

JAMES RUSE AGRICULTURAL HIGH SCHOOL

2019

YEAR 11 EXAMINATION

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Write using black pen
- Draw diagrams using pencil
- NESA approved calculators may be used
- A data sheet, formulae sheet and Periodic Table are provided at the back of this paper
- For questions in Section II, show all relevant working in questions involving calculations

Section I – 20 marks (pages 3–10) • Attempt Questions 1–20

- Allow about 35 minutes for this section

Section II – 60 marks (pages 12–22) • Attempt Questions 21–32

- Allow about 1 hour and 25 minutes for this section

Section I

Multiple Choice: 20 marks

Attempt Questions 1-20

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.

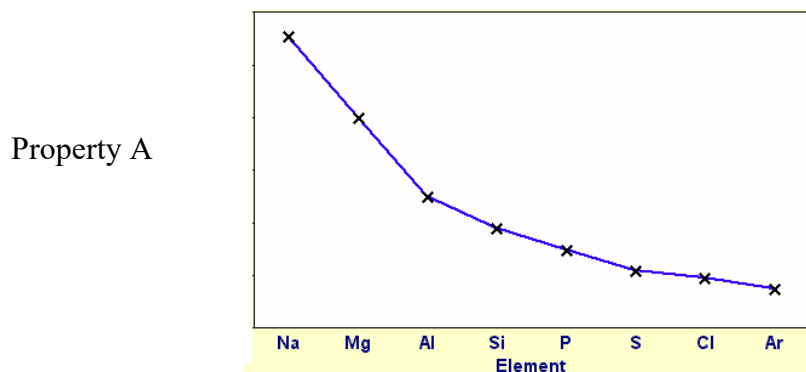
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↙

► Mark your answers for Questions 1 – 20 in the Answer Box on page 11

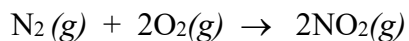
1. Which scientist hypothesized that the energy absorbed or emitted by an electron as it changed energy levels would correspond to a particular wavelength of light?
 - (A) Dalton
 - (B) Rutherford
 - (C) Bohr
 - (D) Schrödinger
2. Which is the most electronegative element?
 - (A) Francium
 - (B) Lithium
 - (C) Fluorine
 - (D) Astatine
3. The graph shows the trend in a particular property across the third period of elements.



Property A is most likely:

- (A) chemical reactivity.
- (B) electronegativity.
- (C) atomic radius.
- (D) atomic mass.

Use the equation to answer the next two questions, 4 and 5

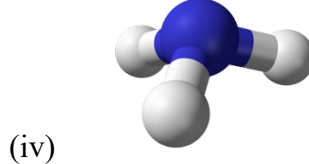
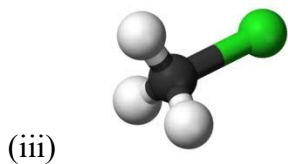
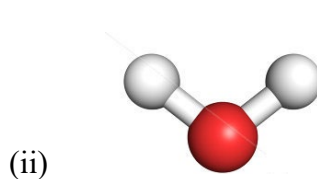
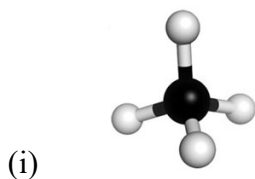


4. What volume of nitrogen dioxide would be produced by the combustion of 1.2 L of nitrogen gas in excess oxygen?
- (A) 1.2 L
 - (B) 2.4 L
 - (C) 0.048 L
 - (D) 0.097 L
5. Whose Law of Combining Volumes is demonstrated in the reaction in question 4?
- (A) Avogadro
 - (B) Boyle
 - (C) Gay-Lussac
 - (D) Charles
6. What are the products of photosynthesis?
- (A) carbon dioxide
 - (B) carbon dioxide, water and oxygen
 - (C) oxygen and glucose
 - (D) oxygen and water

7. What volume of water needs to be added to dilute 10.0 mL of a 0.100 mol L^{-1} solution to a $0.0250 \text{ mol L}^{-1}$ solution?

- (A) 10.0 mL
- (B) 20.0 mL
- (C) 30.0 mL
- (D) 40.0 mL

8. Which of the following compounds have H-bonding between the molecules?



- (A) (i), (ii), (iii) and (iv)
- (B) (ii) and (iii)
- (C) (i) and (iv)
- (D) (ii) and (iv)

9. Uranium -238 undergoes a sequence of both alpha and beta decays to finally become a stable isotope of lead.

In the first part of this sequence, what is the isotope produced when Uranium -238 undergoes first an alpha decay then 2 beta decays?

- (A) ${}^{234}_{92}\text{U}$
- (B) ${}^{238}_{92}\text{U}$
- (C) ${}^{234}_{90}\text{Th}$
- (D) ${}^{234}_{91}\text{Pa}$
10. Which chromium oxide contains 68.45% chromium and 31.55% oxygen?
- (A) chromium (II) oxide
- (B) chromium (III) oxide
- (C) chromium (IV) oxide
- (D) chromium (VI) oxide
11. What are the products of complete combustion of ethane, C_2H_6 ?
- (A) Carbon dioxide and water
- (B) Carbon monoxide and water
- (C) Carbon monoxide, soot, and water
- (D) Carbon dioxide, carbon monoxide, soot, and water
12. What volume will 2.0 moles of hydrogen occupy at 150 °C and 100 kPa?
- (A) 24.9 L
- (B) 49.6 L
- (C) 68.9 L
- (D) 70.3 L

13. The image below displays the fruits of the cycad *Macrozamia*, an important food source for the Aboriginal and Torres Strait Islander Peoples. The fruits of this plant are known to be highly toxic and carcinogenic.



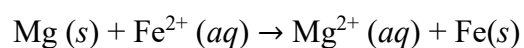
Which of the following procedures is most effective in the removal of toxins from this cycad?

- (A) Allowing the seeds to age sufficiently before consumption.
- (B) Removing the individual seeds from the husk before cooking them with fire.
- (C) Cooking the seeds with fire before leaching them out in running water overnight.
- (D) Removing the individual seeds from the husk and allowing them to dry out in sunlight.

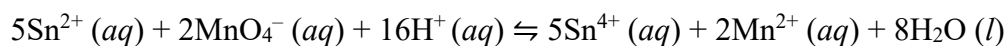
14. Which combination of oxidation and reduction reactions would be spontaneous?

