



James Ruse Agricultural High School

Theory

Year 11 Preliminary Chemistry Exam 2018

General Instructions

Reading Time: 5 minutes

- **Working Time:** 120 minutes
- Write using black pen
- Board approved calculators may be used
- Write your Student Number at the top of page 9
- A Periodic Table and Data sheet are provided

Total Marks : 76

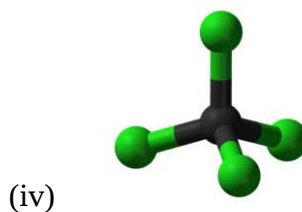
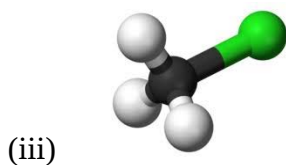
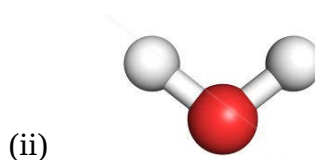
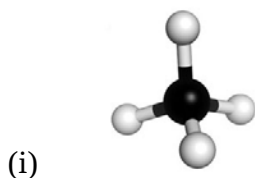
Attempt Questions 1-20

A  B  C  D 

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

1. Which mixture is best separated into its component parts by fractional distillation?
 - (A) sand and salt
 - (B) oil and water
 - (C) sand and small stones
 - (D) hexane C_6H_{14} and decane $C_{10}H_{22}$
2. A compound is found on analysis to have 54.53% carbon, 9.1% hydrogen and 36.32% oxygen. What is the empirical formula of the compound?
 - (A) C_2H_4O
 - (B) $C_4H_8O_2$
 - (C) $C_6H_9O_4$
 - (D) CHO
3. Gallium exists as two isotopes, ^{69}Ga and ^{71}Ga and has a relative atomic mass of 69.72.
What are the isotopic abundances of the two isotopes of Gallium?
 - (A) ^{69}Ga (60.4%) and ^{71}Ga (39.6%)
 - (B) ^{69}Ga (69.0%) and ^{71}Ga (31.0%)
 - (C) ^{69}Ga (50.0%) and ^{71}Ga (50.0%)
 - (D) ^{69}Ga (61.4%) and ^{71}Ga (38.6%)
4. What isotope is produced when Neon-23 undergoes beta decay?
 - (A) $^{24}_{10}Mg$
 - (B) $^{23}_{11}Na$
 - (C) $^{22}_9F$
 - (D) $^{22}_{11}Na$

5. Which element has the highest first ionisation energy?
- (A) oxygen
(B) fluorine
(C) neon
(D) sodium
6. The formula for the dichromate ion is $\text{Cr}_2\text{O}_7^{2-}$. What is the formula for potassium dichromate?
- (A) PCr_2O_7
(B) $\text{P}_2\text{Cr}_2\text{O}_7$
(C) KCr_2O_7
(D) $\text{K}_2\text{Cr}_2\text{O}_7$
7. Identify all the molecules which are polar. Key : H=white O=red C=black Cl=green



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

8. Which of the following pairs represent allotropes?
- (A) 1-chloropropane and 2-chloropropane
 - (B) diamond and graphite
 - (C) $^{14}_6\text{C}$ and $^{13}_6\text{C}$
 - (D) Na^{+1} and F^{-1}
9. What volume of gas is produced when 2.50 g of calcium reacts with water at 25°C and 100 kPa?
- (A) 6.23×10^{-2} L
 - (B) 1.40 L
 - (C) 1.55 L
 - (D) 40.1 L
10. A sample of gas in a sealed flask at 27 °C(300K) and 100 kPa is heated to a temperature of 327 °C(600K). What is the new pressure of the gas?
- (A) 8.26 kPa
 - (B) 80.2 kPa
 - (C) 1211 kPa
 - (D) 2422 kPa
11. Which of the following is a suitable method of a quantitative analysis for the mineral content of a soil sample?
- (A) Gravimetric analysis
 - (B) Atomic Absorption Spectroscopy
 - (C) Flame tests
 - (D) Precipitation reactions

12. Where the most reactive metals found in the Periodic Table?

- (A) At the top left hand side.
- (B) Bottom left hand side.
- (C) Among the transition metals.
- (D) On the far right hand side.

