

Chemistry Review

Unit 1 - Atomic Concepts

The Nature of the Atom, Subatomic Particles, Atomic Structure, Energy Levels, Valance Electrons

1. The modern model of the atom has evolved over a long period of time through the work of many scientists.

✓ *Dalton's Model:*

- Elements are made of atoms
- Atoms of an element are the same.
- Compounds are formed from combinations of atoms.

✓ *Rutherford Experiment*

- Bombarded gold foil with alpha particles. Showed atoms were mostly empty space with small, dense positively charged nucleus.

✓ *Bohr Model*

- Small, dense, positively charged nucleus surrounded by electrons in circular orbits.

✓ *Wave-Mechanical Model (Modern Atomic Theory)*

- Small, dense, nucleus positively charged nucleus surrounded by electrons moving in "electron cloud".
"Orbitals" are areas where an electron with a certain amount of energy is *most likely* to be found.

2. Each atom is made of a positively charged nucleus with one or more orbiting, negatively charged electrons.

3. Protons and neutrons are found in the nucleus.

4. Protons have a positive charge, neutrons no charge, and electrons a negative charge.

5. The number of protons in an atom equals the number of electrons.

- ✓ The positive charges of the protons are cancelled by the negative charges of the electrons, so overall an *atom* has a neutral charge.

6. The mass of a proton is 1 amu. The mass of a neutron is 1 amu. The mass of an electron is almost 0 amu.

- ✓ The amu is defined as 1/12 the mass of a Carbon atom.
- ✓ The atomic mass of an atom is equal to the total number of protons and neutrons.

7. Each electron in an atom has its own distinct amount of energy.

- ✓ When all electrons are at their lowest possible energy, it is called the "ground state."
- ✓ Electrons fill in energy levels and orbitals starting with the one that requires the least energy (1s) and progressively move to those levels and orbitals that require increasing amounts of energy.

8. When the electron gains a specific amount of energy, it moves to a higher orbital and is in the "excited state".

9. When an electron returns from a higher energy state to a lower energy state, it emits a specific amount of energy usually in the form of light. This can be used to identify an element (bright line spectrum).

- ✓ The instrument used to see the bright line spectrum is called a spectroscope.

10. The outermost electrons are called valence electrons. These affect the chemical properties of the element.

- ✓ Atoms with a filled valence level are stable.
- ✓ Most elements can have up to 8 electrons in their valence level. The exceptions are H and He, which can have only 2 valence electrons.
- ✓ Atoms form bonds in order to fill their valence levels.
- ✓ You can use orbital notation or Lewis structures to show the configuration of the valence electrons.

11. Atoms of the same element all contain the same number of protons.

- ✓ Changing the number of protons changes the atom into a different element.
- ✓ The atomic number is the number of protons in an atom of an element.

Unit 1 - Atomic Concept

12. **Isotopes** are atoms with equal numbers of protons but different numbers of neutrons.

✓ Isotopes of an element have the same atomic number (protons only), but different atomic masses (protons + neutrons).

13. The average atomic mass of an element is the weighted average of its naturally occurring isotopes.

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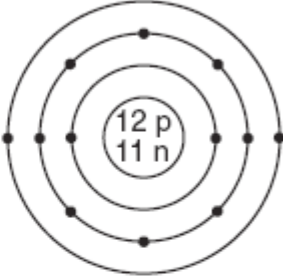
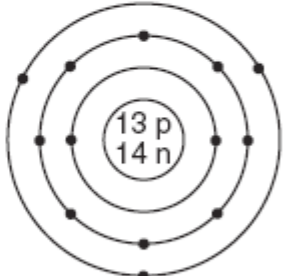
January 2008

