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VCE Chemistry ½
Models of the Atoms [1.1]
Homework

Homework Outline:

Compulsory	Pg 2 – Pg 9
Supplementary	Pg 10 – Pg 20
Solutions	Pg 02 – Pg 20

Section A: Compulsory Questions (45 Marks)

Sub-Section: [1.1.1] Describe the Composition of an Atom, and write the Isotopic Symbol of an Element/Ion & use it to identify an Element's/Ion's Atomic and Mass Number

Question 1 (1 mark)

a. What is the main conclusion that can be made about atoms from Rutherford's Gold Foil Experiment?

_____

b. Explain how an element can be either an atom or a molecule, giving an example for each case.

_____

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_____

Question 2 (2 marks)

a. What is the difference between an atom and a molecule?

_____

_____

_____

b. For each of the following, state how many neutrons and electrons each atom has and state what type of molecule it is.

i. $^{27}_{13}Al^{+}$ (1 mark)

_____

ii. $^{16}_{8}O^{2-}$ (1 mark)

_____

Question 3 (5 marks)

a. Consider Rutherford's model of the atom.

i. Explain the setup of Rutherford's experiment and his subsequent observations. (3 marks)

_____

_____

_____

_____

ii. Regarding the conclusion, state this conclusion and explain it with reference to the model of an atom. (2 marks)

_____

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b. For Chlorine-35 and Chlorine-37:

i. What are their atomic numbers? (1 mark)

_____

_____

ii. How many neutrons does each atom have? (1 mark)

_____

_____

iii. Write out the isotopic symbol for both of them. (1 mark)

_____

_____

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Sub-Section: [1.1.2] Describe Bohr's Model of the Atom & draw Shell Model diagrams & apply Emission Spectra to Bohr's Model of the Atom

Question 4 (2 marks)

What are two key ideas proposed by Bohr's model of the atom?

_____

_____

_____

Question 5 (3 marks)

a. Consider the Rutherford and Bohr models of the atom. Explain the main differences between Bohr's model and Rutherford's model.

_____

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b. Draw the Bohr shell model diagram for magnesium. (1 mark)

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Question 6 (4 marks)

Consider an atom represented using Bohr's model.

a. When an excited electron exists at $n = 4$, what are all the ways that this electron can fall back to the ground state? (2 marks)

_____

_____

_____

_____

b. How can we tell the difference between whether the electron has chosen a particular path versus another path, out of the ones that you have described? (2 marks)

_____

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Sub-Section: [1.1.3] Explain Schrodinger's Model of the Atom and identify differences between his Model and Bohr's Model

Question 7 (2 marks)

State all the different orbitals and how many electrons can be held in them.

_____

Question 8 (3 marks)

What is the difference between Schrödinger's model of the atom and Bohr's model?

_____

_____

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_____

Question 9 (1 mark)

Which of the following statements about atomic models is NOT correct?

A. Bohr's model suggests that electrons exist in specific energy levels called shells.

B. Schrödinger's model introduces the concept of orbitals, which describe regions of probability for finding an electron.

C. Bohr's model accurately explains the behaviour of all multi-electron atoms.

D. Schrödinger's model incorporates wave mechanics to describe electron behaviour.

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Sub-Section: [1.1.4] Write Electron Configurations of Elements and Ions, in both Ground and Excited States, using both Bohr and Schrodinger Models (including Cu and Cr exceptions and Condensed Notation)

Question 10 (2 marks)

a. Using Bohr's model, write the electron configuration for magnesium. (1 mark)

_____

b. Now, write the Schrödinger electron configuration for magnesium. (1 mark)

_____

Question 11 (2 marks)

a. Write the Bohr electron configuration for copper. (1 mark)

_____

b. Now, write the Schrödinger electron configuration for copper. (1 mark)

_____

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Question 12 (4 marks)

Consider the element of iron.

a. Write the Schrödinger electron configuration for Iron. (1 mark)

_____

b. Write its condensed electron configuration. (1 mark)

_____

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Sub-Section: Final Boss

Question 13 (7 marks)

The models of the atom have evolved significantly over time, from Rutherford to Schrödinger. Each model has provided key insights into how atoms behave and their subatomic particles as well.

a. What are some shortcomings of the Bohr model that Schrödinger's model addressed? (3 marks)

b. Using Bohr's Model, explain how the emission spectrum of hydrogen is produced and describe how the colour of the emission spectrum is determined. (2 marks)

c. Write the isotopic symbol for an atom with 17 protons, 20 neutrons, and a charge of -1. (1 mark)

d. Write the Schrödinger electron configuration of the substance you have described in **part a.** (1 mark)

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Section B: Supplementary Questions (63 Marks)

Sub-Section: [1.1.1] Describe the Composition of an Atom, and write the Isotopic Symbol of an Element/Ion & use it to identify an Element's/Ion's Atomic and Mass Number

Question 14 (2 marks)

a. List out the types of subatomic particles that exist. (1 mark)

_____

b. State how many protons, neutrons and electrons the following has. (1 mark)

$^{39}_{19}K$

_____

Question 15 (4 marks)

a. Explain why not all molecules are elements, giving an example for each case. (2 marks)

_____

_____

b. For each of the following, state how many neutrons and electrons each atom has and state what type of ions it is.

i. $^{24}_{12}Mg^{2+}$ (1 mark)

_____

_____

ii. $^{35}_{17}Cl^{-}$ (1 mark)

