) Is the reader's suggestion justified in terms of total air pollution produced?

Explain your answer. **3**

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(d) What justification does the reader give for replacing polythene bags with paper bags? **1**

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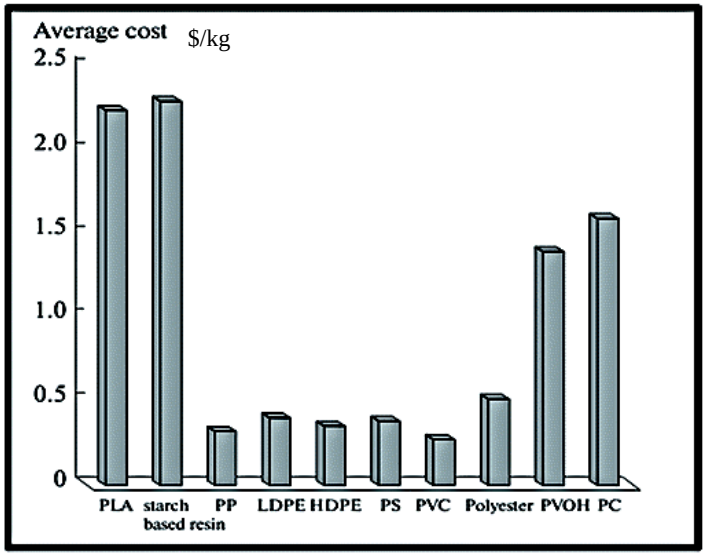
Question 3 (5 marks)

The following table and graph contain information about a range of plastics.

	BIODEGRADABLE PLASTIC TECHNOLOGIES			
	Earth Nurture Additives	Polylactic acid Compostable Bioplastic	Oxodegradable Additives	Starch mixed with Plastics
Additive added to conventional plastics	Yes	No, the material itself is compostable	Yes	Yes
Method of Degrading	Stimulates wild microbes to eat plastic in landfills, soil, or natural bodies of water	Intrinsically degradable, but only in commercial compost facilities, will not degrade in landfills	Chemically breaks down plastic when baked in oven or intense UV, followed by biodegradation -if baking is sufficient	The plastic does not degrade; only the starch degrades, leaving the plastic intact
Common names or brands	ENA	PLA, corn plastic, Natureworks Igneo	Symphony, EPI, Wells Reverte, D2W, Noebeide	Generic
Liklihood of biodegrading in landfills	100%	Will not biodegrade in landfills	Unlikely, due to absence of pretreatment	Starch portion only degrades in landfills - plastic will not.



http://pubs.rsc.org/en/content/articlelanding/2016/ra/c6ra08641a#!divAbstract

Compare the advantages and disadvantages of using Polylactic acid (PLA) with those of starch mixed with plastics (starch based resin plastic mixed with polyethylene (LDPE/HDPE). **5**

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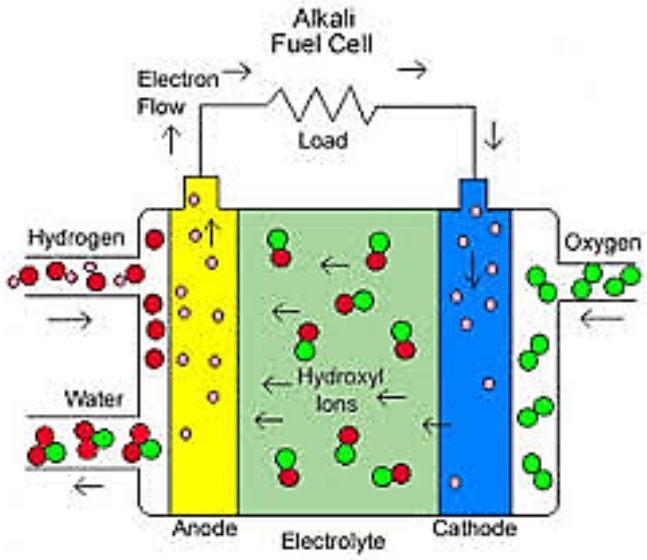
Question 4 (10 marks) **The Hydrogen-Oxygen Fuel Cell**

A fuel cell is an electrochemical device which converts chemical energy, provided by a fuel and an oxidant, into electricity. In contrast to a storage battery, a fuel cell does not need to involve a reversible reaction ; the reactants are supplied to the cell as needed from an external source.