- 1 Which quantity identifies an element?
- (1) atomic number
 - (2) mass number
 - (3) total number of neutrons in an atom of the element
 - (4) total number of valence electrons in an atom of the element
- 2 Which atom in the ground state has a partially filled second electron shell?
- (1) hydrogen atom
 - (2) lithium atom
 - (3) potassium atom
 - (4) sodium atom
- 3 What is the total charge of the nucleus of a nitrogen atom?
- (1) +5
 - (2) +2
 - (3) +7
 - (4) +14
- 4 Which value of an element is calculated using both the mass and the relative abundance of each of the naturally occurring isotopes of this element?
- (1) atomic number
 - (2) atomic mass
 - (3) half-life
 - (4) molar volume
- 5 The mass of 12 protons is approximately equal to
- (1) 1 atomic mass unit
 - (2) 12 atomic mass units
 - (3) the mass of 1 electron
 - (4) the mass of 12 electrons
- 6 Sodium atoms, potassium atoms, and cesium atoms have the same
- (1) atomic radius
 - (2) first ionization energy
 - (3) total number of protons
 - (4) oxidation state
- 32 Which two notations represent different isotopes of the same element?
- (1) ${}^6_4\text{Be}$ and ${}^9_4\text{Be}$
 - (2) ${}^7_3\text{Li}$ and ${}^7_3\text{Li}$
 - (3) ${}^{14}_7\text{N}$ and ${}^{14}_6\text{C}$
 - (4) ${}^{32}_{15}\text{P}$ and ${}^{32}_{16}\text{S}$

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Base your answers to questions 55 through 57 on the information below.

Atomic Diagrams of Magnesium and Aluminum

Key • = electron	Element	Lewis Electron-Dot Diagram	Electron-Shell Diagram
	magnesium	Mg:	
	aluminum	Al:	

- 55 Identify *one* piece of information shown in the electron-shell diagrams that is *not* shown in the Lewis electron-dot diagrams. [1]
- 56 Determine the mass number of the magnesium atom represented by the electron-shell diagram. [1]
- 57 Explain why Lewis electron-dot diagrams are generally more suitable than electron-shell diagrams for illustrating chemical bonding. [1]

August 2007

- 1 What was concluded about the structure of the atom as the result of the gold foil experiment?
- (1) A positively charged nucleus is surrounded by positively charged particles.
 - (2) A positively charged nucleus is surrounded by mostly empty space.
 - (3) A negatively charged nucleus is surrounded by positively charged particles.
 - (4) A negatively charged nucleus is surrounded by mostly empty space.
- 2 An atom is electrically neutral because the
- (1) number of protons equals the number of electrons
 - (2) number of protons equals the number of neutrons
 - (3) ratio of the number of neutrons to the number of electrons is 1:1
 - (4) ratio of the number of neutrons to the number of protons is 2:1

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3 How do the energy and the most probable location of an electron in the third shell of an atom compare to the energy and the most probable location of an electron in the first shell of the same atom?

- (1) In the third shell, an electron has more energy and is closer to the nucleus.
- (2) In the third shell, an electron has more energy and is farther from the nucleus.
- (3) In the third shell, an electron has less energy and is closer to the nucleus.
- (4) In the third shell, an electron has less energy and is farther from the nucleus.

52 Write an electron configuration for an atom of aluminum-27 in an excited state. [1]

52 _____

Base your answers to questions 54 through 56 on the information below.

The accepted values for the atomic mass and percent natural abundance of each naturally occurring isotope of silicon are given in the data table below.

Naturally Occurring Isotopes of Silicon

Isotope	Atomic Mass (atomic mass units)	Percent Natural Abundance (%)
Si-28	27.98	92.22
Si-29	28.98	4.69
Si-30	29.97	3.09

54 _____

55

54 Determine the total number of neutrons in an atom of Si-29. [1]

55 In the space in *your answer booklet*, show a correct numerical setup for calculating the atomic mass of Si. [1]

56 _____ %

56 A scientist calculated the percent natural abundance of Si-30 in a sample to be 3.29%. Determine the percent error for this value. [1]

Unit 1 - Atomic Concept

Base your answers to questions 67 through 69 on the information below.

Elements with atomic numbers 112 and 114 have been produced and their IUPAC names are pending approval. However, an element that would be put between these two elements on the Periodic Table has not yet been produced. If produced, this element will be identified by the symbol Uut until an IUPAC name is approved.