_____

_____

Question 16 (3 marks)

a. One student claims that a molecule must always be electrically neutral, but another argues that ions can also form molecules. Who is correct? Justify your answer. (3 marks)

_____

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b. A student argues that the statement that atoms are the smallest possible unit of an element is untrue because of the existence of subatomic particles such as electrons and protons. Evaluate this student's arguments. (3 marks)

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Question 17 (7 marks)

Oxygen gas is found in nature not as O by itself but as O_2.

a. Which observation of Rutherford's experiment mainly supported his findings? (2 marks)

_____

_____

b. What type of substance do we classify oxygen gas as? (1 mark)

_____

c. Suggest a reason as to why oxygen cannot be found naturally as O. (1 mark)

_____

_____

d. A scientist suggested that to create oxygen in a lab by itself, a potential way to do it would be to take an element that did exist by itself, such as Neon with 10 protons, and then just remove the protons to match the atomic number of oxygen. Explain whether this is possible. (3 marks)

Question 18 (6 marks)

Ions can gain or lose electrons while maintaining the same number of protons. For isotopes, the number of neutrons can differ. Consider the following ions:

$$^{31}_{15}P^{3-} \text{ and } ^{37}_{17}Cl^{-}$$

a. How many neutrons does each have? (1 mark)

b. How many electrons does each have? (1 mark)

c. Explain whether an ion can also be a molecule or element, providing examples of each case. (2 marks)

d. A student suggests the idea that because atoms are usually neutrally charged, ions will tend to be extremely unstable. Do you agree with the student? Explain your answer. (2 marks)

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Sub-Section: [1.1.2] Describe Bohr's Model of the Atom & draw Shell Model diagrams & apply Emission Spectra to Bohr's Model of the Atom

Question 19 (1 mark)

a. When an electron falls back down to its ground state after being excited, what occurs, and how is it different for each atom?

_____

_____

b. According to Bohr's model, an electron that moves between $n = 5$ and $n = 2$ emits higher energy light than an electron that falls between $n = 4$ and $n = 2$. Evaluate this statement.

_____

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Question 20 (3 marks)

a. Draw the shell model diagram for an atom of fluorine. (1 mark)

b. How many electrons are in the valence shell of fluorine? (1 mark)

_____

c. Explain the Octet Rule. (1 mark)

_____

_____

Question 21 (2 marks)

a. Explain what happens when an electron is excited past the highest possible shell it can occupy. (1 mark)

_____

b. Suggest a way that we can observe this happening in real life. (1 mark)

_____

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Question 22 (6 marks)

Consider Bohr's model of the atom and how it explains some parts of an atom's behaviour.

a. State a behaviour of the atom that Bohr's model did not prove. (1 mark)

_____

b. What key point of Bohr's model did emission lines on spectra prove? (2 marks)

_____

_____

_____

c. What occurs to the energy that exists between the electron shells as we increase the shell number? (1 mark)

_____

d. As such, if an atom has $n = 5$, what energy transition would you expect to produce violet light? (2 marks)

_____

_____

Sub-Section: [1.1.3] Explain Schrodinger's Model of the Atom and identify differences between his Model and Bohr's Model

Question 23 (2 marks)

What does the Schrödinger model of the atom say about the position of an electron within an atom?

_____

_____

_____

Question 24 (3 marks)

Explain the relationship between the principal quantum number, n, the orbital type, and the total number of electrons that can exist in an energy level.

_____

_____

_____

_____

Question 25 (1 mark)

Which of the following statements about Schrödinger's model is NOT correct?

A. The exact position of an electron can be calculated using Schrödinger's equation.

B. Orbitals are regions of space where there is a high chance of finding an electron.

C. Schrödinger's model introduced the concept of quantum atomic nature.

D. The Schrödinger model uses math equations to describe electron behaviour.

Question 26 (6 marks)

Consider Schrödinger's model of the atom and the orbitals associated with this model.

a. State the composition of the 3^{rd} shell of an atom. (1 mark)

_____

b. Explain what aspect of Schrödinger's model accounts for the behaviour that the $4s$ subshell is filled before the $3d$ subshell is filled. (3 marks)

_____

_____

_____

_____

c. Explain why, when we refer to locations of electrons inside of a particular orbital, we use 'somewhere' instead of having an exact location. (2 marks)

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Sub-Section: [1.1.4] Write Electron Configurations of Elements and Ions, in both Ground and Excited States, using both Bohr and Schrodinger Models (including Cu and Cr exceptions and Condensed Notation)

Question 27 (1 mark)

Write the Bohr and Schrödinger electron configuration for potassium.

_____

_____

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Question 28 (4 marks)

Schrödinger's electron configuration tells us a lot about where the electrons are orientated in an atom.

a. Write the Schrödinger electron configuration for chromium. (1 mark)

_____

b. Explain why chromium's electron configuration is written in that way instead of being conventional. (2 marks)

_____

_____

_____

c. Now, write the electron configuration of a chromium in an excited state. (1 mark)

_____

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Question 29 (6 marks)

The Schrödinger model provides a more comprehensive explanation of an atom's behaviour, focusing on the orbital and subshell concepts. Compared to other models covered, the Schrödinger model is referred to as the most accurate.

a. Explain why the Schrödinger model provides a more accurate representation of the electron arrangement than Bohr's model for elements with more than one electron. (3 marks)

_____

_____

_____

_____

b. Write the Bohr and Schrödinger electron configuration for an atom of titanium. (1 mark)

_____

_____

c. Compare the size of a chlorine atom with the size of a calcium atom. (2 marks)

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