	<i>Oxidation</i>	<i>Reduction</i>
(A)	$\text{Ni (s)} \rightarrow \text{Ni}^{2+} (\text{aq}) + 2\text{e}^{-}$	$\text{Cu}^{2+} (\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu (s)}$
(B)	$\text{Ag (s)} \rightarrow \text{Ag}^{+} (\text{aq}) + \text{e}^{-}$	$\text{Fe}^{3+} (\text{aq}) + \text{e}^{-} \rightarrow \text{Fe}^{2+} (\text{s})$
(C)	$\text{Pb}^{2+} (\text{aq}) + 2\text{e}^{-} \rightarrow \text{Pb (s)}$	$\text{Cu (s)} \rightarrow \text{Cu}^{2+} (\text{aq}) + 2\text{e}^{-}$
(D)	$\text{Cu}^{2+} (\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu (s)}$	$\text{Fe (s)} \rightarrow \text{Fe}^{2+} (\text{aq}) + 2\text{e}^{-}$

15. Which statement is correct for the following reaction?

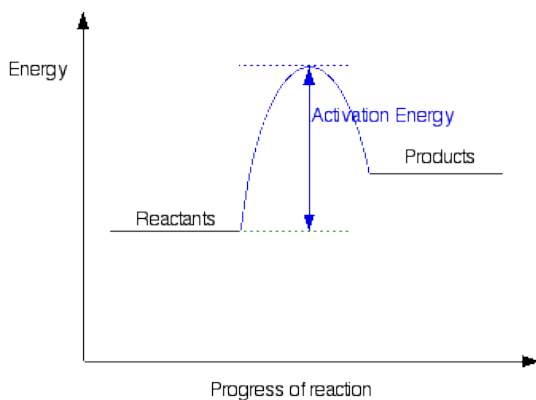


- (A) Mg is the reducing agent because it undergoes reduction.
(B) Mg is the reducing agent because it undergoes oxidation.
(C) Fe^{2+} is the oxidising agent because it undergoes oxidation.
(D) Fe^{2+} is the reducing agent because it undergoes oxidation.
16. Which of the following species decreases in oxidation number?



- (A) Sn^{2+}
(B) MnO_4^{-}
(C) H_2O
(D) H^{+}

17. Which statement best describes the energy profile diagram shown below?



- (A) The products have more energy than the reactants and the surroundings get colder.
- (B) The products have more energy than the reactants and the surroundings get hotter.
- (C) The products have less energy than the reactants and the surroundings get colder.
- (D) The products have less energy than the reactants and the surroundings get hotter.
18. A 10.0 L sample of water (density = 1.0 kg L^{-1}) is contaminated with 10 ppm of lead ions.

What is the mass of lead in this sample?

- (A) 100 mg
- (B) 10 g
- (C) 20 mg
- (D) 1000 mg

19. For each mole of oxygen consumed in complete combustion, which fuel produces the most number of moles of carbon dioxide ?
- (A) Methane, CH_4
 - (B) Ethyne, C_2H_2
 - (C) Ethene, C_2H_4
 - (D) Propane, C_3H_8
20. Which of the following changes will cause a decrease in entropy?
- (A) Ice changing into water
 - (B) Ethanol mixing with water
 - (C) Precipitation of barium sulfate in a solution containing barium ions and sulfate ions.
 - (D) Water boiling

Student No.

Total Mark

Multiple Choice Answer Sheet

Section I : Allow 30 minutes for this part

- | | | | | |
|-----|-------------------------|-------------------------|-------------------------|-------------------------|
| 1. | A ☐ | B ☐ | C ☐ | D ☐ |
| 2. | A ☐ | B ☐ | C ☐ | D ☐ |
| 3. | A ☐ | B ☐ | C ☐ | D ☐ |
| 4. | A ☐ | B ☐ | C ☐ | D ☐ |
| 5. | A ☐ | B ☐ | C ☐ | D ☐ |
| 6. | A ☐ | B ☐ | C ☐ | D ☐ |
| 7. | A ☐ | B ☐ | C ☐ | D ☐ |
| 8. | A ☐ | B ☐ | C ☐ | D ☐ |
| 9. | A ☐ | B ☐ | C ☐ | D ☐ |
| 10. | A ☐ | B ☐ | C ☐ | D ☐ |
| 11. | A ☐ | B ☐ | C ☐ | D ☐ |
| 12. | A ☐ | B ☐ | C ☐ | D ☐ |
| 13. | A ☐ | B ☐ | C ☐ | D ☐ |
| 14. | A ☐ | B ☐ | C ☐ | D ☐ |
| 15. | A ☐ | B ☐ | C ☐ | D ☐ |
| 16. | A ☐ | B ☐ | C ☐ | D ☐ |
| 17. | A ☐ | B ☐ | C ☐ | D ☐ |
| 18. | A ☐ | B ☐ | C ☐ | D ☐ |
| 19. | A ☐ | B ☐ | C ☐ | D ☐ |
| 20. | A ☐ | B ☐ | C ☐ | D ☐ |

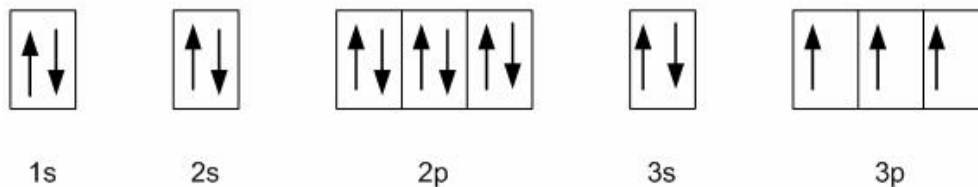
Section II - 60 marks**Attempt questions 21 - 32****Allow about 90 minutes for this part**

► 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

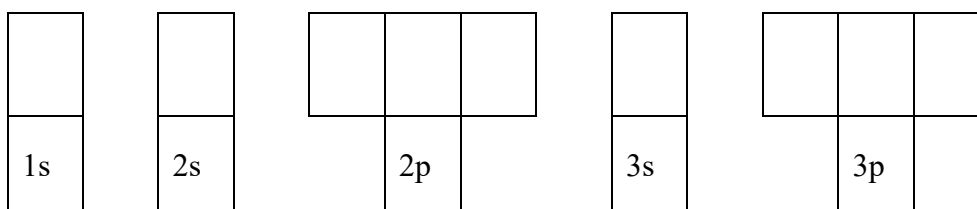
Question 21 (4 marks)

Below is the orbital diagram for phosphorus.

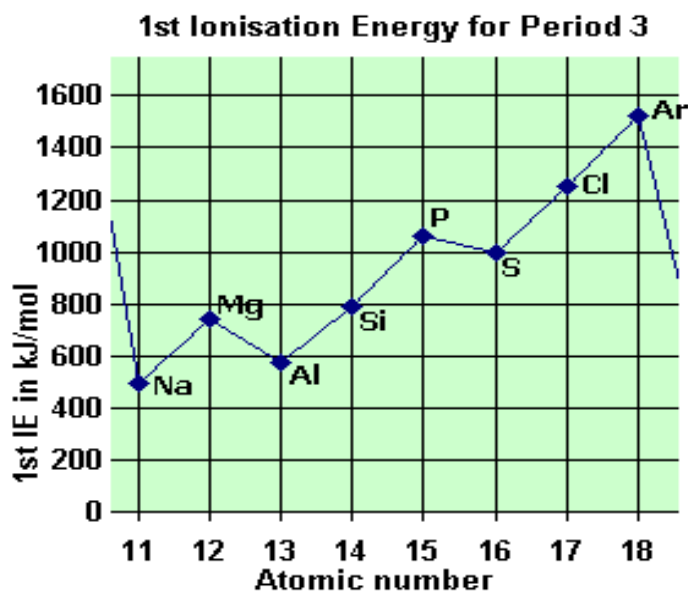


(a) Complete the orbital diagram for sulfur.

