

James Ruse Agricultural High School

Theory

Year 11 Preliminary Chemistry Exam 2013

General Instructions

- **Reading Time:** 5 minutes
- **Working Time:** 50 minutes
- Write using black or blue 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 46

Part A

Multiple Choice: 12 marks

Attempt Questions 1-12

Section I

75 marks

Part A – 15 marks

Attempt Questions 1–15

Allow about 30 minutes for this part

Use the multiple-choice answer sheet.

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

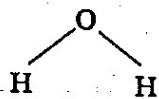
A B C D A B C D A B C D A B C D

► **Mark your answers for Questions 1 – 12 in the Answer Box on page 9**

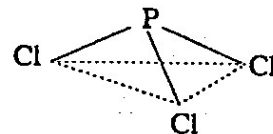
1. What is the number of hydrogen atoms present in 4.0 g of methane, CH_4 ?
- (A) 1.5×10^{23} atoms
(B) 6.0×10^{23} atoms
(C) 2.4×10^{24} atoms
(D) 9.6×10^{24} atoms
2. What is the number of moles of sodium atoms in 16.4 g of sodium phosphate?
- (A) 0.10 mol
(B) 0.30 mol
(C) 10 mol
(D) 30 mol
3. A student weighs a sample of aluminium nitrate and finds that he has 0.15 mol of the compound.
- What mass of nitrogen is present in the sample ?
- (A) 95.85 g
(B) 31.95 g
(C) 6.3 g
(D) 2.1 g

4. Given the following shapes, which of the molecules is NOT polar?

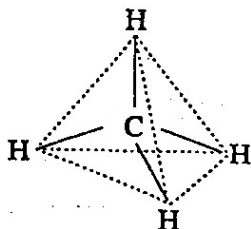
(a) H_2O



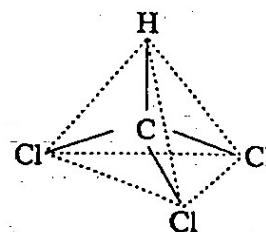
(b) PCl_3



(c) CH_4



(d) CHCl_3



(A) (a)

(B) (b)

(C) (c)

(D) (d)

5. *Below are the simplified solubility rules for some ionic compounds.*

- All group 1 compounds are soluble
- All nitrates are soluble
- All chlorides are soluble *except* PbCl_2 , AgCl , CuCl and Hg_2Cl_2
- All sulfates are soluble *except* BaSO_4 , SrSO_4 and CaSO_4
- All hydroxides are **insoluble** *except* $\text{Ba}(\text{OH})_2$, $\text{Sr}(\text{OH})_2$, $\text{Ca}(\text{OH})_2$, NH_4OH and the hydroxides of group 1 elements

Silver nitrate was added to an unknown colourless liquid. A thick white precipitate formed.

Which of the following could be the identity of the unknown colourless liquid?

(A) NaNO_3

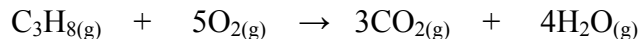
(B) KOH

(C) $(\text{NH}_4)_2\text{SO}_4$

(D) NaCl

6. Which of the following substances dissociate in aqueous solution to produce three moles of ions per mole of dissolved solute?
- (A) K_2SO_4
 - (B) NaNO_3
 - (C) NaCl
 - (D) HClO_4
7. A 4.86 g piece of metal was placed in a measuring cylinder containing 15.5 mL of water. The water level rose to 17.3 mL. What is the density of the metal?
- (A) 2.70 g/mL
 - (B) 0.31 g/mL
 - (C) 0.27 g/mL
 - (D) 3.6 g/mL
8. What volume of 1.5 mol L^{-1} NaOH contains 0.75 mol of NaOH?
- (A) 500 L
 - (B) 5.0 L
 - (C) 500 mL
 - (D) 0.75 L
9. Which of the statements below is the correct definition of ignition temperature ?
- (A) The temperature at which vapour pressure of the fuel equals atmospheric pressure.
 - (B) The temperature at which the fuel/air mixture will spontaneously ignite.
 - (C) The temperature at which the fuel/air mixture can be ignited by a flame or spark.
 - (D) The temperature at which the fuel is rapidly turned into a gas.