13. W, X, Y and Z represent atoms or ions of four elements.

<i>Atom/Ion</i>	<i>No of Protons</i>	<i>No of neutrons</i>	<i>No of electrons</i>
W	17	20	18
X	19	21	18
Y	17	19	17
Z	20	20	20

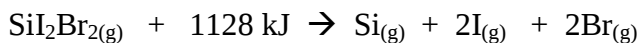
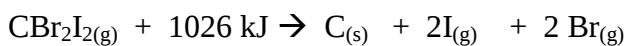
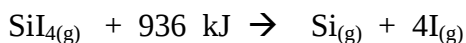
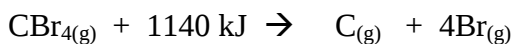
Which two are an ion and an atom of the same element?

- (A) W and X
 - (B) W and Y
 - (C) W and Z
 - (D) X and Z
14. Which substance will form the strongest intermolecular forces with water?
- (A) H_2
 - (B) CH_4
 - (C) CH_3Cl
 - (D) CH_3OH

15. Which statement is the best explanation for the solubility of ionic compounds in water?

- (A) Ion-dipole attraction is greater than ion-ion attraction.
- (B) Dipole-dipole attraction is greater than the ion-ion attraction
- (C) Ion-oxygen attraction is greater than the dipole-dipole attraction
- (D) Ion-hydrogen attraction is greater than the dipole-dipole attraction

16. The equations show the amount of energy needed to separate atoms in four gaseous compounds :



Which atoms have the strongest bonds between them?

- (A) A carbon atom and a bromine atom
- (B) A carbon atom and an iodine atom
- (C) A silicon atom and a bromine atom
- (D) A silicon atom and an iodine atom

17. Four metals, Pb, x, y and z were connected in pairs in a galvanic cell and the voltages recorded. The results obtained are shown below :

<i>Anode</i>	<i>Cathode</i>	<i>Voltage(V)</i>
Pb	x	0.35
y	Pb	1.10
z	Pb	2.60

What is the order of ease of oxidation of the metals from least to most?

- (A) z, y, Pb, x
(B) Pb, x, y, z
(C) x, y, Pb, z
(D) x, Pb, y, z
18. The table gives the heat of combustion in kJ g^{-1} for some fuels.

<i>Fuel</i>	<i>Heat of Combustion (kJ g^{-1})</i>
Methanol	22.7
Ethanol	29.6
Propanol	33.6
Petrol	47.8

The heat of combustion in kJ mol^{-1} for one of the fuels was calculated as 2016 kJ mol^{-1} .

What was the fuel?

- (A) methanol
(B) ethanol
(C) propanol
(D) petrol

19. Combustion is used in the internal engine of some cars today.

Which of the following options best describes this chemical reaction?

	<i>Type of reaction</i>	<i>Enthalpy change</i>
(A)	Endothermic	Positive
(B)	Exothermic	Positive
(C)	Endothermic	Negative
(D)	Exothermic	Negative

20. Which of the following chemical reactions is a possible step in a combustion energy cycle?

- (A) $\text{O}_2 (g) + \text{H}_2 (g) \rightarrow \text{H}_2\text{O}_2 (l)$
- (B) $\text{O} (g) + \text{O} (g) \rightarrow \text{O}_2 (g)$
- (C) $\text{H} (g) + \text{H} (g) \rightarrow \text{H}_2 (g)$
- (D) $\text{O}_2 (g) + 2\text{H}_2 (g) \rightarrow 2\text{H}_2\text{O} (l)$

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Student No.