1



(b) The first ionisation energies of the elements in the third period are shown in the graph.



Question 21 continued on the next page

Explain the difference in first ionisation energy between phosphorus and sulfur.

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Question 22 (4 marks)

Explain the characteristics of the two chlorides given below.

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<i>Compound</i>	<i>Melting Point °C</i>	<i>Conductivity when molten</i>
XCl ₂	714	good
YCl ₂	-121	poor

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Question 23 (4 marks)

Carbon has both allotropes and isotopes.

Compare and contrast:

(a) TWO allotropes of carbon.

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(b) TWO isotopes of carbon

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Question24 (7 marks)

Copper (II) hydroxide can be precipitated from the reaction of copper (II) chloride solution with sodium hydroxide solution.

- (a) Write the net ionic equation for the precipitation reaction. 2

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- (b) Calculate the mass of precipitate formed when 20.0 mL of 0.100 mol L⁻¹ of copper (II) chloride solution is added to 30.0 mL of 0.200 mol L⁻¹ sodium hydroxide solution. 3

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- (c) Calculate the concentration of the chloride ions in the final solution. 2

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Question 25 (3 marks)

A student performed a series of experiments to investigate the solubility of silver salts. He tested the reactions of a 0.1 mol L^{-1} silver nitrate solution with 0.1 mol L^{-1} solutions of magnesium hydroxide, magnesium chloride, and magnesium sulfate and obtained the following table of results:

	<i>Observation</i>
Magnesium hydroxide	No reaction
Magnesium chloride	White precipitate
Magnesium sulfate	No reaction

- (a) Write a balanced chemical equation for the reaction with magnesium chloride. 2

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- (b) Name the white precipitate. 1

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Question 26 (1 marks)

A series of experiments were conducted to demonstrate the reactivity of different metals. Samples of four different metals (W, X, Y, and Z) were placed into separate beakers containing water, boiling water (to represent steam) and dilute hydrochloric acid. The results are recorded in the table below:

<i>Metal</i>	<i>Reactant</i>		
	<i>Water</i>	<i>Steam</i>	<i>Dilute Acid</i>
W	No reaction	Mild reaction producing H_2 gas	Mild reaction producing H_2 gas
X	Mild reaction producing H_2 gas	Rapid reaction producing H_2 gas	Violent reaction producing H_2 gas
Y	No reaction	No reaction	No reaction
Z	No reaction	No reaction	Mild reaction producing H_2 gas

- Rank the metals from MOST to LEAST reactive. 1

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Question 27 (4 marks)

Explain the relationship between atomic radius and ionization energy with metal reactivity down Group 2 of the Periodic Table.

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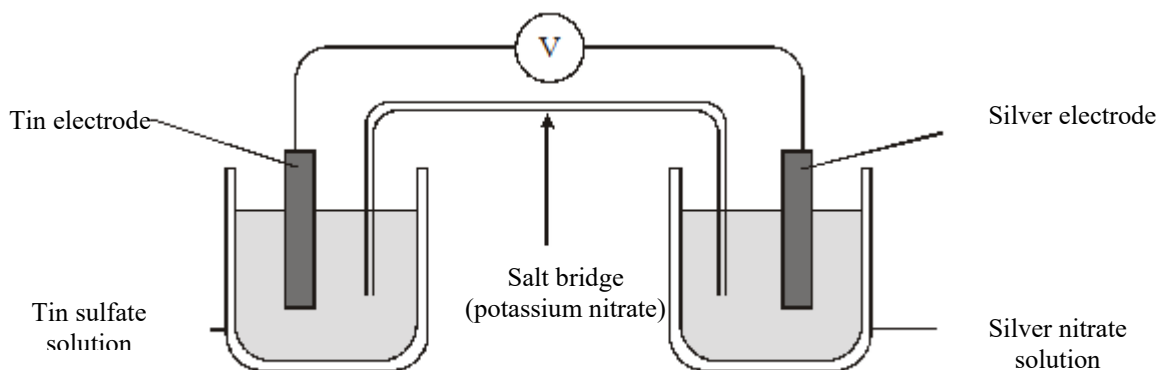
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Question 28 (3 marks)

A galvanic cell was assembled as shown below.



- (a) Indicate the direction of electron flow with a labelled arrow on the diagram. 1
- (b) Label the anode and the cathode. 1
- (c) Indicate the direction of anion flow with a labelled arrow. 1

Question 29 (2 marks)

Catalysts are chemicals which are often used in chemical reactions. 2

Explain how the use of a catalyst affects the rate of a reaction.

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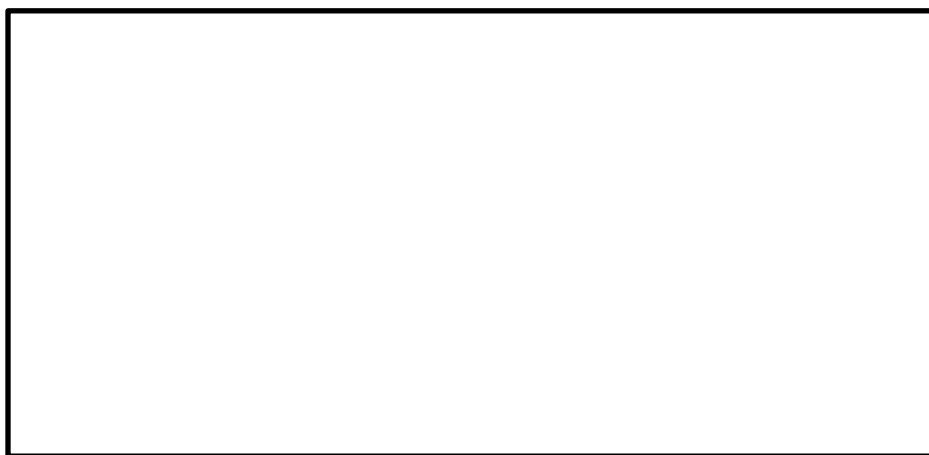
Question 30 (8 marks)

A student conducted an experiment to measure the enthalpy change when 1.00 g of solid ammonium nitrate was dissolved in 50.0 mL of deionised water. The student measured the initial and final temperature of the water and recorded their results in the table below:

Mass of water	50.0 g
Mass of ammonium nitrate	1.00 g
Initial temperature of water	21.6 °C
Final Temperature of water	20.2 °C
Temperature Change	1.40 °C

- (a) Draw a labelled diagram of the set up for this experiment.

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- (b) Calculate the molar heat of solution of ammonium nitrate.

