

1. Which of the following five statements accurately describes the current simplified atomic model? (3 marks)

- a) Neutrons are positive, while electrons are negative.
- b) The total volume of the nucleus is very small compared to the total volume of the atom.
- c) Electrons revolve within well-defined energy levels arranged around the nucleus.
- d) The mass of an electron is 1840 times greater than that of a neutron.
- e) Neutrons are particles that help keep the nucleus together.

Answers: \_\_\_\_\_

1. Which of the following five statements accurately describes the current simplified atomic model? (3 marks)

- a) The mass of a proton is 1840 times greater than that of an electron.
- b) The ratio of the mass of a proton to that of a neutron is 1.
- c) The maximum number of electrons in the 1<sup>st</sup> three energy levels are: 2, 8, and 16 respectively.
- d) Protons travel within well-defined zones called energy levels.
- e) The nucleus contains protons and neutrons with opposite charges that neutralize each other.

Answers: \_\_\_\_\_

2. Which of the following five statements pertain to metals? (3 marks)

- a) They are dull.
- b) They are malleable.
- c) They are all solids at room temperature.
- d) They do not conduct electricity.
- e) Their position is given in grey in the following periodic table.

Answers: \_\_\_\_\_

The diagram shows a simplified periodic table with the following structure:

- Row 1: 1 cell (Hydrogen)
- Row 2: 2 cells (Helium, Lithium)
- Row 3: 2 cells (Boron, Carbon)
- Row 4: 18 cells (Nitrogen, Oxygen, Fluorine, Neon, Sodium, Magnesium, Aluminum, Silicon, Phosphorus, Sulfur, Chlorine, Argon, Potassium, Calcium, Scandium, Titanium, Vanadium, Chromium, Manganese, Iron, Cobalt, Nickel, Copper, Zinc, Gallium, Germanium, Arsenic, Selenium, Bromine, Krypton, Rubidium, Strontium, Yttrium, Zirconium, Niobium, Molybdenum, Technetium, Ruthenium, Rhodium, Palladium, Silver, Cadmium, Indium, Tin, Antimony, Tellurium, Iodine, Xenon, Francium, Barium, Lanthanum, Cerium, Praseodymium, Neodymium, Promethium, Samarium, Europium, Gadolinium, Terbium, Dysprosium, Holmium, Erbium, Thulium, Ytterbium, Lutetium, Hafnium, Tantalum, Tungsten, Rhenium, Osmium, Iridium, Platinum, Gold, Mercury, Thallium, Lead, Bismuth, Polonium, Astatine, Radon, Francium, Radium, Actinium, Thorium, Protactinium, Uranium, Neptunium, Plutonium, Americium, Curium, Bkeryllium, Californium, Einsteinium, Fermium, Mendelevium, Nobelium, Lawrencium, Rutherfordium, Dubnium, Seaborgium, Bohrium, Hassium, Meitnerium, Darmstadtium, Roentgenium, Copernicium, Nihonium, Flerovium, Tennessine, Oganesson)

The shaded region (transition metals) includes the following elements: Scandium, Titanium, Vanadium, Chromium, Manganese, Iron, Cobalt, Nickel, Copper, Zinc, Gallium, Germanium, Arsenic, Selenium, Bromine, Krypton, Rubidium, Strontium, Yttrium, Zirconium, Niobium, Molybdenum, Technetium, Ruthenium, Rhodium, Palladium, Silver, Cadmium, Indium, Tin, Antimony, Tellurium, Iodine, Xenon, Francium, Barium, Lanthanum, Cerium, Praseodymium, Neodymium, Promethium, Samarium, Europium, Gadolinium, Terbium, Dysprosium, Holmium, Erbium, Thulium, Ytterbium, Lutetium, Hafnium, Tantalum, Tungsten, Rhenium, Osmium, Iridium, Platinum, Gold, Mercury, Thallium, Lead, Bismuth, Polonium, Astatine, Radon, Francium, Radium, Actinium, Thorium, Protactinium, Uranium, Neptunium, Plutonium, Americium, Curium, Bkeryllium, Californium, Einsteinium, Fermium, Mendelevium, Nobelium, Lawrencium, Rutherfordium, Dubnium, Seaborgium, Bohrium, Hassium, Meitnerium, Darmstadtium, Roentgenium, Copernicium, Nihonium, Flerovium, Tennessine, Oganesson.