The best known fuel cell is the hydrogen-oxygen cell used in the Gemini, Apollo and Space Shuttle programs. The net reaction is the oxidation of hydrogen with oxygen to give water. Rather than allowing these gases to react directly and produce energy in the form of heat, they are made to react in such a way that the energy produced can be tapped by an electric device. A stream of hydrogen gas is pumped onto the anode of the cell, and pure oxygen gas is directed to the cathode. The cell contains concentrated potassium hydroxide, so the anode and cathode reactions occur under basic conditions.

The diagram below shows a typical fuel cell.



The product, water is swept out of the cell as a vapour in the hydrogen and oxygen stream and can be purified for drinking purposes.

Fuel cells have been valuable in the space program because they are light weight and highly efficient. The fuel cells on board the Space Shuttle deliver the same power as batteries weighing 10 times more. On a typical seven day mission, the Shuttle fuel cells consume 3000kg of hydrogen and generates a sufficient water supply for the astronauts to survive.

Adapted from *" Chemistry and Chemical Reactivity", Kotz and Treichel(1996)*

(a) Write the net balanced chemical equation for the hydrogen-oxygen fuel cell. **1**

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(b) Outline how a fuel cell differs from a storage battery. **2**

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(c) Justify the use of the fuel cell in Space Missions. **3**

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(d) Calculate the volume of water produced by Shuttle fuel cells on a typical seven-day mission, (assuming 25^0 C and 100 kPa conditions in the Shuttle) . **4**

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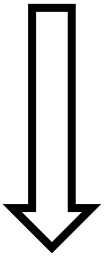
Question 5 (9 marks)

A scientist at ANTARES (Australian National Tandem Accelerator for Applied Research) was performing radioisotope analysis on a range of samples and obtained the following decay series information:

Element	*Half Life*
$^{234}_{92}$U	250 000 years
$^{230}_{90}$Th	80 000 years
$^{226}_{88}$Ra	1 602 years
$^{222}_{86}$Rn	4 days
$^{218}_{84}$Po	3 minutes

Less stable



More stable

(a) Complete the following table. **2**

Element	*Protons (P)*	*Neutrons (N)*	*Ratio (P / N)*
Uranium			
Thorium			
Radium			
Radon			
Polonium			

(b) Rank these elements in order of increasing stability. **1**

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(c) Justify the trend in stability **3**

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(d) Identify a subsequent element of this decay series. **1**

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(e) Predict the stability of the above element and provide reasoning. **2**

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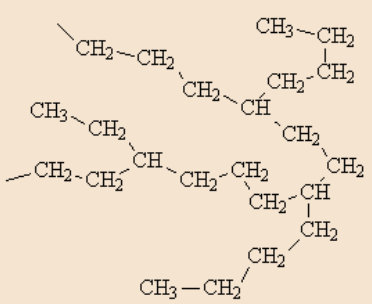
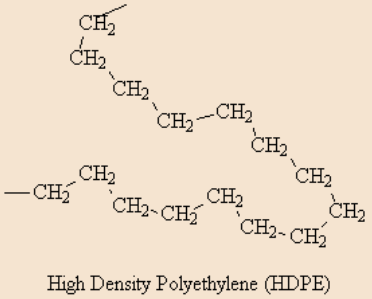
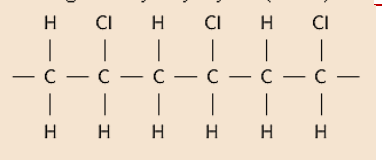
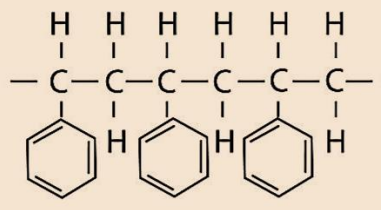
End of Data Processing Task

2016 Term 4 HSC Chemistry Assessment Task Answers for students
M.C. 1.B 2.D 3.C 4.D 5.B 6.C 7.C 8.B 9.A
Part B : Sample Answers and Marking Criteria
10. Sample Answer : *The structure and properties of the following polymers:*