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- (c) Outline ONE possible source of error in this experiment.

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Question 31 (12 marks)

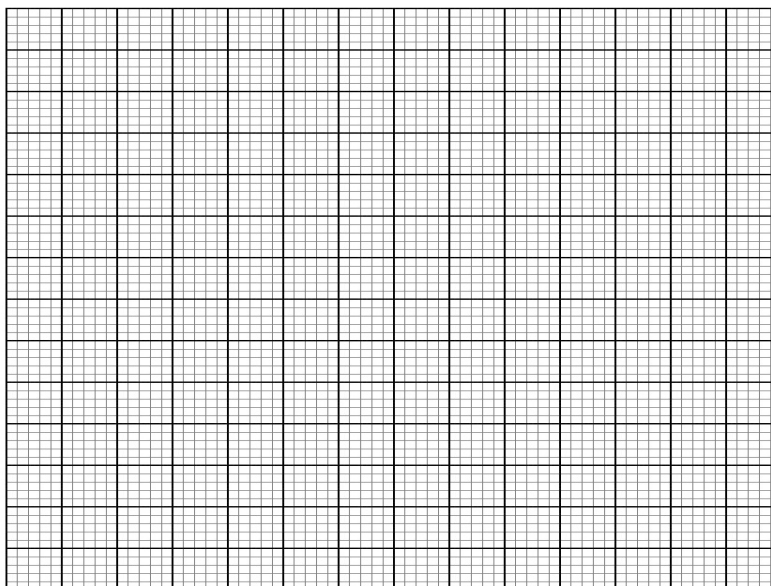
A student carried out a set of first-hand investigations in which 5.00g of calcium carbonate was reacted with excess hydrochloric acid at 25⁰ C and 100 kPa. The volume of carbon dioxide gas produced was measured at regular time intervals in each experiment.

In one experiment calcium carbonate was supplied as marble chips and in another experiment, as a powder.

The results of the two experiments are tabulated below :

<i>Time (s)</i>	<i>Experiment A</i> <i>Volume of CO_{2(g)} produced (mL)</i>	<i>Experiment B</i> <i>Volume of CO_{2(g)} produced (mL)</i>
0	0.00	0.00
10	60.0	15.0
20	78.0	30.0
30	85.0	42.0
40	90.0	56.0
50	90.0	68.0
60	90.0	80.0
70	90.0	90.0
80	90.0	90.0
90	90.0	90.0

- (a) Construct a graph of volume of CO_{2(g)} against time for each investigation and draw TWO lines of best fit on the grid. 5



Question 31 continued on next page

(b) Label the lines as Experiment A for the use of marble chips and Experiment B for the use of powdered calcium carbonate. **1**

(c) (i) Which experiment had the faster reaction? **1**

(ii) Explain why one reaction was faster than the other? **1**

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(d) Calculate the maximum mass of carbon dioxide produced for the reactions. **3**

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(e) Why did both experiments produce the same volume of carbon dioxide? **1**

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Question 32 (8 marks)

The enthalpy changes for many thermochemical reactions cannot be accurately determined in the school laboratory. However the heats of formation for individual chemical species are known and so enthalpies for complex reactions can be calculated, using Hess' Law.

- (a) State Hess's Law. 2

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- (b) Given these heats of formation, ΔH_f : 4

<i>Chemical</i>	<i>ΔH_f (kJ mol⁻¹)</i>
C ₂ H _{2(g)}	+226
CO _{2(g)}	-393
CO _(g)	-115
H ₂ O _(l)	-286

Calculate the enthalpy change for the combustion of :

- (i) 1 mole of ethyne, C₂H₂ to produce carbon dioxide and water.

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- (ii) 1 mole of ethyne, C₂H₂ to produce carbon monoxide and water.

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- (c) Explain the difference in values determined in (b). 2

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End of Theory Exam

Part B extra writing space.

If you use this space, clearly indicate which question you are answering.

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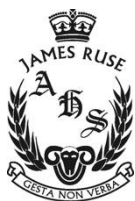
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Answers

JAMES RUSE AGRICULTURAL HIGH SCHOOL

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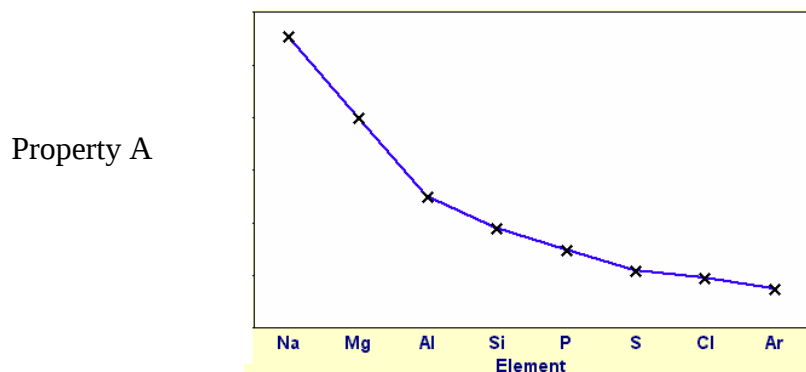
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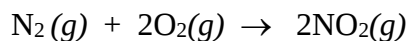
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- (A) Dalton
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- (C) **Bohr**
- (D) Schrödinger
2. Which is the most electronegative element?
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- (C) **Fluorine**
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3. The graph shows the trend in a particular property across the third period of elements.



Property A is most likely:

- (A) chemical reactivity.
- (B) electronegativity.
- (C) **atomic radius.**
- (D) atomic mass.

Use the equation to answer the next two questions, 4 and 5

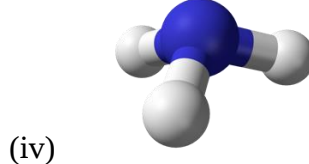
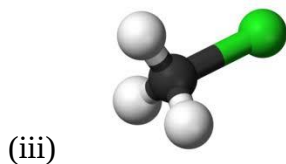
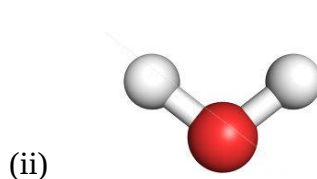
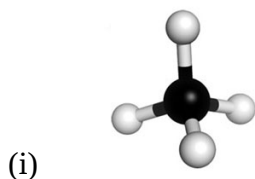


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- (C) Gay-Lussac**
- (D) Charles
6. What are the products of photosynthesis?
- (A) carbon dioxide
- (B) carbon dioxide, water and oxygen
- (C) oxygen and glucose**
- (D) oxygen and water

7. What volume of water needs to be added to dilute 10.0 mL of a 0.100 mol L^{-1} solution to a $0.0250 \text{ mol L}^{-1}$ solution?

- (A) 10.0 mL
- (B) 20.0 mL
- (C) 30.0 mL**
- (D) 40.0 mL

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- (A) (i), (ii), (iii) and (iv)
- (B) (ii) and (iii)
- (C) (i) and (iv)
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In the first part of this sequence, what is the isotope produced when Uranium -238 undergoes first an alpha decay then 2 beta decays?