2. Which of the following five statements are true? (3 marks)

- a) Metals are ductile.
- b) The alkali metals react strongly with oxygen and halogens.
- c) Metalloids have properties of metals and nonmetals.
- d) Nonmetals are poor electrical conductors.
- e) Hydrogen belongs to the family of alkali metals.

Answers: \_\_\_\_\_

3. Complete the following table, giving, where possible, the electron configuration, family name or period number of each element. If necessary, refer to the attached periodic table. (4 marks)

Electron configuration of the element	Family name	Period number
	Halogen	3
	Nitrogen	3
2e 8e		
2e 8e 8e		
2e 8e 4e		
	Alkali metal	3
2e 5e		
2e 8e 8e 2e		
	Alkali metal	2
	Oxygen	2
2e 8e 2e		
2e 8e 3e		
	Noble gas	3

4. a) Use the periodic table attached to find the silicon (Si) isotopes among the elements listed below. (2 marks)

Elements	Number of protons	Number of neutrons	Number of electrons
A	14	14	15
B	13	12	13
C	14	13	14
D	15	14	16
E	13	13	12
F	14	15	13

b) Indicate whether the six elements above are neutral atoms, anions or cations by placing their corresponding letters in the appropriate boxes. (2 marks)

Neutral Atoms	Anions	Cations

4. a) Use the periodic table attached to find the sulphur (S) isotopes among the elements listed below. (2 marks)

Elements	Number of protons	Number of neutrons	Number of electrons
A	16	15	16
B	15	15	16
C	14	15	13
D	17	17	17
E	16	16	17
F	16	17	15

- c) Indicate whether the six elements above are neutral atoms, anions or cations by placing their corresponding letters in the appropriate boxes. (2 marks)

Neutral Atoms	Anions	Cations





6. (4 marks) Match each of the substances in the table below with the appropriate category of a substance. Fill in the table, writing the letter for each category next to the substance it describes.

Categories: A - ~~Solution~~ Homogeneous Mixture  
 B - Element  
 C - Suspension  
 D - ~~Solid mixture~~ Heterogeneous Mixture  
 E - Compound

Substance	Category
Brass ring	
Table salt	
Aluminum wire	
Dairy Queen Smarties Blizzard	
Ocean water	
Dirt	
Vinegar	
White gold bracelet	
V8 juice	

7. Complete the following table, giving either the name or the chemical formula of the compound. The names of the polyatomic ions are given in Appendix. (4 marks)

Chemical formula	Name according to the new nomenclature	Name according to the traditional nomenclature
AsF <sub>5</sub>		
	Barium nitride	
K <sub>2</sub> SO <sub>4</sub>		
CS <sub>2</sub> CrO <sub>4</sub>		
		Aluminum phosphate
	Carbon tetrachloride	
		Sodium acetate
Cr <sub>2</sub> S <sub>3</sub>		

8. Indicate whether, according to the theory of Arrhenius, each of the four substances listed below is an acid, a base, or a salt. Explain your answer. (4 marks)

a)  $\text{BaI}_2$ : \_\_\_\_\_

\_\_\_\_\_

b)  $\text{H}_3\text{BO}_3$ : \_\_\_\_\_

\_\_\_\_\_

c)  $\text{Ca}(\text{OH})_2$ : \_\_\_\_\_

\_\_\_\_\_

d)  $\text{SrO}$ : \_\_\_\_\_

\_\_\_\_\_

e)  $\text{H}_2\text{SO}_4$ : \_\_\_\_\_

\_\_\_\_\_

f)  $\text{PBr}_5$ : \_\_\_\_\_

\_\_\_\_\_

g)  $\text{Fe}_2\text{O}_3$ : \_\_\_\_\_

\_\_\_\_\_

h)  $\text{LiOH}$ : \_\_\_\_\_

\_\_\_\_\_



9. A student conducted laboratory tests using litmus paper and an electrical conductivity detector. The following table shows the results for the five liquids tested:

(4 marks)

	LIQUIDS				
TESTS	A	B	C	D	E
Conducts current	No	+++	+++	+++	+
Red litmus paper turns/remains	Red	Red	Red	Blue	Red
Blue litmus paper turns/remains	Blue	Blue	Red	Blue	Red

On the basis of these results, indicate:

- a) Which liquid is a solution of base and a strong electrolyte? \_\_\_\_\_
- b) Which liquid is a solution of acid and a strong electrolyte? \_\_\_\_\_
- c) Which liquid is a non-electrolyte solution? \_\_\_\_\_
- d) Which liquid is a solution of acid and a weak electrolyte? \_\_\_\_\_
- e) Which liquid is a neutral salt solution? \_\_\_\_\_

9. (4 marks) A student conducted laboratory tests using litmus paper and an electrical conductivity detector. The following table shows the results for the five liquids tested:

	LIQUIDS				
TESTS	A	B	C	D	E
Conducts current	+++	No	+++	+	+++
Red litmus paper turns/remains	Red	Red	Blue	Red	Red
Blue litmus paper turns/remains	Red	Blue	Blue	Red	Blue

On the basis of these results, indicate:

- a) Which liquids are solutions of strong electrolytes? \_\_\_\_\_
- b) Which liquids are solutions of weak electrolytes? \_\_\_\_\_
- c) Which liquid is a salt solution? \_\_\_\_\_
- d) Which liquid could be distilled water? \_\_\_\_\_

10. List the following substances in ascending order of acidity – in other words, from the least acidic to the most acidic. (4 marks)
- a) Nitric acid at  $1 \times 10^{-1}$  mol/L.
  - b) Vinegar has a pH of 3.
  - c) Water is neutral.
  - d) Drano has a  $H^+$  concentration of  $1 \times 10^{-13}$ .

Answer: \_\_\_\_\_

10. List the following substances in ascending order of acidity – in other words, from the least acidic to the most acidic. (4 marks)
- a) Tums have a pH of 10.8.
  - b) Rainwater has a pH of 5.7.
  - c) The  $H^+$  concentration of lemon juice is  $1 \times 10^{-3}$ .
  - d) Barium hydroxide has a  $H^+$  concentration of  $1 \times 10^{-14}$  mol/L.

Answer: \_\_\_\_\_

10. List the following substances in ascending order of acidity – in other words, from the least acidic to the most acidic. (4 marks)
- a) An orange has a  $H^+$  concentration of  $1 \times 10^{-3}$  mol/L
  - b) Maalox has a pH of 11.5.
  - c) Milk is almost neutral.
  - d) An unidentified solution has a  $H^+$  concentration of  $1 \times 10^{-6}$  mol/L.

Answer: \_\_\_\_\_

10. List the following substances in ascending order of acidity – in other words, from the least acidic to the most acidic. (4 marks)
- a) Blood: pH = 7.4
  - b) Hydrochloric acid with a pH = 0
  - c) Pure water
  - d) Tears: pH = 7.2
  - e) Grapes: concentration of  $H^+ = 1 \times 10^{-3}$  M
  - f) Oven cleaner: concentration of  $H^+ = 1 \times 10^{-13}$  M
  - g) Urine: concentration of pH =  $1 \times 10^{-5}$  mol/L

Answer: \_\_\_\_\_



11. Copper (II) nitrate ( $\text{Cu}(\text{NO}_3)_2$ ) decomposes to produce  $\text{CuO}$ ,  $\text{NO}_2$ , and  $\text{O}_2$ . Write the balanced equation that represents this decomposition reaction. Show all steps.  
(4 marks)

11. When propane ( $\text{C}_3\text{H}_8$ ) is combined with oxygen ( $\text{O}_2$ ), it produces carbon dioxide ( $\text{CO}_2$ ) and steam ( $\text{H}_2\text{O}$ ). Write the balanced equation that shows this combustion. Show all steps.  
(4 marks)

11. When iron combines with oxygen gas ( $\text{O}_2$ ) and water, iron (III) hydroxide ( $\text{Fe}(\text{OH})_3$ ) is often produced. Write the balanced equation for this reaction, which shows the production of rust. Show all steps.  
(4 marks)

11. When ammonia gas ( $\text{NH}_3$ ) is burned in the presence of oxygen ( $\text{O}_2$ ), the following products result:  $\text{NO}_2$  and  $\text{H}_2\text{O}$ . Write the balanced chemical equation for this reaction. Show all steps.  
(4 marks)

11. When iron pyrite ( $\text{FeS}_2$ ) is combined with oxygen ( $\text{O}_2$ ), it produces  $\text{Fe}_2\text{SO}_3$  and  $\text{SO}_2$ . Write the balanced equation that represents this combustion.  
(4 marks)