67 In the space *in your answer booklet*, draw a Lewis electron-dot diagram for an atom of Uut. [1]

68 Determine the charge of an Uut nucleus. Your response must include *both* the numerical value and the sign of the charge. [1]

69 Identify *one* element that would be chemically similar to Uut. [1]

67

68 _____

69 _____

Unit 1 - Atomic Concept

June 2007

- 1 According to the wave-mechanical model of the atom, electrons in an atom
- (1) travel in defined circles
 - (2) are most likely found in an excited state
 - (3) have a positive charge
 - (4) are located in orbitals outside the nucleus
- 2 What is the total charge of the nucleus of a carbon atom?
- (1) -6
 - (2) 0
 - (3) +6
 - (4) +12
- 4 Which two particles each have a mass approximately equal to one atomic mass unit?
- (1) electron and neutron
 - (2) electron and positron
 - (3) proton and electron
 - (4) proton and neutron
- 8 When an atom loses one or more electrons, this atom becomes a
- (1) positive ion with a radius smaller than the radius of this atom
 - (2) positive ion with a radius larger than the radius of this atom
 - (3) negative ion with a radius smaller than the radius of this atom
 - (4) negative ion with a radius larger than the radius of this atom
- 31 Which electron configuration could represent a strontium atom in an excited state?
- (1) 2-8-18-7-1
 - (2) 2-8-18-7-3
 - (3) 2-8-18-8-1
 - (4) 2-8-18-8-2
- 33 What is the total number of neutrons in an atom of $^{57}_{26}\text{Fe}$?
- (1) 26
 - (2) 31
 - (3) 57
 - (4) 83
- 35 What is the total number of electrons in a Mg^{2+} ion?
- (1) 10
 - (2) 12
 - (3) 14
 - (4) 24
- 37 Compared to an electron in the first electron shell of an atom, an electron in the third shell of the same atom has
- (1) less mass
 - (2) less energy
 - (3) more mass
 - (4) more energy

January 2007

- 1 Which subatomic particles are located in the nucleus of a neon atom?
- (1) electrons and positrons
 - (2) electrons and neutrons
 - (3) protons and neutrons
 - (4) protons and electrons
- 2 The total mass of the protons in an atom of gold-198 is approximately
- (1) 79 atomic mass units
 - (2) 119 atomic mass units
 - (3) 198 atomic mass units
 - (4) 277 atomic mass units
- 3 In a calcium atom in the ground state, the electrons that possess the *least* amount of energy are located in the
- (1) first electron shell
 - (2) second electron shell
 - (3) third electron shell
 - (4) fourth electron shell
- 4 Which group of atomic models is listed in historical order from the earliest to the most recent?
- (1) hard-sphere model, wave-mechanical model, electron-shell model
 - (2) hard-sphere model, electron-shell model, wave-mechanical model
 - (3) electron-shell model, wave-mechanical model, hard-sphere model
 - (4) electron-shell model, hard-sphere model, wave-mechanical model

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5 Which isotopic notation represents an atom of carbon-14?

- (1) ${}^6_6\text{C}$ (3) ${}^6_{14}\text{C}$
(2) ${}^8_6\text{C}$ (4) ${}^{14}_6\text{C}$

15 Compared to a phosphorus atom, a P^{3-} ion has

- (1) more electrons and a larger radius
(2) more electrons and a smaller radius
(3) fewer electrons and a larger radius
(4) fewer electrons and a smaller radius

28 Given the structural formula:



What is the total number of electrons shared in the bond between the two carbon atoms?

- (1) 6 (3) 3
(2) 2 (4) 4

51 Naturally occurring boron is composed of two isotopes. The percent abundance and the mass of each isotope are listed below.

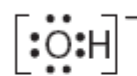
- 19.9% of the boron atoms have a mass of 10.013 atomic mass units.
- 80.1% of the boron atoms have a mass of 11.009 atomic mass units.

In the space in *your answer booklet*, calculate the atomic mass of boron. Your response must include *both* a correct numerical setup and the calculated result. [2]

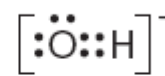
32 Which isotopic notation identifies a metalloid that is matched with the corresponding number of protons in each of its atoms?