Name	*Structure*	*Properties by structure*	*Uses by properties*
Low-densitypolyethene/ Low-density polyethylene	 Low Density Polyethylene (LDPE)	*Soft, flexible solid (Extensive chain branching, thus reduced dispersion force)*	*Cling wrap, Squeeze bottles*
High-densitypolyethene/ High-density polyethylene	 High Density Polyethylene (HDPE)	*Hard, rigid solid (Extensive dispersion forces compared to LDPE due to unbranched chains)*	*Heavy-duty waste bins*
Polychloroethene/ Polyvinylchoride		*-Hard and brittle due to the large chlorine atom, there is an increase in dispersion forces and possible dipole-dipole interactions between C-Cl sections of the polymer* *-Pure PVC (the C-Cl bond) is light-sensitive hence will decompose in light*	*Underground piping*
		-Poor electrical conductor since there is no free-moving charges *-Plasticisers can be added to weaken the intermolecular forces hence result in a tough but more flexible material*	*Electrical wiring*
Polyphenylethene/ Polystyrene		*Crystalline polystyrene:*	
		-Hard and brittle due to the bulky phenyl group, there is extensive dispersion forces *- Good electrical insulator since there is no free-moving charges*	*CD cases, screwdriver handles*

		Expanded polystyrene:	
		-Good heat insulators due to the air trapped between the polymer chains	*Foam cups*
		-Good shock absorbers since the material can contract and return back to its original shape	*Packaging material*

Due to the wide range of properties, there are many different applications of these polymers. Hence developing polymers with different structures are very advantageous to the society.

Marking Criteria	Marks
• Identified that the polymers of vinyl chloride and styrene includes chlorine atoms and phenyl groups respectively. • At least one property from each of TWO polymers was linked to the structure of the polymer. • At least one use from each of TWO polymers was linked to the property of the polymer.	**5**
• Identified that the polymers of vinyl chloride and styrene includes chlorine atoms and phenyl groups respectively. • At least one use from each of ONE polymer was linked to the property of the polymer. • At least one use from each of TWO polymers was linked to the property of the polymer. OR • Identified that the polymers of vinyl chloride and styrene includes chlorine atoms and phenyl groups respectively. • At least one property from each of TWO polymers was linked to the structure of the polymer. • At least one use from each of ONE polymer was linked to the property of the polymer.	**4**
• Identified that the polymers of vinyl chloride and styrene includes chlorine atoms and phenyl groups respectively. • At least one use from each of TWO polymers was linked to the property of the polymer. OR • At least one property from each of ONE polymer was linked to the structure of the polymer. • At least one use from each of TWO polymers was linked to the property of the polymer.	**3**
• Identified that the polymers of vinyl chloride and styrene includes chlorine atoms and phenyl groups respectively. • At least one use from each of TWO polymers was linked to the property of the polymer. OR • Identified that the polymers of vinyl chloride and styrene includes chlorine atoms and phenyl groups respectively. • At least one property from each of ONE polymer was linked to the structure of the polymer. • At least one use from each of ONE polymer was linked to the property of the polymer.	**2**

• Identified that the polymers of vinyl chloride and styrene includes chlorine atoms and phenyl groups respectively.	**1**

11. Sample Answer :

(a) $C_2H_4\ (g) + H_2O\ (g) \leftrightarrow C_2H_5OH\ (g)$

Marking Criteria	Marks
• Provided a balanced chemical equation. • Included correct states.	**2**

(b) To increase the rate of reaction by lowering the activation energy.

Marking Criteria	Marks
• Identified a clear purpose for the acid catalyst.	**1**

(c) Molecules will have greater kinetic energy at a higher temperature, hence increases the number of successful collisions over time.
OR
The rate of reaction was increased at the expense the yield of ethanol.