Total Mark

Multiple Choice Answer Sheet

Part A : Allow 30 minutes for this part

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|-----|-------------------------|-------------------------|-------------------------|-------------------------|
| 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 ☐ |

Part B. 56 marks

Attempt questions 21 - 30

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)

Hydrogen chloride is a gas with a boiling point of -114°C . Lithium chloride is a crystalline solid with a melting point of 610°C .

Account for the observation that both compounds dissolve in water to form solutions that conduct an electric current. Use relevant equations to support your answer.

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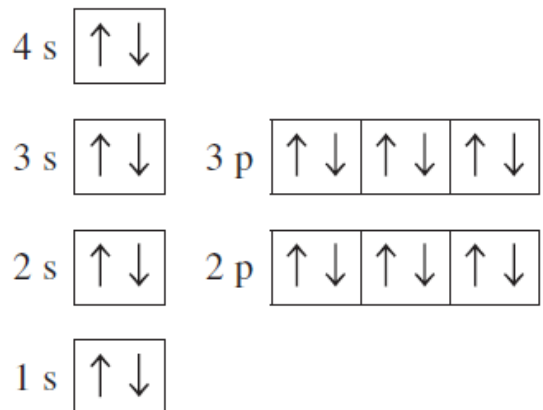
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Question 22 (5 marks)

The electronic configuration of an element is shown.



- (a) Identify and name the valency of the element

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- (b) Explain why ions of this element produce a characteristic flame colour when heated strongly.

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Question 23 (7 marks)

When nickel sulfate solution is added to sodium hydroxide solution, a green precipitate forms.

- (a) Give a full equation for the precipitation reaction. 2

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- (b) Calculate the mass of precipitate formed when 40.0 mL of 0.500 mol L^{-1} of nickel sulfate is added to 60.0 mL of 0.200 mol L^{-1} sodium hydroxide solution. 3

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

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Question 24 (4 marks)

Our understanding of the behaviour of gases has been developed from the investigations of a number of scientists.

Outline how Guy-Lussac, Boyle, Charles and Avogadro contributed to the development of the of the Ideal Gas Law.

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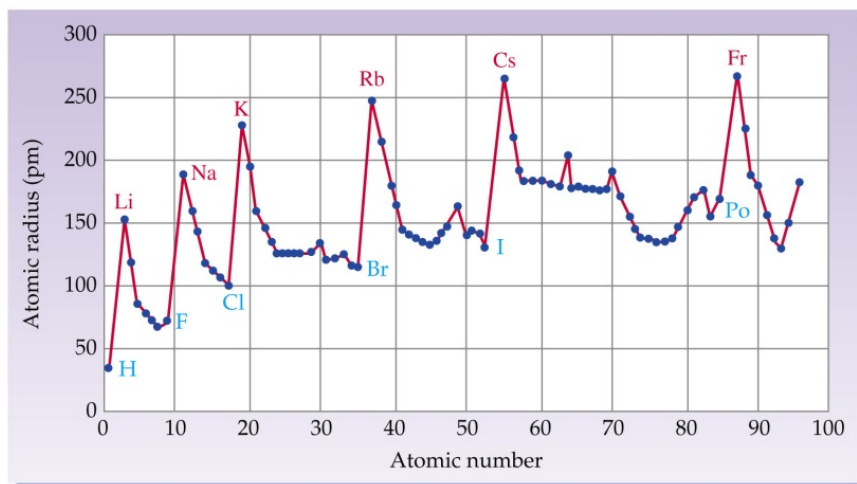
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Question 25 (4 marks)

The graph below shows the trend in changes of atomic radius vs atomic number.



Explain the trends in the graph.

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Question 26 (8 marks)

- (a) Draw and label a diagram a galvanic cell consisting of aluminium in a solution of aluminium ions and nickel in a solution of nickel ions. Label the anode, cathode, direction of electron flow and direction of cation and anion flow.

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- (b) Write the half-equations and the net ionic equation for the cell.