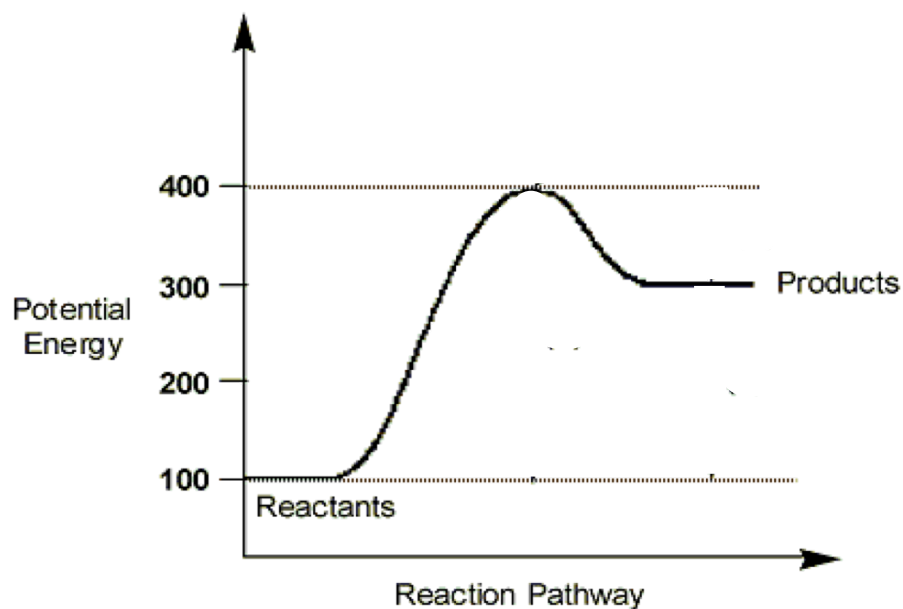
10. Propane is often used as a fuel in portable barbecues. The equation for the reaction is



Which statement below best explains the energy changes which occur in the combustion of propane?

- (A) Exothermic and the total chemical energy of the products is less than that of the reactants.
 - (B) Endothermic and the total chemical energy of the products is less than that of the reactants.
 - (C) Exothermic and the total chemical energy of the products is greater than that of the reactants.
 - (D) Endothermic and the total chemical energy of the products is greater than that of the reactants.
11. Which of the following is the best description of photosynthesis?
- (A) The energy from light is used to take inorganic carbon dioxide and oxygen and convert it into organic sugar and water.
 - (B) The energy from light is used to take inorganic carbon dioxide and sugar and convert it into organic carbon and oxygen.
 - (C) Light energy is absorbed to allow the reaction between carbon dioxide and water to produce oxygen gas and glucose sugar.
 - (D) Light energy causes glucose molecules and oxygen gas to react to produce carbon dioxide and water.

12. The following graph shows an energy profile diagram for a chemical reaction as the reaction proceeds.



Based on the graph, which of the following is a true statement about the reaction?

- (A) The activation energy is 400 units and the reaction is exothermic.
- (B) The activation energy is 300 units and the reaction is exothermic
- (C) The activation energy is 100 units and the reaction is endothermic.
- (D) The activation energy is 300 units and the reaction is endothermic.

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Student No.

Total Mark

Part A: Answer grid for multiple choice questions

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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 ☐ |

Part B. 34 marks

Attempt Questions 13- 20

Allow about 40 minutes for this part

► *Show all relevant working in questions involving calculations.*

Question 13 (5 marks)

A 15.0 g sample of an oxide of nitrogen decomposes to nitrogen and oxygen when heated. All of the oxygen is removed and 3.89 g of nitrogen remains.

Calculate the empirical formula of this compound. Show all your working.

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Question 14 (2 marks)

There are many different pollutants produced during the combustion of fossil fuels.

Identify two other pollutants (besides carbon dioxide) and indicate how they are produced by the combustion processes.

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Question 15 (6 marks)

A student performed an experiment in a school laboratory where he added 0.260 g zinc to 100 mL of 1.00 mol L^{-1} hydrochloric acid at 25°C and 100 kPa.

- (a) Write a balanced chemical equation for the reaction of zinc with hydrochloric acid. (1mk)

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- (b) Calculate the volume of hydrogen gas produced from the above reaction. Show all working. (3 marks)

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- (c) Outline two changes to the experiment that would increase the rate of production of hydrogen gas. (2 marks)

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Question 16 (5 marks)

Use the substances in the following list to complete the table.

Potassium chloride
Silicon dioxide
Nitrogen
Carbon (diamond)
Nickel (II) sulfate

a. Which two substances would you expect to dissolve in water?		
b. Which two would you expect to dissolve in a non polar covalent solvent?		
c. Which two have ionic lattices?		
d. Which two have covalent network structures?		