- (1) ${}^{24}\text{Mg}$ and 12 protons
(2) ${}^{28}\text{Si}$ and 14 protons
(3) ${}^{75}\text{As}$ and 75 protons
(4) ${}^{80}\text{Br}$ and 80 protons

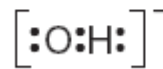
37 Which Lewis electron-dot diagram correctly represents a hydroxide ion?



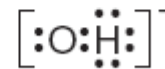
(1)



(3)



(2)



(4)

Unit 1 - Atomic Concept

Base your answers to questions 67 through 70 on the information below, which describes the proposed discovery of element 118.

In 1999, a nuclear chemist and his team announced they had discovered a new element by crashing krypton atoms into lead. The new element, number 118, was assigned the name ununoctium and the symbol Uuo. One possible isotope of ununoctium could have been Uuo-291.

However, the discovery of Uuo was not confirmed because other scientists could not reproduce the experimental results published by the nuclear chemist and his team. In 2006, another team of scientists claimed that they produced Uuo. This claim has yet to be confirmed.

Adapted from *Discover* January 2002

- 67 Based on atomic number, in which group on the Periodic Table would element 118 be placed? [1]
- 68 What would be the total number of neutrons present in a theoretical atom of Uuo-291? [1]
- 69 What would be the total number of electrons present in a theoretical atom of Uuo-291? [1]
- 70 Explain why being able to reproduce scientific results is an important component of scientific research. [1]

67 _____

68 _____

69 _____

70 _____

Unit 1 - Atomic Concept

August 2006

1 Which statement correctly describes the charge of the nucleus and the charge of the electron cloud of an atom?

- (1) The nucleus is positive and the electron cloud is positive.
- (2) The nucleus is positive and the electron cloud is negative.
- (3) The nucleus is negative and the electron cloud is positive.
- (4) The nucleus is negative and the electron cloud is negative.

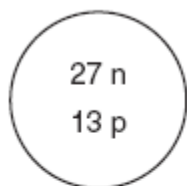
31 What is the mass number of an atom that has six protons, six electrons, and eight neutrons?

- (1) 6
- (2) 12
- (3) 14
- (4) 20

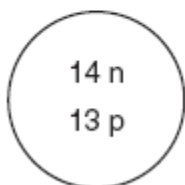
32 Which diagram represents the nucleus of an atom of ${}_{13}^{27}\text{Al}$?



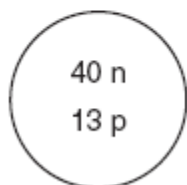
(1)



(3)



(2)



(4)

33 A student constructs a model for comparing the masses of subatomic particles. The student selects a small, metal sphere with a mass of 1 gram to represent an electron. A sphere with which mass would be most appropriate to represent a proton?

- (1) 1 g
- (2) $\frac{1}{2}$ g
- (3) $\frac{1}{2000}$ g
- (4) 2000 g

48 A 100.00-gram sample of naturally occurring boron contains 19.78 grams of boron-10 (atomic mass = 10.01 atomic mass units) and 80.22 grams of boron-11 (atomic mass = 11.01 atomic mass units). Which numerical setup can be used to determine the atomic mass of naturally occurring boron?

- (1) $(0.1978)(10.01) + (0.8022)(11.01)$
- (2) $(0.8022)(10.01) + (0.1978)(11.01)$
- (3) $\frac{(0.1978)(10.01)}{(0.8022)(11.01)}$
- (4) $\frac{(0.8022)(10.01)}{(0.1978)(11.01)}$

Unit 1 - Atomic Concept

June 2006

- 1 Which notation represents an atom of sodium with an atomic number of 11 and a mass number of 24?
- (1) ${}_{11}^{24}\text{Na}$ (3) ${}_{11}^{13}\text{Na}$
(2) ${}_{24}^{11}\text{Na}$ (4) ${}_{11}^{35}\text{Na}$
- 4 Atoms of different isotopes of the same element differ in their total number of
- (1) electrons (3) protons
(2) neutrons (4) valence electrons
- 12 Which changes occur as a cadmium atom, Cd, becomes a cadmium ion, Cd^{2+} ?
- (1) The Cd atom gains two electrons and its radius decreases.
(2) The Cd atom gains two electrons and its radius increases.
(3) The Cd atom loses two electrons and its radius decreases.
(4) The Cd atom loses two electrons and its radius increases.
- 32 What is the total number of electrons in a S^{2-} ion?
- (1) 10 (3) 16
(2) 14 (4) 18
- 34 Compared to an atom of phosphorus-31, an atom of sulfur-32 contains
- (1) one less neutron (3) one more neutron
(2) one less proton (4) one more proton