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- (c) Calculate the net E^0 of the cell.

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Question 27 (6 marks)

(a) State the Law of Conservation of Energy.

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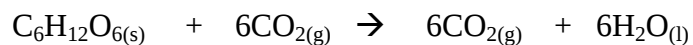
(b) When the Law of Conservation of energy is applied to chemical reactions it is called Hess' Law.

State Hess' Law

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(c) Consider the reaction occurring during respiration :



Given the following heats of summation:

$$\Delta H_f \text{ CO}_2 = -393 \text{ kJ mol}^{-1}$$

$$\Delta H_f \text{ H}_2\text{O} = -286 \text{ kJ mol}^{-1}$$

$$\Delta H_f \text{ C}_6\text{H}_{12}\text{O}_6 = -1256 \text{ kJ mol}^{-1}$$

Calculate the enthalpy change for the respiration reaction.

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Question 28 (6 marks)

A gaseous mixture containing 100 mL of ethane, C_2H_6 and 900 mL of oxygen was ignited with a spark. Assume the volume of each gas was measured at 200°C and 100 kPa.

- (a) Determine the composition by volume of the resultant mixture. 3

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- (b) Calculate the energy liberated by the reaction given that the enthalpy change for the combustion of ethane is $-1557 \text{ kJ mol}^{-1}$ 3

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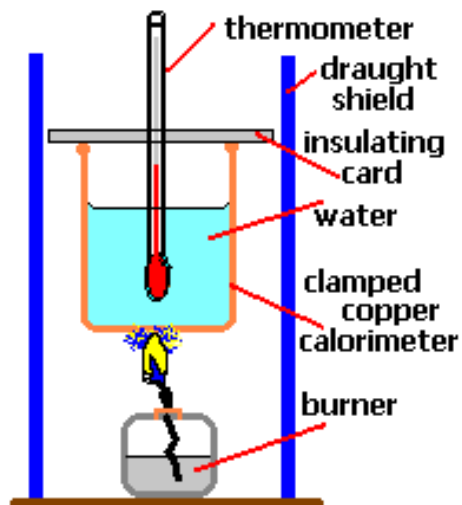
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Question 29 (4 marks)

A student used the apparatus shown to determine the molar heat of combustion of ethanol, $\text{CH}_3\text{CH}_2\text{OH}$.



The following results were obtained :

Initial mass of burner	133.20 g
Final mass of burner	132.05 g
Mass of water	300.00 mL
Initial temperature of water	25 °C
Final temperature of water	45.5 °C

- (a) Calculate the molar heat of combustion of ethanol using the recorded data. 3

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- (b) The accepted value for the molar heat of combustion for ethanol is 1367 kJ mol^{-1} . 1
Account for the difference in the accepted value and the experimental value.

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Question 30 (8 marks)

There are many factors that affect the rate of chemical reactions.

Identify FOUR factors that affect the rate of a chemical reaction.

Describe an example for each factor, in terms of collision theory.

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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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2018 For Students Year 11 chemistry Yearly Exam Answers and Marking Criteria

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

PART B:



Lithium chloride is an ionic solid. Water is polar and causes the solid to dissociate into ions in solution. These mobile ions can then conduct electricity.

$\text{HCl}(g) + \text{H}_2\text{O}(l) \rightarrow \text{Cl}^-(aq) + \text{H}_3\text{O}^+(aq)$ *HCl is a polar covalent molecular gas. When bubbled through water, a polar solvent, water causes the molecule to ionise forming chloride ions and hydronium ions. These mobile ions can then transfer electricity.*

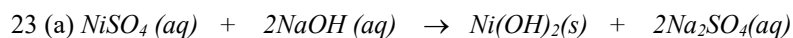
Marking Criteria	Mark(s)
- Accounts for the observation that both solutions conduct - Gives at least one balanced equation to show the formation of the solutions	4 AAE
- Outlines the reasons why both solutions conduct AND - Gives one balanced equation to show the formation of the solutions OR - Accounts for the observation that both solutions conduct	3 RRE AA AE AER AR
- Gives some account of the observations OR - Accounts for the observation that one solution conducts OR - Gives one balanced equation to show the formation of the solution and some other information	2 RR A RE
Gives some relevant information	1 R or E