Question 17 (6 marks)

(a) The following image shows a metal paper clip in a beaker of water.



Explain why water that allows the paper clip to float on it. (4 marks)

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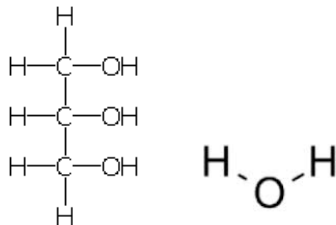
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(b) Below are the structures for glycerol and water.



Explain the difference in viscosity between glycerol and water.(2 marks)

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Question 18 (5 marks)

Sucrose is a molecular organic compound. It has a white crystalline structure and is very soluble in water.

Sodium chloride is very similar in that it is also a white crystalline substance and dissolves easily in water.

Compare the composition of the two substances and give reasons for their solubility in water.

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Question 19 (3 marks)

Outline the energy changes during an exothermic reaction in terms of bond breaking and bond making.

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Question 20 (2 marks)

(a) Write the balanced chemical equation for photosynthesis? (1 mark)

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(b) Outline the major reason why the process of photosynthesis is of great significance to nearly all living things on Earth? (1 mark)

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End of Theory Test

Part A: Answer grid for multiple choice questions

- | | | | | |
|-----|------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| 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 ☒ |

1. What is the number of hydrogen atoms present in 4.0 g of methane, CH₄?

- (A) 1.5×10^{23} atoms
- (B) **6.0×10^{23} atoms**
- (C) 2.4×10^{24} atoms
- (D) 9.6×10^{24} atoms

Outcomes : P10

2. What is the number of moles of sodium atoms in 16.4 g of sodium phosphate?

- (A) 0.10 mol
- (B) **0.30 mol**
- (C) 10 mol
- (D) 30 mol

Outcomes : P10

3. A student weighs a sample of aluminium nitrate and finds that he has 0.15 mol of the compound.

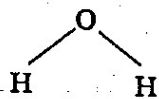
What mass of nitrogen is present in the sample?

- (A) 95.85 g
- (B) 31.95 g
- (C) **6.3 g**
- (D) 2.1 g

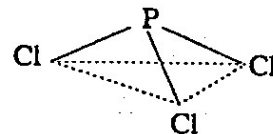
Outcomes : P10

4. Given the following shapes, which of the molecules is NOT polar?

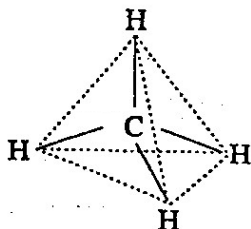
(a) H_2O



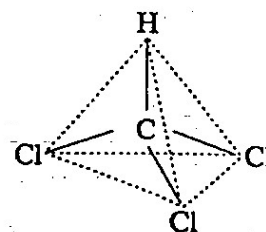
(b) PCl_3



(c) CH_4



(d) CHCl_3



(A) (a)

(B) (b)

(C) (c)

(D) (d)

Outcomes : P6

5. *Below are the simplified solubility rules for some ionic compounds.*

- All group 1 compounds are soluble
- All nitrates are soluble
- All chlorides are soluble *except* PbCl_2 , AgCl , CuCl and Hg_2Cl_2
- All sulfates are soluble *except* BaSO_4 , SrSO_4 and CaSO_4
- All hydroxides are **insoluble** *except* Ba(OH)_2 , Sr(OH)_2 , Ca(OH)_2 , NH_4OH and the hydroxides of group 1 elements

Silver nitrate was added to an unknown colourless liquid. A thick white precipitate formed.

Which of the following could be the identity of the unknown colourless liquid?

- (A) NaNO_3
- (B) K_2SO_4
- (C) $(\text{NH}_4)_2\text{SO}_4$
- (D) NaCl**

Outcomes : P8

6. Which of the following substances dissociate in aqueous solution to produce three moles of ions per mole of dissolved solute?
- (A) K_2SO_4**
 - (B) NaNO_3
 - (C) NaCl
 - (D) HClO_4

Outcomes : P10

7. A 4.86 g piece of metal was placed in a measuring cylinder containing 15.5 mL of water. The water level rose to 17.3 mL. What is the density of the metal?
- (A) 2.7 g/mL**
 - (B) 0.31 g/mL
 - (C) 0.27 g/mL
 - (D) 3.6 g/mL

Outcomes : P10

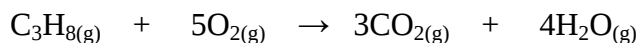
8. What volume of 1.5 mol L^{-1} NaOH contains 0.75 mol of NaOH?
- (A) 500 L
 - (B) 5.0 L
 - (C) 500 mL**
 - (D) 0.75 L

Outcomes : P10

9. Which of the statements below is the correct definition of ignition temperature ?
- (A) The temperature at which vapour pressure of the fuel equals atmospheric pressure.
 - (B) The temperature at which the fuel/air mixture will spontaneously ignite.**
 - (C) The temperature at which the fuel/air mixture can be ignited by a flame or spark.
 - (D) The temperature at which the fuel is rapidly turned into a gas.