11. When  $\text{C}_2\text{H}_2$  is burned with oxygen ( $\text{O}_2$ ), it gives  $\text{CO}_2$  and water ( $\text{H}_2\text{O}$ ). Write the balanced equation that represents this combustion.  
(4 marks)

11. When phosphorous ( $\text{P}_4$ ) is burned with oxygen ( $\text{O}_2$ ), a gaseous phosphorous oxide ( $\text{P}_2\text{O}_5$ ) is produced. Write the balanced equation that represents this combustion.  
(4 marks)

11. When glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ) is burned in the body, it reacts with oxygen ( $\text{O}_2$ ) to produce carbon dioxide ( $\text{CO}_2$ ) and water ( $\text{H}_2\text{O}$ ). Write the balanced equation that represents this combustion reaction.  
(4 marks)

12. Na and Cl are two elements. (8 marks)

- a) What type of chemical bond exists between these two elements?
  - b) Explain what led you to this conclusion.
  - c) Give the Lewis diagram for each of these elements.
  - d) Give the Lewis diagram of the compound formed by these two elements, as well as its structural formula representation, if applicable.
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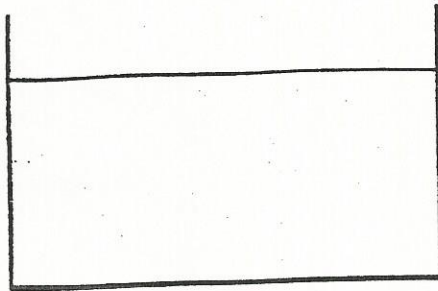
12. N and F are two elements. (8 marks)

- a) What type of chemical bond exists between these two elements?
- b) Explain what led you to this conclusion.
- c) Give the Lewis diagram for each of these elements.
- d) Give the Lewis diagram of the compound formed by these two elements, as well as its structural formula representation, if applicable.



13. A sugar solution does not conduct electricity. (4 marks)

- a) Illustrate, in the vessel shown below, what happens when sucrose ( $C_{12}H_{22}O_{11}$ ) is dissolved in an aqueous solution.

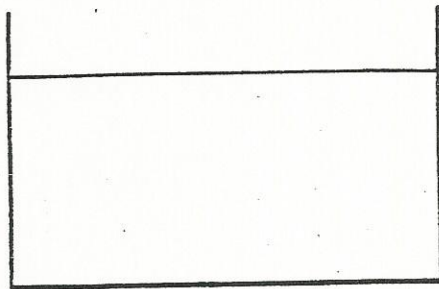


- b) What type of dissolution takes place?

- c) Explain your answer:

13. A nitric acid solution ( $HNO_3$ ) is a good conductor of electricity. (4 marks)

- a) Illustrate, in the vessel shown below, what happens when this acid is dissolved in an aqueous solution.



- b) What type of dissolution takes place?

- c) Explain your answer:

14. Given the following three solutions:

Solution A: 9 mol of  $\text{Ba}(\text{NO}_3)_2$  in 4 L of solution

Solution B: 0.18 mol of  $\text{Ba}(\text{NO}_3)_2$  in 79.6 mL of solution

Solution C: 24 g of  $\text{Ba}(\text{NO}_3)_2$  in 55 mL of solution

Which solution has the highest concentration of  $\text{Ba}(\text{NO}_3)_2$ ? Your answer must include the formula or formulas used and all of the calculations, including a clear indication of the units of measure.

(6 marks)

14. Given the following three solutions:

Solution A: 3 g of  $\text{AlCl}_3$  in 150 mL of solution

Solution B: 3 mol of  $\text{AlCl}_3$  in 15 L of solution

Solution C: 15 g of  $\text{AlCl}_3$  in 1.2 L of solution

Which solution has the highest concentration of  $\text{AlCl}_3$ ? Show all work.

(6 marks)

14. Given the following three solutions:

Solution A: 50 g  $\text{NaNO}_3$  in 0.5 L of solution

Solution B: 0.1 mol  $\text{NaNO}_3$  in 100 mL of solution

Solution C: 0.18 kg  $\text{NaNO}_3$  in 1 L of solution

Which solution has the highest concentration of  $\text{NaNO}_3$ ? Show all work.  
(6 marks)

15. A chemist decides that he wants to prepare ten 250 mL jars of fertilizer. Unfortunately, he has no diluted nitric acid. He decides to prepare some diluted nitric acid by using a concentrated (18 M) solution of nitric acid ( $\text{HNO}_3$ ). He uses 750 mL of this, then adds water until he obtains 5 L.