22 (a) *Calcium*, 2

Criteria	Mark
Correct identification and valency	2
Correct identification OR valency	1

(b) *When a salt of calcium is heated in a Bunsen flame some electrons absorb that energy and jump up to the next energy level and are in an excited state. When they fall back to their original position they give out energy that is emitted as a unique wavelength. This corresponds to a particular colour of light giving the characteristic flame colour for calcium, brick red.*

Marking Criteria	Mark(s)
Explains the characteristic flame colour of calcium	3
Describes how flame colours are produced	2
Outlines how flame colours are produced OR Gives flame colour	1



Criteria	Mark
Complete balanced equation with states	2
Complete balanced equation without states OR identifies $\text{Ni}(\text{OH})_2(s)$	1

(b) $n \text{NiSO}_4 = c \times V = 0.500 \times 0.0400 = 0.020 \text{ mol}$
 $n \text{NaOH} = c \times V = 0.200 \times 0.0600 = 0.012 \text{ mol}$
NaOH is the limiting reagent
 $n \text{Ni(OH)}_2 = \frac{1}{2} \text{ mol NaOH} = \frac{1}{2} \times 0.012 = 0.006 \text{ mol}$
 $\text{mass Ni(OH)}_2 = \text{mol} \times \text{molar mass} = 0.006 \times (58.69 + 2(1.008 + 16)) = 0.556 \text{ g}$

Marking Criteria	Mark(s)
Correct mass calculation showing all relevant working including mole calculations, limiting reagent, molar ratio, mass calculation	3
Most relevant calculations shown	2
Some relevant calculation given	1

(c) $[\text{Na}^{+1}] = \text{mol}/V = 0.012/0.0400 + 0.0600 = 0.120 \text{ molL}^{-1}$

Marking Criteria	Mark(s)
Correctly calculates the concentration of sodium ions	2
Completes some relevant calculation	1

Question 24

Charles carried out experiments to determine the relationship between temperature, pressure and the volume of gases. Gay-Lussac showed that the volume of a fixed amount of a gas, held at the same pressure, is directly proportional to its absolute temperature, measured in kelvins.

He called this relationship Charles' Law, $V \propto T$. Boyle's law states that, for a given mass of a gas at constant temperature, its volume is inversely proportional to the pressure, $P \propto 1/V$ or $PV = \text{constant}$ which leads to $P_1V_1 = P_2V_2$. Avogadro's law states that equal volumes of all gases at the same temperature and pressure, have the same number of molecules. The Ideal Gas Law brings together Charles, Boyles and Avogadro's Laws.

Marking Criteria	Mark(s)
Outlines how the contributions of the 4 scientists contributed to the development of the Ideal Gas Law.	4
Outlines how the contributions of the 3 scientists contributed to the development of the Ideal Gas Law.	3
- Identifies the work of two of the scientists. - Identifies the work of 4 scientists	2
Identifies the work of one of the scientists	1

25. Atomic size gradually decreases from left to right across a period of elements. This is because, within a period or family of elements, all electrons are added to the same shell. However, at the same time, protons are being added to the nucleus, making it more positively charged. The effect of increasing proton number is greater than that of the increasing electron number; therefore, there is a greater nuclear attraction. This means that the nucleus attracts the electrons more strongly, pulling the atom's shell closer to the nucleus. The valence electrons are held closer towards the nucleus of the atom. As a result, the atomic radius decreases.