Outcomes : P8

10. Propane is often used as a fuel in portable barbecues. The equation for the reaction is



Which statement below best explains the energy changes which occur in the combustion of propane?

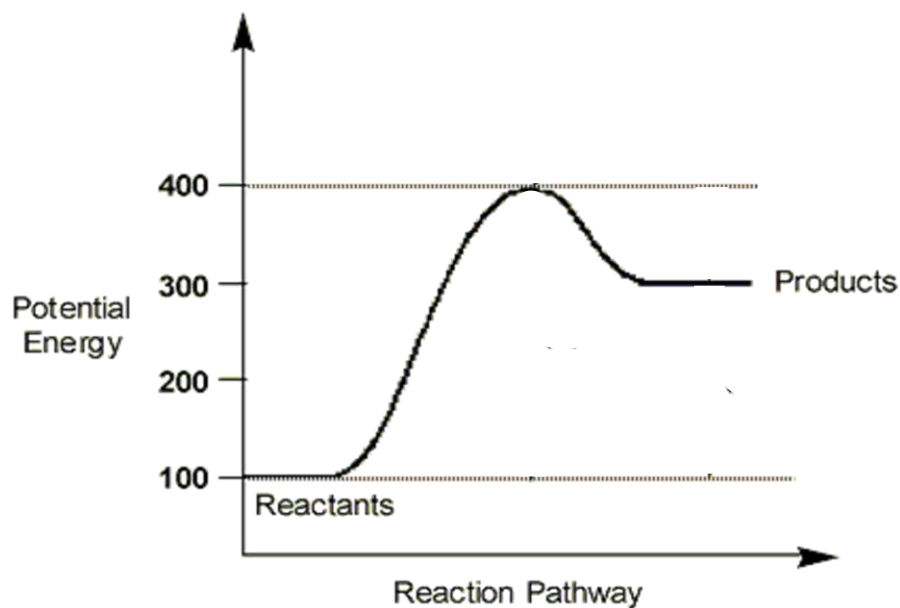
- (A) Exothermic and the total chemical energy of the products is less than that of the reactants.**
- (B) Endothermic and the total chemical energy of the products is less than that of the reactants.
- (C) Exothermic and the total chemical energy of the products is greater than that of the reactants.
- (D) Endothermic and the total chemical energy of the products is greater than that of the reactants.

Outcomes : P7

11. Which of the following is the best description of photosynthesis?
- (A) The energy from light is used to take inorganic carbon dioxide and oxygen and convert it into organic sugar and water.
 - (B) The energy from light is used to take inorganic carbon dioxide and sugar and convert it into organic carbon and oxygen.
 - (C) Light energy is absorbed to allow the reaction between carbon dioxide and water to produce oxygen gas and glucose sugar.**
 - (D) Light energy causes glucose molecules and oxygen gas to react to produce carbon dioxide and water.

Outcomes : P7,P9

12. The following graph shows an energy profile diagram for a chemical reaction as the reaction proceeds.



Based on the graph, which of the following is a true statement about the reaction?

- (A) The activation energy is 400 units and the reaction is exothermic.
- (B) The activation energy is 300 units and the reaction is exothermic
- (C) The activation energy is 100 units and the reaction is endothermic.
- (D) The activation energy is 300 units and the reaction is endothermic.**

Outcomes : P7, P14

Question 13. (5 marks)

A 15.0 g sample of an oxide of nitrogen is heated and decomposes to nitrogen and oxygen.

All of the oxygen is removed and 3.89 g of nitrogen remains.

Calculate the empirical formula of this compound. Show all your working.