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- (D) Carbon dioxide, carbon monoxide, soot, and water
12. What volume will 2.0 moles of hydrogen occupy at 150 °C and 100 kPa?
- (A) 24.9 L
- (B) 49.6 L
- (C) 68.9 L
- (D) 70.3 L**

13. The image below displays the fruits of the cycad *Macrozamia*, an important food source for the Aboriginal and Torres Strait Islander Peoples. The fruits of this plant are known to be highly toxic and carcinogenic.



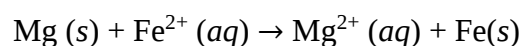
Which of the following procedures is most effective in the removal of toxins from this cycad?

- (A) Allowing the seeds to age sufficiently before consumption.
- (B) Removing the individual seeds from the husk before cooking them with fire.
- (C) **Cooking the seeds with fire before leaching them out in running water overnight.**
- (D) Removing the individual seeds from the husk and allowing them to dry out in sunlight.

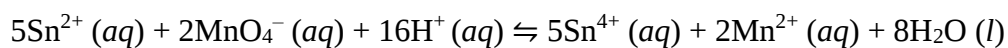
14. Which combination of oxidation and reduction reactions would be spontaneous?

	<i>Oxidation</i>	<i>Reduction</i>
(A)	$\text{Ni (s)} \rightarrow \text{Ni}^{2+} (\text{aq}) + 2\text{e}^{-}$	$\text{Cu}^{2+} (\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu (s)}$
(B)	$\text{Ag (s)} \rightarrow \text{Ag}^{+} (\text{aq}) + \text{e}^{-}$	$\text{Fe}^{3+} (\text{aq}) + \text{e}^{-} \rightarrow \text{Fe}^{2+} (\text{s})$
(C)	$\text{Pb}^{2+} (\text{aq}) + 2\text{e}^{-} \rightarrow \text{Pb (s)}$	$\text{Cu (s)} \rightarrow \text{Cu}^{2+} (\text{aq}) + 2\text{e}^{-}$
(D)	$\text{Cu}^{2+} (\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu (s)}$	$\text{Fe (s)} \rightarrow \text{Fe}^{2+} (\text{aq}) + 2\text{e}^{-}$

15. Which statement is correct for the following reaction?

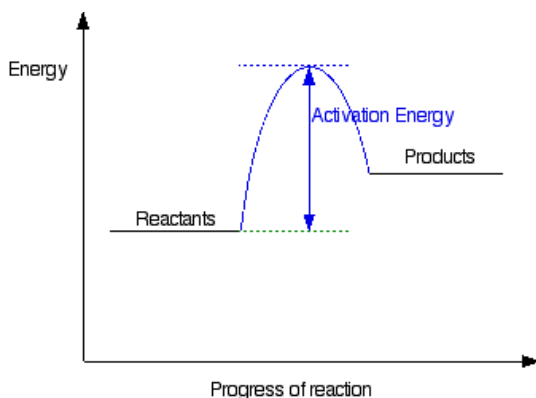


- (A) Mg is the reducing agent because it undergoes reduction.
- (B) Mg is the reducing agent because it undergoes oxidation.**
- (C) Fe^{2+} is the oxidising agent because it undergoes oxidation.
- (D) Fe^{2+} is the reducing agent because it undergoes oxidation.
16. Which of the following species decreases in oxidation number?



- (A) Sn^{2+}
- (B) MnO_4^{-}**
- (C) H_2O
- (D) H^{+}

17. Which statement best describes the energy profile diagram shown below?



- (A) The products have more energy than the reactants and the surroundings get colder.
- (B) The products have more energy than the reactants and the surroundings get hotter.
- (C) The products have less energy than the reactants and the surroundings get colder.
- (D) The products have less energy than the reactants and the surroundings get hotter.
18. A 10.0 L sample of water (density = 1.0 kg L^{-1}) is contaminated with 10 ppm of lead ions.

What is the mass of lead in this sample?

- (A) 100 mg
- (B) 10 g
- (C) 20 mg
- (D) 1000 mg

19. For each mole of oxygen consumed in complete combustion, which fuel produces the most number of moles of carbon dioxide ?
- (A) Methane, CH_4
 - (B) Ethyne, C_2H_2**
 - (C) Ethene, C_2H_4
 - (D) Propane, C_3H_8
20. Which of the following changes will cause a decrease in entropy?
- (A) Ice changing into water
 - (B) Ethanol mixing with water
 - (C) Precipitation of barium sulfate in a solution containing barium ions and sulfate ions.**
 - (D) Water boiling

Student No.

Total Mark

Multiple Choice Answer Sheet

Section I : Allow 30 minutes for this part

- | | | | | |
|-----|------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| 1. | A ☐ | B ☐ | C ☒ | D ☐ |
| 2. | A ☐ | B ☐ | C ☒ | D ☐ |
| 3. | A ☐ | B ☐ | C ☒ | D ☐ |
| 4. | A ☐ | B ☒ | C ☐ | D ☐ |
| 5. | A ☐ | B ☐ | C ☒ | D ☐ |
| 6. | A ☐ | B ☐ | C ☒ | D ☐ |
| 7. | A ☐ | B ☐ | C ☒ | D ☐ |
| 8. | A ☐ | B ☐ | C ☐ | D ☒ |
| 9. | A ☒ | B ☐ | C ☐ | D ☐ |
| 10. | A ☐ | B ☒ | C ☐ | D ☐ |
| 11. | A ☒ | B ☐ | C ☐ | D ☐ |
| 12. | A ☐ | B ☐ | C ☐ | D ☒ |
| 13. | A ☐ | B ☐ | C ☒ | D ☐ |
| 14. | A ☒ | B ☐ | C ☐ | D ☐ |
| 15. | A ☐ | B ☒ | C ☐ | D ☐ |
| 16. | A ☐ | B ☒ | C ☐ | D ☐ |
| 17. | A ☒ | B ☐ | C ☐ | D ☐ |
| 18. | A ☒ | B ☐ | C ☐ | D ☐ |
| 19. | A ☐ | B ☒ | C ☐ | D ☐ |
| 20. | A ☐ | B ☐ | C ☒ | D ☐ |

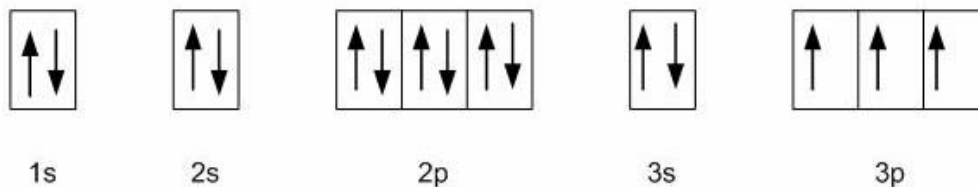
Section II - 60 marks**Attempt questions 21 - 32****Allow about 90 minutes for this part**

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

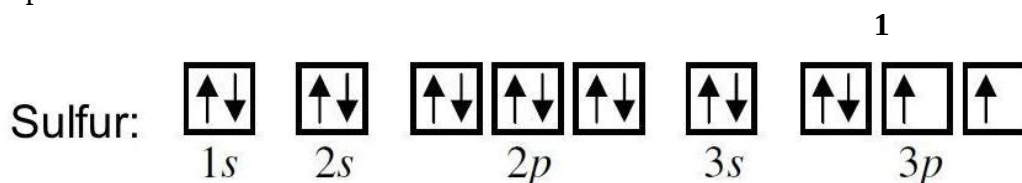
► Show all relevant working in questions involving calculations

Question 21 (4 marks)

Below is the orbital diagram for phosphorus.