Unit 1 - Atomic Concept

50 Given the table below that shows students' examples of proposed models of the atom:

Proposed Models of the Atom

Model	Location of Protons	Location of Electrons
A	in the nucleus	specific shells
B	in the nucleus	regions of most probable location
C	dispersed throughout the atom	specific shells
D	dispersed throughout the atom	regions of most probable location

Which model correctly describes the locations of protons and electrons in the wave-mechanical model of the atom?

- (1) A (3) C
(2) B (4) D

Base your answers to questions 53 and 54 on the information below.

An atom has an atomic number of 9, a mass number of 19, and an electron configuration of 2-6-1.

53 What is the total number of neutrons in this atom? [1]

54 Explain why the number of electrons in the second and third shells shows that this atom is in an excited state. [1]

53 _____

54 _____

Unit 1 - Atomic Concept

January 2006

1 Which two nuclides are isotopes of the same element?

- (1) $^{20}_{11}\text{Na}$ and $^{20}_{10}\text{Ne}$ (3) $^{39}_{19}\text{K}$ and $^{42}_{19}\text{K}$
 (2) $^{39}_{19}\text{K}$ and $^{40}_{20}\text{Ca}$ (4) $^{14}_6\text{C}$ and $^{14}_7\text{N}$

2 An atom of oxygen is in an excited state. When an electron in this atom moves from the third shell to the second shell, energy is

- (1) emitted by the nucleus
 (2) emitted by the electron
 (3) absorbed by the nucleus
 (4) absorbed by the electron

3 The charge of a beryllium-9 nucleus is

- (1) +13 (3) +5
 (2) +9 (4) +4

4 Which sequence represents a correct order of historical developments leading to the modern model of the atom?

- (1) the atom is a hard sphere → most of the atom is empty space → electrons exist in orbitals outside the nucleus
 (2) the atom is a hard sphere → electrons exist in orbitals outside the nucleus → most of the atom is empty space
 (3) most of the atom is empty space → electrons exist in orbitals outside the nucleus → the atom is a hard sphere
 (4) most of the atom is empty space → the atom is a hard sphere → electrons exist in orbitals outside the nucleus

11 Compared to a calcium atom, the calcium ion Ca^{2+} has

- (1) more protons (3) more electrons
 (2) fewer protons (4) fewer electrons

51 What is the total number of neutrons in an atom of aluminum-27? [1] 51 _____

52 Explain, in terms of atomic structure, why the atomic radius of iodine is greater than the atomic radius of fluorine. [1]

52 _____

26 Which Lewis electron-dot diagram is correct for CO_2 ?



(1) (3)



(2) (4)

29 When an atom becomes a positive ion, the radius of the atom

- (1) decreases
 (2) increases
 (3) remains the same

31 Which electron configuration represents the electrons in an atom of chlorine in an excited state?

- (1) 2-7-7 (3) 2-8-7
 (2) 2-7-8 (4) 2-8-8

34 The atomic mass of element A is 63.6 atomic mass units. The only naturally occurring isotopes of element A are A-63 and A-65. The percent abundances in a naturally occurring sample of element A are closest to

- (1) 31% A-63 and 69% A-65
 (2) 50% A-63 and 50% A-65
 (3) 69% A-63 and 31% A-65
 (4) 100% A-63 and 0% A-65