Sample Answer :

$$\text{Mass of oxygen} = 15.00 - 3.89 = 11.11 \text{ g}$$

$$n(\text{N}) = 3.89 / 14 = 0.278 \text{ mol}$$

$$n(\text{O}) = 11.11 / 16 = 0.694 \text{ mol}$$

$$\text{Ratio of } n(\text{O}) : n(\text{N}) = 0.694 / 0.278 = 2.5 : 1 \text{ thus simplest ratio is } 5:2$$

Thus empirical formula is N_2O_5

Marking Guidelines

Criteria	Marks
Correct calculations showing all working for mass of oxygen, moles of oxygen and nitrogen and empirical formula	5
Any one of the above incorrect	4
Any 2 of the above incorrect	3
Any 3 of the above incorrect	2
Only 1 correct calculation	1

Outcomes : P10**Question 14** (2 marks)

There are many different pollutants produced during the combustion of fossil fuels.

Identify two other pollutants (besides carbon dioxide) and indicate how they are produced by the combustion processes.

Sample Answer : Any two of the following possible pollutants

Carbon monoxide formed by incomplete combustion of fossil fuels

Carbon particle residues formed as fossil fuel burns incompletely.

Sulfur dioxide formed when sulfur in the fossil fuel burns in air.

Non-combustible mineral ash particles, which may form a smoke if sufficiently small.

Gaseous hydrocarbon compounds, which have not been oxidized during combustion.

Compounds of carbon formed by partial combustion of fossil fuels.

Marking Criteria	Marks
2 correct pollutants and how each is produced	2
1 correct pollutant and how it is produced	1

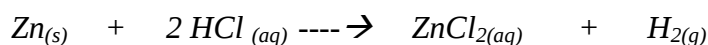
Outcomes : P4.P9

Question 15 (6 marks)

A student performed an experiment in a school laboratory where he added 0.260 g zinc to 100 mL of 1.00 mol L⁻¹ hydrochloric acid at 25°C and 100 kPa.

- (a) Write a balanced chemical equation for the reaction of zinc with hydrochloric acid.

Sample Answer :



Criteria	Mark
Correct balanced equation	1

- (b) Calculate the volume of hydrogen gas produced from the above reaction. Show all working. (3 marks)

Sample Answer :

Balanced equation shows 1:1 mol ratio of Zn : H₂

Thus 0.26 g Zn = 0.26 / 65.4 = 3.98 x 10⁻³ mol of Zn = mol of H₂

Volume of H₂ produced = mol H₂ X 24.79(molar volume of gas at RTP)

= 3.98 X 10⁻³ x 24.79 = 0.0987 L of H₂ gas produced

Marking Criteria	Mark
Correct calculations of H ₂ volume and mol ratios of Zn : H ₂	3
Any one incorrect	2
Any 2 incorrect.	1

- (c) Outline two changes to the experiment that would increase the rate of production of hydrogen gas. (2marks)

Sample Answer :

Any 2 of the following :

- 1. Increase the temperature of the HCl before adding to zinc.*
- 2. Use a HCl of higher concentration*
- 3. Use finely divided pieces of Zinc metal*

Marking Criteria	Marks
2 correct ways to increase rate of reaction	2
1 correct way to increase rate of reaction	1

Outcomes : P8.P10

Question 16. (5 marks)

Use the substances in the following list to complete the table.

Potassium chloride

Silicon dioxide

Nitrogen

Carbon (diamond)

Nickel (II) sulfate

a. Which two substances would you expect to dissolve in water?	Potassium chloride	Nickel (II) sulfate	2 mark
b. Which one would you expect to dissolve in a non polar covalent solvent?	Nitrogen		1 mark
c. Which two have ionic lattices?	Potassium chloride	Nickel(II) sulfate	
c. Which two have covalent network structures?	Silicon dioxide	Carbon (diamond)	2 mark

Question 17 (6 marks)

(a) The following image shows a metal paper clip in a beaker of water.



Explain why water allows the paper clip to float on it. (4 marks)

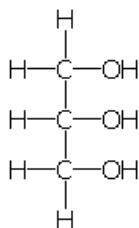
• The water molecules are polar compounds (have a net dipole) (1 mark) AND • Form hydrogen bonds between them. (1 mark) AND • This bonding forms a strongly cohesive layer across the surface of the water. (1 mark) AND • The mass of the paper clip is insufficient force to break through this strongly cohesive layer and hence floats. (1 mark)	4 Marks
• The water molecules are polar compounds (have a net dipole) (1 mark) AND • form hydrogen bonds between them. (1 mark) AND • This bonding forms a strongly cohesive layer across the surface of the water. (1 mark)	3 marks

- The water molecules are polar compounds (have a net dipole) (1 mark) AND - form hydrogen bonds between them. (1 mark) OR - The water molecules are polar compounds (have a net dipole) (1 mark) AND - This bonding forms a strongly cohesive layer across the surface of the water. (1 mark)	2 marks
- The paper clip floats because the water molecules form hydrogen bonds between them. OR - Water molecules form a cohesive layer or skin across their surface.	1 mark

Sample answer

The water molecules are polar compounds (have a net dipole) and form hydrogen bonds between them. This bonding forms a strongly cohesive layer across the surface of the water. The mass of the paper clip is insufficient force to break through this strongly cohesive layer and hence floats.