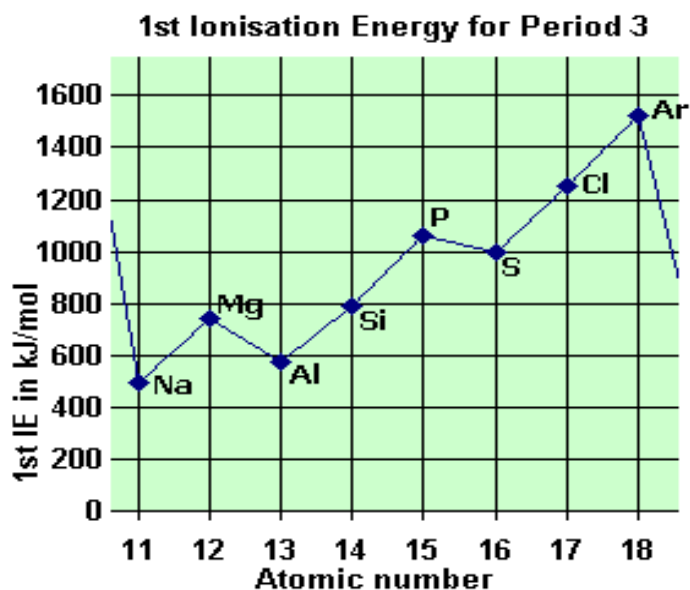


(a) Sample Answer :



Marking Criteria	Mark(s)
Gives the correct orbital diagram for sulfur	1

(b) The first ionisation energies of the elements in the third period are shown in the graph.



Question 21 continued on the next page

Explain the difference in first ionisation energy between phosphorus and sulfur.

3

Sample Answer :The ionisation energy for phosphorus is slightly higher than sulfur going against the general trend. This is because phosphorus has 3 half -filled p orbitals which provide a stable configuration. The extra electron in the sulfur atom is more easily removed so its ionisation energy is lower.

Marking Criteria	Mark(s)
- Identifies the lower ionisation energy for sulfur AND - Explains the lower stability of the p orbitals in sulfur and therefore lower IE	3
- Identifies the lower ionisation energy for sulfur AND - Outlines some information about IE	2
Gives some relevant information	1

Question 22 (4 marks)

Explain the characteristics of the two chlorides given below.

4

Compound	Melting Point °C	Conductivity when molten
XCl ₂	714	good
YCl ₂	-121	poor

Sample Answer :

XCl₂ is an ionic chloride. It's melting point is high as there are strong electrostatic forces between the ions throughout the crystal lattice that need to overcome to melt the solid. When it is molten, the ions are mobile and can transfer charge.

YCl₂ is a covalent molecular chloride. There are only weak dispersion forces between the molecules. These are easily overcome so the melting point is very low. There are no mobile charged particles available in the liquid to transfer charge so it does not conduct.

Marking Criteria	Mark(s)
- Gives a thorough explanation of the four characteristics AND - Identifies the ionic and covalent molecular chlorides.	4
- Identifies the ionic and covalent molecular chlorides AND - Outlines explanations for some characteristics	3
Outlines explanations for some characteristics	2
Gives some relevant information	1

Question 23 (4 marks)

Carbon has both allotropes and isotopes.

Compare and contrast:

(a) TWO allotropes of carbon.

2

(a) Allotropes are different physical arrangements of atoms in an element eg carbon diamond and graphite. Both are made up of carbon atoms, but diamond is very hard because of the 3D crystal lattice and graphite is soft as it is layered with weak dispersion forces between the layers. They have different physical characteristics but the same chemical properties.

(b) TWO isotopes of carbon

2

Sample Answer :

(b)Carbon -12 and carbon-13 are examples of isotopes of carbon. The atoms have the same number of protons but different numbers of neutrons in the nucleus. Carbon- 12 has 6 and carbon-13 has 7.

<i>Marking Criteria</i>	<i>Mark(s)</i>
• Compares and contrast the allotropes and isotopes of carbon AND • Identifies examples of each	4
• Compares and contrast the allotropes and isotopes of carbon	3
• Outlines allotropes and isotopes and how they are different	2
• Gives some relevant information	1

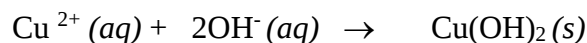
Question24 (7 marks)

Copper (II) hydroxide can be precipitated from the reaction of copper (II) chloride solution with sodium hydroxide solution.

- (a) Write the net ionic equation for the precipitation reaction.

2

Sample Answer :



Marking Criteria	Mark(s)
Correct net ionic equation with states	2
- Balanced general equation given OR - Correct net ionic equation without states	1

- (b) Calculate the mass of precipitate formed when 20.0 mL of 0.100 mol L⁻¹ of copper (II) chloride solution is added to 30.0 mL of 0.200 mol L⁻¹ sodium hydroxide solution.

3

Sample Answer:

$$\text{Mol Cu}^{2+} = c \times V = 0.100 \times 0.020 = 0.002 \text{ mol}$$

$$\text{Mol OH}^{-} = c \times V = 0.200 \times 0.030 = 0.006 \text{ mol}$$

Cu^{2+} limiting reagent therefore

$$\text{Mol Cu}(\text{OH})_2 = 0.002$$

$$\text{Mass Cu}(\text{OH})_2 = n \times \text{MM} = 0.002 \times (63.55 + 2(1.008 + 16)) = 0.195$$

Marking Criteria	Mark(s)
Correct answer with all working shown	3
Some relevant working shown	2
Some correct calculation	1

(c) Calculate the concentration of the chloride ions in the final solution.

2

Sample answer:

$$\begin{aligned}\text{Mol Cl}^- &= 2 \times 0.002 = 0.004 \text{ mol} \\ [\text{Cl}^-] &= n/V = 0.004 / 0.02 + 0.03 = 0.80 \text{ mol L}^{-1}\end{aligned}$$

Marking Criteria	Mark(s)
• Correctly calculates the concentration showing relevant working	2
• Shows some working or correct answer	1

Question 25 (3 marks)

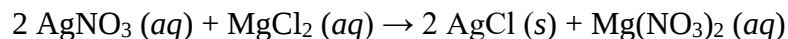
A student performed a series of experiments to investigate the solubility of silver salts. He tested the reactions of a 0.1 mol L^{-1} silver nitrate solution with 0.1 mol L^{-1} solutions of magnesium hydroxide, magnesium chloride, and magnesium sulfate and obtained the following table of results:

	Observation
Magnesium hydroxide	No reaction
Magnesium chloride	White precipitate
Magnesium sulfate	No reaction

(a) Write a balanced chemical equation for the reaction with magnesium chloride.