What is the concentration of the diluted solution of nitric acid? Your answer must include the formula or formulas used and all of the calculations, including a clear indication of the units of measure.  
(4 marks)



15. A housekeeper wants to use an ammonia solution to clean a kitchen. The concentration of ammonia ( $\text{NH}_4\text{OH}$ ) in a 500 mL bottle is 14 mol/L. The housekeeper needs a solution whose concentration of ammonia is 0.2 mol/L, using a spray bottle with a capacity of 12 litres. How much undiluted ammonia should she put in her spray bottle? Your answer must include the formula or formulas used and all of the calculations, including a clear indication of the units of measure. (4 marks)

16. A red solution is always obtained when A, B, or C is added to an unidentified solution. The solution remains colorless when indicator D is added to it. Use the information in the following table to determine the pH range of this solution.

Indicators	Change of color	Turning point
A	Red -> Yellow	From 3.0 to 4.4
B	Red -> Blue	From 5.2 to 8.0
C	Clear -> Red	From 0.2 to 2.0
D	Colorless -> Fuchsia	From 8.2 to 10.0

Include all the steps in your answer.

(4 marks)

16. A blue solution is always obtained when M, N, or O is added to an unidentified solution. The solution is red when indicator P is added to it.

Use the information in the following table to determine the pH range of this solution.

Indicators	Change of color	Turning point
M	Yellow -> blue	From 3.8 to 5.4
N	Red -> blue	From 5.2 to 8.0
O	Blue -> yellow	From 12.0 to 14.0
P	Yellow -> red	From 6.4 to 8.2

Include all the steps in your answer.

(4 marks)

16. A yellow solution is obtained when indicator A or B is added to an unidentified solution. The solution is blue when indicator C or D is added to it. Use the information in the following table to determine the pH range of this solution.

Indicators	Change of color	Turning Point
A	From yellow to blue	From 3.8 to 5.4
B	From yellow to violet	From 7.6 to 9.2
C	From blue to red	From 2.7 to 5.7
D	From blue to colorless	From 4.5 to 9.0

Include all the steps in your answer.

(4 marks)

16. A violet solution is obtained when indicator H or J is added to an unidentified solution. A red solution is obtained when indicator I or K is added to the solution. Use the information in the following table to determine the pH range of this solution.

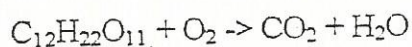
Indicators	Change of color	Turning Point
H	Yellow to violet	From 3.0 to 4.6
I	Yellow to red	From 10.1 to 11.1
J	Yellow to violet	From 5.2 to 6.8
K	Yellow to red	From 6.4 to 8.2

Include all the steps in your answer.

(4 marks)

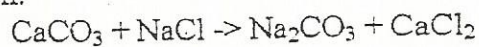


17. By burning 0.73g of sucrose ( $C_{12}H_{22}O_{11}$ ), the human body obtains enough energy for a minute. The combustion of this quantity of sugar is expressed by the following chemical equation:



Two astronauts burn 15 903 grams of sucrose during a 7.5 day flight on a space shuttle. How many moles of oxygen are needed to burn this much sucrose? Your answer must include the formula or formulas used and all of the calculations, including a clear indication of the units of measure. (4 marks)

17. Sodium carbonate ( $Na_2CO_3$ ) is a compound used in the manufacture of glass. Since very little of it is found in nature, it is manufactured using two very abundant components, calcium carbonate (marble) and sodium chloride. The transformation is expressed by the following chemical equation:



How many grams of sodium chloride are required to form 4.5 mol of sodium carbonate ( $Na_2CO_3$ ) ?

Your answer must include the formula or formulas used and all of the calculations, including a clear indication of the units of measure. (4 marks)

18. Sam spilled some drain cleaner ( $\text{NaOH}$ ) on the floor. He decided to attempt to neutralize it before cleaning it up. To this end, he added some vinegar ( $\text{CH}_3\text{COOH}$ ).

a) Write the equation for the reaction.

b)

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b) Why does this reaction have a neutralizing effect?

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(4 marks)

18. TUMS contain calcium hydroxide ( $\text{Ca}(\text{OH})_2$ ). They are used to neutralize stomach acid ( $\text{HCl}$ ). Use equations to explain how the antacid TUMS gives you relief from acid indigestion and heartburn.

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