(b) Below are the structures for glycerol and water.



Explain the difference in viscosity between glycerol and water.

Recognises that glycerol is more viscous than water and relates this to the number of sites where hydrogen bonds form between their molecules.	2 marks
Recognises that glycerol is more viscous than water	1 mark

Sample answer: Glycerol is more viscous than water because it has 3 sites where hydrogen bonds form between their molecules whilst water has 2 sites. Thus holding the molecules more strongly together and increasing their viscosity.

Question 18 (5 marks)

Sucrose is a molecular organic compound. It has a white crystalline structure and is very soluble in water.

Sodium chloride is very similar in that it is also a white crystalline substance and dissolves easily in water.

Compare the composition of the two substances and give reasons for their solubility in water.

Rubric:

- Sucrose is a polar covalent molecule which will form hydrogen bonds with water molecules without ionisation. (1 mark) - The bond with the water molecules disperses the sucrose molecules throughout the solution. (1 mark) - Sodium chloride is an ionic compound that dissociates to form ions Na^+ and Cl^-. (1 mark) - These ions form bonds with the water molecules and disperse the ions throughout the solution. (1 mark) - Refers to the fact that both have a white crystalline structure and are very soluble in water. (1 mark)	5 marks
- Recognises that both substances have similar appearance and behaviour but dissolve differently. (1 mark) AND - Mentions that the difference in solubility results from the fact that sucrose is a polar covalent compound which will	

form hydrogen bonds with water molecules without ionisation. (1 mark) AND • Mentions that the difference in solubility results from the fact that NaCl is a soluble ionic compound. (1 mark) AND These ions form bonds with the water molecules (1 mark)	4 marks
• Recognises that both substances have similar appearance and behaviour but dissolve differently AND • Mentions that the difference in solubility results from the fact that sucrose is a polar covalent compound. AND • Mentions that the difference in solubility results from the fact that NaCl is a soluble ionic compound.	3 marks
• Recognises that both substances have similar appearance and behaviour but dissolve differently AND • Mentions that the difference in solubility results from the fact that sucrose is a polar covalent compound. OR • Recognises that both substances have similar appearance and behaviour but dissolve differently AND • Mentions that the difference in solubility results from the fact that NaCl is a soluble ionic compound.	2 marks
• Recognises that both substances have similar appearance and behaviour but dissolve in different ways.	1 mark

Sample answer: Question does ask for **COMPARE**

In spite of the fact that both substances have a white crystalline structure and are very soluble in water, their solubility occurs for different reasons that are based on their structure. Sucrose is a polar covalent molecule which will form hydrogen bonds with water molecules without ionisation. The bond with the water molecules disperses the sucrose molecules throughout the solution. Sodium chloride is an ionic compound that dissociates to form ions Na^+ and Cl^- . These form bonds with the water molecules which disperse the sucrose molecules throughout the solution.

Question 19. (3 marks)

Describe the energy changes during an exothermic reaction in terms of bond breaking and bond making.

Sample answer

Energy is used to break bonds

Energy is released when bonds are formed.

In an exothermic reaction the energy given out in the formation of the new bonds is greater than the energy being used to break the bonds in the reactants.

Marking Criteria	Mark
Describes the energy changes during an exothermic reaction	3
Outlines the energy changes	2
Identifies that energy is used in bond breaking OR Identifies that energy is released in bond making	1

Outcomes : P2,P7

Question 20. (2 marks)

- (a) Write the balanced chemical equation for photosynthesis? (1 mar
- (b) Outline the major reason why the process of photosynthesis is of great significance to nearly all living things on Earth? (1 mark)

Ques. 2	Marking	Marks
(a)	$6 \text{ CO}_2 + 6 \text{ H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{ O}_2$	1
(b)	Photosynthesis is the <u>main method that energy from sunlight is absorbed</u> and convert to organic molecules that <u>become available for all living things</u> , either directly for autotrophs, or indirectly for heterotrophs	1

Outcomes : P4.P7