2

Sample answer:



Criteria	Mark
• Correct balanced chemical equation.	2
• Correct chemical equation (not balanced)	1

(b) Name the white precipitate.

1

Sample answer:

The precipitate is silver chloride

<i>Criteria</i>	<i>Mark</i>
• Identifies the precipitate	1

Question 26 (1 marks)

A series of experiments were conducted to demonstrate the reactivity of different metals. Samples of four different metals (W, X, Y, and Z) were placed into separate beakers containing water, boiling water (to represent steam) and dilute hydrochloric acid. The results are recorded in the table below:

<i>Metal</i>	<i>Reactant</i>		
	<i>Water</i>	<i>Steam</i>	<i>Dilute Acid</i>
W	No reaction	Mild reaction producing H ₂ gas	Mild reaction producing H ₂ gas
X	Mild reaction producing H ₂ gas	Rapid reaction producing H ₂ gas	Violent reaction producing H ₂ gas
Y	No reaction	No reaction	No reaction
Z	No reaction	No reaction	Mild reaction producing H ₂ gas

Rank the metals from MOST to LEAST reactive.

1

Sample answer:

X, W, Z, Y

<i>Criteria</i>	<i>Mark</i>
• Ranks metals from MOST to LEAST reactive.	1

Question 27 (4 marks)

Explain the relationship between atomic radius and ionization energy with metal reactivity down Group 2 of the Periodic Table.

4

Sample answer:

Atomic Radius increases going down a Group as a new electron shell is added to the atom going down a Group.

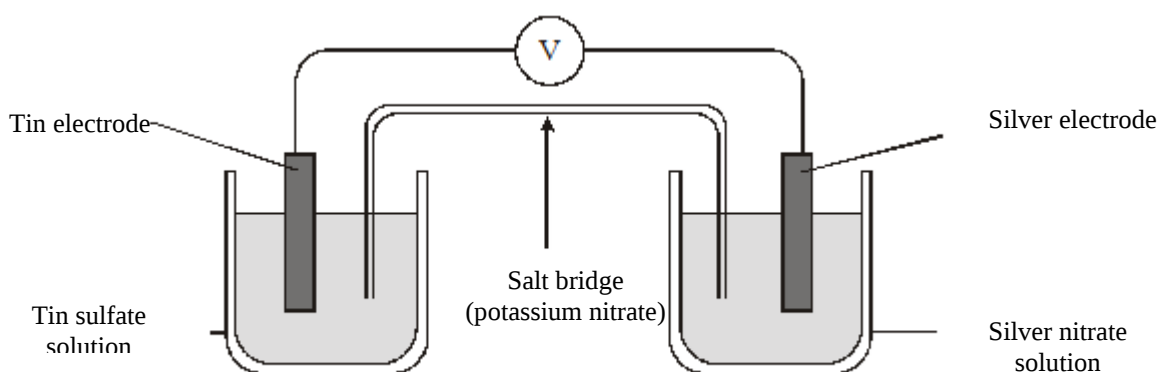
The valence electron is further away from the nucleus and hence the force of the positive nucleus on the valence electron decreases as the electron shell is further away from the nucleus. Thus less energy is required to remove the electron from the valence shell and thus ionization energy decrease down Group 2.

This correlates with an increase in reactivity as it requires less energy to remove the valence electron in the valence shell.

<i>Criteria</i>	<i>Mark</i>
- Explains the relationship between atomic radius and ionisation metal reactivity. - Determines the position of metals along the same period.	4
- Explains the relationship between atomic radius or ionisation energy with metal reactivity. - Determines the position of metals along the same period. OR - Describes the trends in atomic radius and ionisation energy. - Determines the position of metals along the same period.	3
- Describes the trends in atomic radius or ionisation energy. - Determines the position of metals along the same period.	2
Provides some relevant information	1

Question 28 (3 marks)

A galvanic cell was assembled as shown below.



- (a) Indicate the direction of electron flow with a labelled arrow on the diagram. **1**
- (b) Label the anode and the cathode. **1**
- (c) Indicate the direction of anion flow with a labelled arrow. **1**

Sample Answer :

- (a) arrow on conducting wire from tin to silver with e^-
- (b) Anode = tin electrode, Cathode = Silver electrode
- (c) Anions flow from Silver nitrate solution to tin sulfate solution

Criteria	Marks
(a),(b) and (c) correct	3
One error	2
Two errors	1

Question 29 (2 marks)

Catalysts are chemicals which are often used in chemical reactions.

2

Explain how the use of a catalyst affects the rate of a reaction.

Sample Answer :

A catalyst is used to speed up the rate of a chemical reaction by lowering the activation energy and providing a different reaction pathway for the reaction.

Criteria	Mark
Correct explanation of the effect of a catalyst on the rate of a chemical reaction	2
Identification of the effect of a catalyst	1

Question 30 (8 marks)

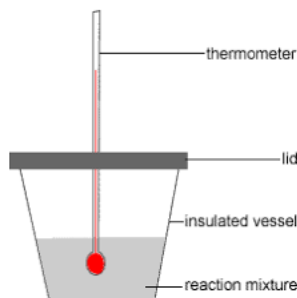
A student conducted an experiment to measure the enthalpy change when 1.00 g of solid ammonium nitrate was dissolved in 50.0 mL of deionised water. The student measured the initial and final temperature of the water and recorded their results in the table below:

Mass of water	50.0 g
Mass of ammonium nitrate	1.00 g
Initial temperature of water	21.6 °C
Final Temperature of water	20.2 °C
Temperature Change	1.40 °C

(a) Draw a labelled diagram of the set up for this experiment.

3

Sample Answer :



Criteria	Mark
Correct, neatly drawn and labelled 2-D diagram	3
One component missing or incorrectly drawn	2
One correct component	1

(b) Calculate the molar heat of solution of ammonium nitrate.

4

Sample Answer : $q = mC \Delta T = 50 \times 4.18 \times 1.4 = 293 \text{ J}$

$n (\text{ammonium nitrate}) = 1.0/80.0 = 0.0125 \text{ mol}$

$q = 293/0.0125 = +23 \text{ kJmol}^{-1}$

Criteria	Mark
Correct calculation showing all working with correct units	4
One error in calculation or units	3
Two errors in calculations	2
One correct calculation	1

(c) Outline ONE possible source of error in this experiment.

1

Sample Answer: Loss of heat to the surroundings or use of tap water instead of demin water or not all solid dissolved or water in cup before adding solid(cup initially not dry).