Marking Criteria	Marks
• Provided a through reason.	**1**

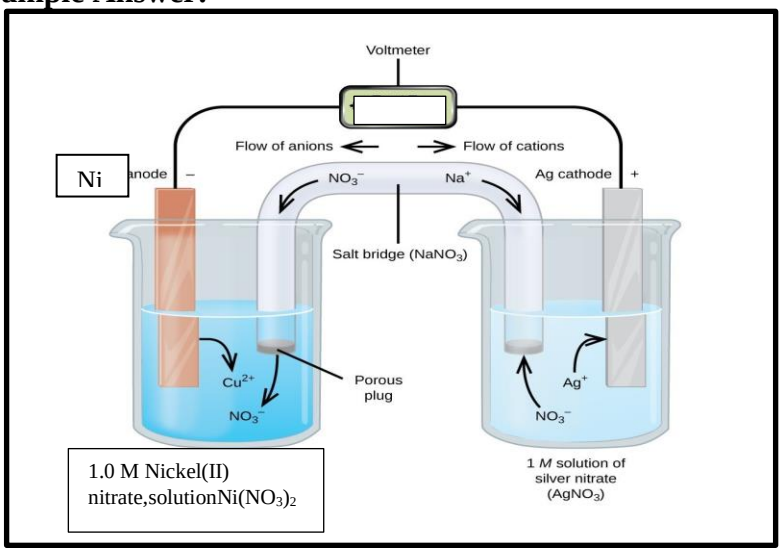
12. Sample Answer : Procedure

1. Measure and record the mass of a burner containing ethanol and repeat for 1-butanol.
2. Measure eg. 100 mL of water into a beaker and measure the temperature of the water.
3. Place the beaker of water directly eg.5 cm above the burner and light it.
4. Allow the burner to heat the water for eg. two minutes, then extinguish it.
5. Immediately measure and record the final mass of the burner and temperature of the water.
6. Calculate the change in mass and temperature.
7. Substitute the experimental results into the formula below to determine the enthalpy change: $\Delta H = -mC\Delta T$ and calculate then compare experimental versus calculated values
8. Determine the number of moles of ethanol combusted (number of moles = mass/MM), and divide the enthalpy change in kilojoules by this number to determine the experimental value of the molar heat of combustion of ethanol in kilojoules per mole.

If the same experiment was conducted for another alkanol, such as 1-butanol, and the difference between the experimental value and systematic errors accounted for and accepted value was found, this difference could be used to calibrate the experimental results for ethanol and produce a more accurate experimental result.The process described above can be applied to any alkanol, and can be modified slightly in order to find the heat of combustion in kilojoules per gram instead of kilojoules per mole.

CRITERIA	MARK
Correct procedure providing all 5 quantitative values, provides 4+ steps in sequence needed and makes a comparison between the 2 fuels in depth	5
4 of the features with sufficient depth and sequence	4
3 features or 4 features with lack of depth or steps missing	3
2 features	2
1 clear feature or safety precaution	1

13. Sample Answer:



Marking Criteria

Criteria	Marks
ONE mark for each of the following: • Correct equipment (two beakers, salt bridge, voltmeter, electrodes, electrical leads and electrolytes). • Appropriate scientific diagrams • Correctly labelled anode and cathode • Correctly assigned electrolytes	4

(b) Anode : $Ni \rightarrow Ni^{2+} + 2e^-$ Cathode : $Ag^+ + e^- \rightarrow Ag$

Criteria	Marks
Correct anode AND cathode half-equations w/ appropriate labels.	2
Correct anode OR cathode half-equation Correct anode AND cathode half-equation w/o appropriate labels.	1

(c) Net Equation = $Ni^{2+} + 2\,Ag_{(s)} \rightarrow Ni_{(s)} + 2Ag^+$

$E^0net = (+0.24V)\ (+0.80V) = +1.04V$

Criteria	Marks
Correct net equation and calculation forE^0net	2
Correct net equation or calculation for E^0net	1

14. Named Radioactive isotope: Technetium-99m (meta-stable)
Technetium does not occur naturally but is synthesized in two ways either by bombarding molybdenum-98 with a hydrogen-2 nuclei in a particle accelerator on site in a hospital complex or
by bombarding molybdenum-98 with a neutron in a nuclear reactor through a two-step production process as shown below.

$$^{98}_{42}Mo + ^{2}_{1}H \longrightarrow ^{99}_{43}Tc + ^{1}_{0}n$$ OR

$$^{98}_{42}Mo + ^{1}_{0}n \longrightarrow ^{99}_{42}Mo$$

$$^{99}_{42}Mo \longrightarrow ^{99}_{43}Tc + ^{0}_{-1}e$$

$^{99m}_{43}Tc \rightarrow ^{99}_{43}Tc$ + gamma ray

Benefits of Tc-99m Use:

- Technetium-99 is a gamma emitter which is used regularly in medical tracer diagnosis to identify blood flow disorders in the brain, bone, liver, spleen and kidney myocardial tissue in the heart after a heart attack.
- It is heavily used in non-invasive diagnosis/ as a diagnostic tool in replacement of surgery which has serious possible risks or complications.
- Contains a wide variety of oxidation states meaning it can bind to a variety of biological molecules used to target specific or wide variety cells/organs within the body.
- Technicium-99m emits high penetrating, low energy/ionising gamma radiation that minimises damage to healthy tissues but can still be detected in a person's body by a gamma ray sensitive camera/scintillation counter.
- it is quickly excreted/eliminated from the body as it has a very short half-life of only 6 hours
- Technetium-99m decays by a process called "isomeric"; which emits gamma rays and low energy electrons. Since there is no high-energy beta emission the radiation dose to the patient is low.
- The short half-life of the isotope allows for scanning procedures that collect data accurately and rapidly but does not remain in the body for lengthy periods of time.
- The fact that both its physical half-life and its biological half-life are very short leads to very fast clearing from the body after an imaging process.

Problems of Tc-99m Use:

- The major possible concern associated with using this medical tracer is the impact on the staff regularly coming in contact and administering the radioactive doses to patients who may have brain, blood flow, liver, spleen and kidney abnormalities that need diagnosis. They may themselves have alterations to their DNA which can cause cancer.
- Due to the short half-life it needs to be produced as Mo99 in a nuclear reactor, which as a slightly longer 66 hour half-life and be located close to the hospitals which utilize this radioisotope.
- Hospitals can also generate technicium-99m onsite directly using a charged particle accelerator but this process is even more expensive to generate due to its extremely short half-life.

Tc-99m is an excellent medical tracer as it has very little possible long-term problems to the patient injected with the isotope due to its 6 hour short half-life.

CRITERIA	MARKS
• Names a radioisotope used in a medical industry • Describes how the particular radioisotope is produced in detail • Describes 2 or more benefits & problems and links these to the radioactive isotopes medical use in terms of its properties in detail	5-6
• Names a radioisotope used in a medical industry • Describes how the particular radioisotope is produced in detail • Outlines its medical use and relates its beneficial and problematic properties of the	4

element.	
• Names a radioisotope used in a medical industry • Outlines its use in that medical field and at least one benefit and problem relevant to its use	3
• Names a radioisotope used in a medical industry and identifies a use or a property of the radioisotope OR • Identifies use(s) and/or property(ies) of radioisotopes used in non-medical industries	2
• Names a radioisotope OR • Identifies a use or a property of radioisotopes used in medical industries	1

Data Processing Task Answers and Marking criteria
Sample Answers : Data Results Table

Time (minutes)	***Mass of flask 1 + contents (g)***	***Mass of flask 2 + contents (g)***	***Loss in mass (flask 1)(g)***	***Gain in mass (flask 2)(g)***
0	257.00	300.00		
10	256.00	300.65	*1.00*	*0.65*
30	253.85	301.90	*3.15*	*1.90*
50	252.85	302.80	*4.15*	*2.80*
70	252.25	303.30	*4.75*	*3.30*
90	252.15	303.20	*4.85*	*3.20*

Marking Criteria	Marks
• Correctly completes both columns of the table	**2**
• Completes some data	**1**