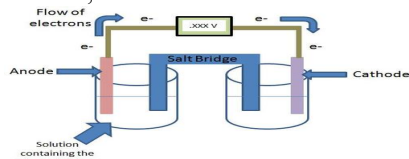
Down a group, atomic radius increases. The valence electrons occupy higher levels due to the increasing quantum number (n). As a result, the valence electrons are further away from the nucleus as 'n' increases. Electron shielding prevents these outer electrons from being attracted to the nucleus; thus, they are loosely held, and the resulting atomic radius is large.

The Group 1 elements are at the peaks as a new shell starts to fill at the start of a new period.

The troughs are Group 8 elements as these have the 8 electrons in the outer shell and the force of attraction between the nucleus and the outer shell electrons are stronger thus the outer shell is pulled closer to the nucleus.

Criteria	Mark
Any TWO trends Clearly explained	4
Any ONE trend clearly explained and ONE trend described	3
Any ONE trend clearly explained and another identified OR Two trends described	2
Any ONE trend identified	1

26 (a) Anode = aluminium, Cathode = nickel, Salt bridge = KNO_3 , anions flow towards anode, cations flow towards cathode, electrons flow from anode to cathode (aluminium to nickel) and appropriate electrolytes



(b) oxidation : $\text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^-$ Reduction : $\text{Ni}^{2+} + 2\text{e}^- \rightarrow \text{Ni}$

Balanced net ionic : $2\text{Al} + 3\text{Ni} \rightarrow 2\text{Al}^{3+} + 3\text{Ni}$

(c) $E_{\text{net}}^0 = 1.68 + (-0.24) = 1.44 \text{ V}$

Criteria	Mark
(a) Complete, neat and correctly labelled galvanic cell showing anode , cathode, salt bridge , electrolyte ,anion and cation flow, electron flow.	4
Any one error	3
Any two errors	2
Any three errors	1
(b) Correct half equations and balanced net ionic equation	3
Any one error If oxidation and reduction equations were reversed but has correct half equations and balanced net ionic equation.	2
Any two errors	1
(c) Complete and correct calculation	1

27 (a) *Energy can neither be created nor destroyed, only transferred or transformed into a different form. The total energy in a closed system remains the same.*

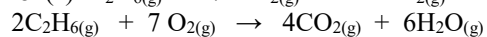
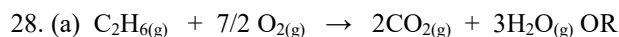
Marking Criteria	Mark(s)
Correctly state the law.	1

(b) The total enthalpy change will remain constant regardless of the steps between the reactants and products within a chemical reaction.

Marking Criteria	Mark(s)
- States that the total enthalpy change is constant. - The total enthalpy is independent of steps within a reaction.	2
States that the total enthalpy change is constant. OR The total enthalpy is independent of steps within a reaction.	1

$$(c) \Delta H = [6(-393) + 6(-286)] - (-1256) \\ = -2818 \text{ kJ mol}^{-1}$$

Marking Criteria	Mark(s)
- Multiplies the values of enthalpy of formation with the respective coefficient from a balanced chemical equation. - Identifies that the $\Delta H_f \text{ O}_2 = 0 \text{ kJ mol}^{-1}$. - Correct positive and negative signs used.	3
- Multiplies the values of enthalpy of formation with the respective coefficient from a balanced chemical equation. - Identifies that the $\Delta H_f \text{ O}_2 = 0 \text{ kJ mol}^{-1}$.	2
Multiplies the values of enthalpy of formation with the respective coefficient from a balanced chemical equation.	1



Ethene is the limiting reagent,

$4(100/2) = 200 \text{ mL}$ of carbon dioxide gas produced

$6(100/2) = 300 \text{ mL}$ of water vapour produced

$7(100/2) = 350 \text{ mL}$ of oxygen gas used

Hence, $900 - 350 = 550 \text{ mL}$ of oxygen gas leftover

Marking Criteria	Mark(s)
- Provides a correct balanced chemical equation. - Identifies that ethane is the limiting reagent AND correctly calculates the volume of BOTH carbon dioxide and water produced. - Correctly calculates the volume of oxygen used AND calculated the oxygen gas leftover.	3
- Provides a correct balanced chemical equation. - Identifies that ethane is the limiting reagent AND correctly calculates the volume of BOTH carbon dioxide and water produced.	2
Provides a correct balanced chemical equation.	1