Criteria	Mark
Outline of ONE correct source of error	1

Question 31 (12 marks)

A student carried out a set of first-hand investigations in which 5.00g of calcium carbonate was reacted with excess hydrochloric acid at 25⁰ C and 100 kPa. The volume of carbon dioxide gas produced was measured at regular time intervals in each experiment.

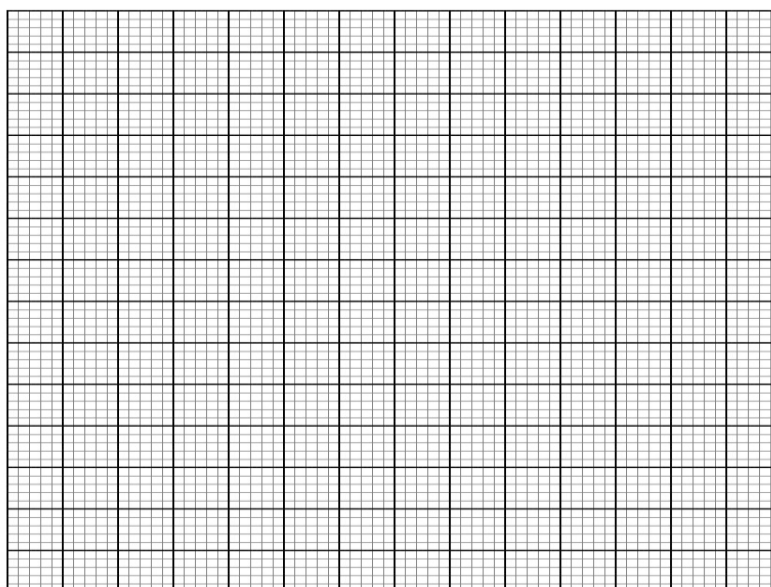
In one experiment calcium carbonate was supplied as marble chips and in another experiment, as a powder.

The results of the two experiments are tabulated below :

<i>Time (s)</i>	<i>Experiment A</i> <i>Volume of CO_{2(g)} produced (mL)</i>	<i>Experiment B</i> <i>Volume of CO_{2(g)} produced (mL)</i>
0	0.00	0.00
10	60.0	15.0
20	78.0	30.0
30	85.0	42.0
40	90.0	56.0
50	90.0	68.0
60	90.0	80.0
70	90.0	90.0
80	90.0	90.0
90	90.0	90.0

- (a) Construct a graph of volume of CO_{2(g)} against time for each investigation and draw TWO lines of best fit on the grid.

5



Criteria	Mark
Correctly labelled axes, scales with units and lines of best fit for both experiments	5
One error in the drawing and /or labelling of either graph	4
Two errors in the drawing and/or labelling of either graph	3
Three errors in the drawing and/or labelling of graphs	2
One correct feature of graph	1

Question 31 continued on next page

- (b) Label the lines as Experiment A for the use of marble chips and Experiment B for the use of powdered calcium carbonate. 1

Sample Answer: Correctly labelled lines for Experiments with A with the steeper gradient.

Criteria	Mark
Correctly labelled lines for each experiment	1

- (c) (i) Which experiment had the faster reaction? 1
- (ii) Explain why one reaction was faster than the other? 1

Sample Answer : (i) Experiment A had the steeper gradient thus the faster rate of reaction.
(ii) Experiment A used the powdered calcium carbonate thus had a greater surface area to react with the acid.

Criteria	Mark
(i) Experiment A	1
(ii) Correct explanation of higher SA gives faster reaction	1

- (d) Calculate the maximum mass of carbon dioxide produced for the reactions. 3

Sample Answer :Maximum volume of carbon dioxide is 90.00 mL

$$n(\text{CO}_2) = \text{Vol}/\text{Vol}_{\text{M at RTP}} = 90.00/ 24.79 =$$

$$m = n \times M = \quad \times 44.00 \text{ g} =$$

Criteria	Mark
Correct calculation showing all working and units	3
One error in calculation	2
One correct calculation	1

- (e) Why did both experiments produce the same volume of carbon dioxide? 1

Sample Answer : Both had the same amount of calcium carbonate reacting with excess hydrochloric acid hence the maximum amount of carbon dioxide for both reactions will be the same as all the calcium carbonate reacted in both Experiments.

Criteria	Mark
Correct explanation for production of carbon dioxide by both experiments	1

Question 32 (8 marks)

The enthalpy changes for many thermochemical reactions cannot be accurately determined in the school laboratory. However the heats of formation for individual chemical species are known and so enthalpies for complex reactions can be calculated, using Hess' Law.

- (a) State Hess's Law. 2

Sample Answers :

(a) Hess' Law - A chemical reaction can be expressed as the algebraic sum of two or more reactions and its heat of reaction is the algebraic sum of the heats of reaction for these separate reactions.

$$\text{OR } \Delta H = \sum \Delta H(\text{products}) - \sum \Delta H(\text{Reactants})$$

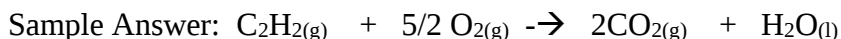
Criteria	Marks
Correct and complete definition of Hess Law	2
One error in definition of Hess Law	1

- (b) Given these heats of formation, ΔH_f : 4

Chemical	ΔH_f (kJ mol ⁻¹)
C ₂ H _{2(g)}	+226
CO _{2(g)}	-393
CO _(g)	-115
H ₂ O _(l)	-286

Calculate the enthalpy change for the combustion of :

- (i) 1 mole of ethyne, C₂H₂ to produce carbon dioxide and water.

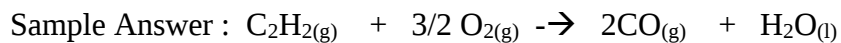


$$\begin{aligned} \Delta H &= \sum \Delta H(\text{products}) - \sum \Delta H(\text{reactants}) \\ &= [2(-393) + (-286)] - (226) = -1298 \text{ kJ} \end{aligned}$$

Thus $\Delta H_{\text{comb}} = 1298 \text{ kJ mol}^{-1}$

Criteria	Mark
Correct calculation	2
One error in calculation	1

(ii) 1 mole of ethyne, C_2H_2 to produce carbon monoxide and water.



$$\Delta H = [2(-115) + (-286)] - (226) = -742 \text{ kJ}$$

Thus $\Delta H_{\text{comb}} = 742 \text{ kJ mol}^{-1}$

Criteria	Mark
Correct calculation	2
One error in calculation	1

(c) Explain the difference in values determined in (b).

2

Sample Answer: The calculated values for (b) show that complete combustion is the more efficient combustion process as more energy is produced per mole of ethyne combusted with excess oxygen than in a limited oxygen supply.

Criteria	Mark
Correct explanation for the difference in values	2
Outline for the difference in values	1

End of Theory Exam

Part B extra writing space.

If you use this space, clearly indicate which question you are answering.

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