(b) *Carbon dioxide. The limewater will go milky as white precipitate forms.*

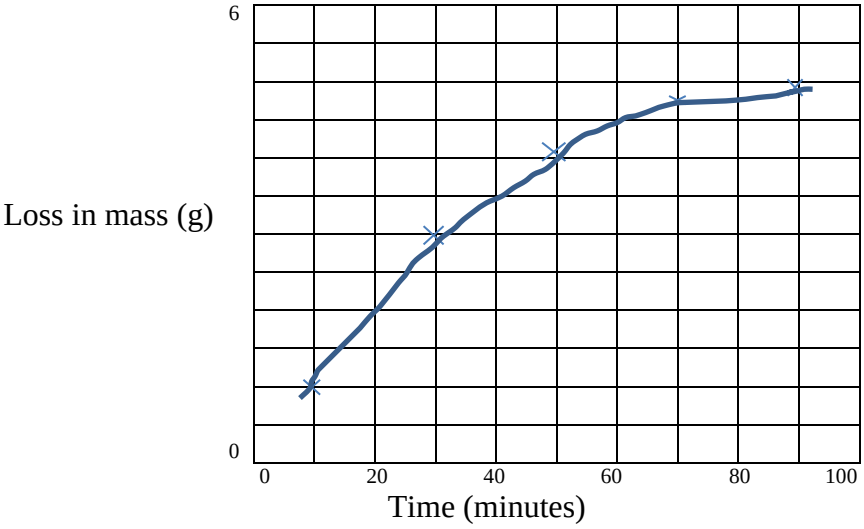
Marking Criteria	Marks
• Identifies the gas as carbon dioxide and • describes the test result	**2**
• Identifies the gas as carbon dioxide OR • describes the test result	**1**

(c)

$$C_6H_{12}O_6\ (aq) \xrightarrow{yeast} 2C_2H_5OH\ (aq) + 2CO_2\ (g)$$

Marking Criteria	Marks
• correct equation with yeast	**2**
• some correct chemistry	**1**

(d) Graph the results of the loss in mass in flask 1 on the grid provided. 2



Marking Criteria	Marks
• correct plots and line of best fit	**2**
• some correct plotting	**1**

(e) Compare the mass lost from flask 1with the mass gain in flask 2 and suggest a reason for this difference. 2

The mass loss from flask 1 is 4.85 g and gain in flask 2 is 3.20 g. The gain is less than the loss from flask 1.
This could be due to CO_2 gas escaping from the system, or to the saturation of the limewater.

Marking Criteria	Marks
• quantitatively compares the mass of the two flasks AND • gives a reason for the difference	**2**
• gives some relevant information	**1**

2.(a)

Requirements/products		Polythene bags	Paper bags
Energy required for production (MJ)		58000	1340000
Air pollution produced (kg)	Sulfur dioxide	198	388
	Oxides of nitrogen	136	204
	Hydrocarbons	76	24
	Carbon monoxide	20	60
	dust	10	64
Waste water discharged (kg)		10	512

Marking Criteria	Marks
• Complete table of data given	**3**
• Some data not tabulated	**2**
• Minimal data tabulated	**1**

(b) *The energy required to produce 1 polythene bag is 0.58 MJ and for one paper bag, 1.34 MJ which is much greater.*

Marking Criteria	Marks
• Quantitatively compares the energy	**2**
• Qualitatively compares the energy	**1**

(c) *The total air pollution produced for 1 million polythene bags is 440 kg and for paper bags, 740 kg, a much greater amount. Therefore the reader's suggestion would not be justified as the use of paper bags produces much more air pollution than the use of polythene bags.*

Calculates both numbers and explains why it is not justified.

Marking Criteria	Marks
• Identifies that the suggestion is not justified • Quantitatively compares the two in terms of pollution produced	**3**
• Identifies that the suggestion is not justified • Compares the two in terms of pollution produced	**2**
• Gives some relevant information	**1**

(d)*The reader suggest paper bags instead as they are made from renewable sources whereas the*

polythene bags are made from non -renewable petrochemicals.

Marking Criteria	Marks
• Identifies the justification given	**1**

Question 3 (5 marks) **Sample Answer :**

	PLA	Starch based resin mixed with polyethylene
advantages	• Natural plastic not made from petrochemicals • Will completely degrade in purpose built compost facilities • Others acceptable from table	• Starch completely degrades in land fill • The combination of starch resin based and polyethylene is much less costly to produce
disadvantages	• Much more costly per kg of production than petrochemical plastics. Slightly less costly than starch based resin however, when this is combined with other polyethylene, PLA would be more costly than the combination of the two. • Will not degrade in normal landfill	• Plastic additives do not degrade in land fill.