(b) $PV = nRT$; $n(\text{ethane}) = PV/RT = (100 \text{ kPa} \times 0.100 \text{ L}) / (8.314 \times 473.15 \text{ K}) = 2.54 \times 10^{-3} \text{ mol}$
 $\text{Energy released} = 1557 \times (2.54 \times 10^{-3}) = 3.958 \text{ kJ}$

Marking Criteria	Mark(s)
- Identifies the ideal gas equation AND makes n the subject. - Correct values substituted into the equation. - Multiplies the molar heat of combustion with the identified moles.	3
- Identifies the ideal gas equation AND makes n the subject. - Multiplies the molar heat of combustion with the identified moles.	2
OR - Identifies the ideal gas equation AND makes n the subject. - Multiplies the molar heat of combustion with the identified moles.	1

29. (a) $\Delta H (q) = mc\Delta T = -300 \times 4.18 \times 20.5 = -25.707 \text{ kJ per 1.15g}$

$n(\text{ethanol}) = 1.15 / 46.0 = 0.025 \text{ mol}$

Molar heat of combustion = $25.707 \text{ kJ} / 0.025 \text{ mol} = 1028 \text{ kJ mol}^{-1}$ (1028 to 1030 kJ mol^{-1})

(b) Heat loss to the surroundings resulted in a lower experimental value than accepted value or incomplete combustion.

(a) Correct calculation showing all working for) ΔH_c	Mark
One error in calculation	3
Two errors in calculation	2
Three errors in calculation	1
(b) Suitable reason for the difference in values in accepted and experimental values	1

30. The four major factors that affect the rate of reaction are :

1. Concentration 2. Temperature 3. Catalyst 4. Surface area

Concentration – low concentration does not allow for many successful collisions between particles. However as concentration increases the number of successful collisions increases thus the rate of the reaction will be faster eg more concentrated HCl acid (1.0 mol L^{-1}) reacting with Mg has a faster rate of reaction than using lower concentration of HCl acid (0.1 mol L^{-1})

Temperature – at low temperature the particles have very little kinetic energy to move for successful collisions, however as the temperature rises the kinetic energy of the particles increases hence the number of successful collisions increases thus the rate of the reaction increases eg cross is obscured at a faster time when temperature of HCl acid added to thiosulfate solution is higher (60°C) than at lower temperature (20°C).

Catalyst- chemical reactions require an activation energy to start and the use of a catalyst may lower the activation energy required thus providing an alternative pathway for the reaction thus increasing the rate of the reaction eg use of manganese oxide converts hydrogen peroxide to oxygen and water at a faster rate.

Surface area – the larger the surface area of particles in contact with the reagent, the greater the chance of successful collisions hence the faster the rate of the reaction eg use of powdered calcium carbonate occurs at a faster rate than the use of marble chips with HCl acid.

* Pressure will affect rate of reaction if all reactants and products are gases; if pressure is increased all particles are pushed closer together hence more chance of successful collision eg in Haber Process $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$ an increase in pressure will increase the rate of NH_3 formation and a decrease in pressure causes particles to move further away from each other hence a lower chance of successful collisions.

M.C.

Criteria	Marks
Correct, complete and thorough identification and description of the four different factors that affect rate of reaction with suitable examples for all four factors	8
Correct, complete and thorough identification and description of the four different factors that affect rate of reaction with three examples	7
Correct, complete and thorough identification and description of three factors with 3 examples or four factors with two examples	6
Correct, complete and thorough identification and description of four factor one suitable example	5
Correct, complete and thorough identification and description of four factors without examples	4
Outline of four factors or description of one and outline of three factors	3
Outline of two factors	2
Identification of two factors	1