Marking Criteria	Marks
• Correctly compares the required plastics • Gives both advantages and disadvantages of the two types of plastics (at least 4)	**5**
• Correctly compares the required plastics • Gives some advantages and disadvantages of the two types of plastics	**4**
• Gives advantages and disadvantages of one of the required plastics • Gives advantages or disadvantages of both types of plastic	**3**
• Gives advantages or disadvantages of one type of plastic	**2**

• Gives some relevant information	**1**

Question 4 (10 marks) **Sample Answers :**

a) Net reaction : $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$

Criteria	Marks
Correct net balanced chemical equation	1

b) A fuel cell does not need to involve a reversible reaction, required for a storage cell. The reactants are supplied to the cell as needed from an external source

Criteria	Marks
Correct outline of differences between a fuel cell and a storage battery	2
Identifying one difference	1

c) A fuel cell is best known for its use in the Gemini, Apollo and Space Shuttle programs. They are light weight and highly efficient delivering the same power as batteries but weighing 10 times less. The only products are water and energy. The energy is used to run the engines and the water can be purified for drinking or reused to fuel the cell (renewable energy source).

Criteria	Marks
Correct explanation of the use of the fuel cell in the space program (advantages)	4
Description of the use of the fuel cell in the space program	3
Outline the use of the fuel cell in the space program	2
Identify the use of the fuel cell in the space program	1

d) 3000kg hydrogen gas consumed in 7 days.

Balanced equation : : $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$

Thus number of moles of hydrogen = 3000,000g / 2.0 g Molar Mass of H_2 = 2.0 g

= 1500,000 moles

From balanced equation 2 mole H_2 produces 2 moles H_2O

Thus y moles of H_2O produced

Mass of H_2O = moles H_2O X molar mass H_2O

= 1500,000 X 18.0g

= 27,000,000 g

Density of H_2O = 1.0g mL^{-1} at 25^0C and 100kPa

Thus volume of water = mass of water = 27,000,000 g = 27,000,000 mL = 27,000 L

Criteria	Marks
Correct calculation of the volume of water produced from the amount of hydrogen gas consumed in 6 days.	4
One error in the calculation	3

Two errors in the calculation	2
Three errors in the calculation	1

Question 5 (9 marks) **Sample Answers :**

(a)

Element	*Protons (P)*	*Neutrons (N)*	*Ratio (P / N)*
Uranium	**142**	**92**	**1.54**
Thorium	**140**	**90**	**1.56**
Radium	**138**	**88**	**1.57**
Radon	**136**	**86**	**1.58**
Polonium	**134**	**84**	**1.60**

Criteria	**Mark**
Correctly calculates the P/N ratio AND Correctly tabulates the no. of protons and neutrons.	2
Correctly calculates the P/N ratio OR Correctly tabulates the no. of protons and neutrons.	1

(b) Uranium > Thorium > Radium > Radon > Polonium

Criteria	**Mark**
Correctly ranks the elements in order of INCREASING stability.	1

(c) The stability of an element is linked to its half-life, where elements with longer half-lives are those which are more stable. The stability in this case is observed to increase as the atomic number and / or mass number increases within elements of the decay series. As there is an increase in the atomic size, there is also an increase in the number of protons and neutrons, however the N / P ratio actually decreases alongside this. Therefore we can conclude that the increase in stability of elements is directly linked to a decrease in N / P ratio.

Or as alpha decay occurs nucleus gets smaller and becomes more stable.

Or as P:N ratio approaches 1 nuclues becomes more stable.

Criteria	**Mark**
Correctly justifies the trend in stability with the following: • Identifies the link between half-life and stability. • Identifies the link between N / P ratio and stability. • Identifies link between N / P ratio and atomic size.	3

(d) Lead – 214 or $^{214}_{82}$Pb

Criteria	**Mark**
Correctly identifies the element as lead-214 with the appropriate isotope number or mass number.	1

(e) According to the observed trend lead should be the least stable element with the shortest half-life since it has the highest N / P ratio of 1.61.

Or the lead isotope is still unstable and will undergo further decay.

Or it is stable as nucleus is smaller than previous element.

Criteria	**Mark**
Correctly predicts that lead-214 is the least stable element since with link made towards it having the highest N / P ratio.	2
Correctly predicts that lead is the least stable element.	1

End of Data Processing Task