Unit 1 - Atomic Concept

54 Explain, in terms of atomic structure, why liquid mercury is a good electrical conductor. [1]

54

August 2005

- 1 Which subatomic particle has a negative charge?
- (1) proton (3) neutron
(2) electron (4) positron
- 2 Which statement best describes the nucleus of an aluminum atom?
- (1) It has a charge of +13 and is surrounded by a total of 10 electrons.
(2) It has a charge of +13 and is surrounded by a total of 13 electrons.
(3) It has a charge of -13 and is surrounded by a total of 10 electrons.
(4) It has a charge of -13 and is surrounded by a total of 13 electrons.
- 3 The atomic mass of an element is the weighted average of the
- (1) number of protons in the isotopes of that element
(2) number of neutrons in the isotopes of that element
(3) atomic numbers of the naturally occurring isotopes of that element
(4) atomic masses of the naturally occurring isotopes of that element
- 4 In which pair do the particles have approximately the same mass?
- (1) proton and electron
(2) proton and neutron
(3) neutron and electron
(4) neutron and beta particle
- 15 What occurs when an atom loses an electron?
- (1) The atom's radius decreases and the atom becomes a negative ion.
(2) The atom's radius decreases and the atom becomes a positive ion.
(3) The atom's radius increases and the atom becomes a negative ion.
(4) The atom's radius increases and the atom becomes a positive ion.
- 32 Which symbol represents a particle with a total of 10 electrons?
- (1) N (3) Al
(2) N³⁺ (4) Al³⁺
- 33 Which electron configuration represents an atom of aluminum in an excited state?
- (1) 2-7-4 (3) 2-8-3
(2) 2-7-7 (4) 2-8-6
- 42 Which Lewis electron-dot diagram is correct for a S²⁻ ion?
- $\left[\cdot \ddot{\text{S}} \cdot \right]^{2-}$ $\left[\text{:} \ddot{\text{S}} \cdot \right]^{2-}$
(1) (3)
- $\left[\ddot{\text{S}} \right]^{2-}$ $\left[\text{:} \ddot{\text{S}} \text{:} \right]^{2-}$
(2) (4)

Unit 1 - Atomic Concept

Base your answers to questions 59 through 61 on the information below.

Two isotopes of potassium are K-37 and K-42.

59 What is the total number of neutrons in the nucleus of a K-37 atom? [1]

60 How many valence electrons are in an atom of K-42 in the ground state? [1]

61 Explain, in terms of subatomic particles, why K-37 and K-42 are isotopes of potassium. [1]

59 _____

60 _____

61 _____

63 In the space in *your answer booklet*, draw a Lewis electron-dot diagram for a molecule of phosphorus trichloride, PCl_3 . [1]

63

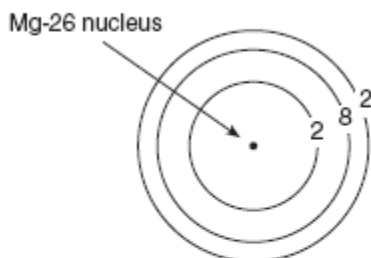
Unit 1 - Atomic Concept

June 2005

- 1 In the modern wave-mechanical model of the atom, the orbitals are regions of the most probable location of
- (1) protons (3) electrons
(2) neutrons (4) positrons
- 2 Compared to a proton, an electron has
- (1) a greater quantity of charge and the same sign
(2) a greater quantity of charge and the opposite sign
(3) the same quantity of charge and the same sign
(4) the same quantity of charge and the opposite sign
- 3 Which two notations represent atoms that are isotopes of the same element?
- (1) $^{121}_{50}\text{Sn}$ and $^{119}_{50}\text{Sn}$ (3) $^{19}_8\text{O}$ and $^{19}_9\text{F}$
(2) $^{121}_{50}\text{Sn}$ and $^{121}_{50}\text{Sn}$ (4) $^{39}_{17}\text{Cl}$ and $^{39}_{19}\text{K}$
- 11 As a chlorine atom becomes a negative ion, the atom
- (1) gains an electron and its radius increases
(2) gains an electron and its radius decreases
(3) loses an electron and its radius increases
(4) loses an electron and its radius decreases
- 33 An electron in an atom moves from the ground state to an excited state when the energy of the electron
- (1) decreases
(2) increases
(3) remains the same
- 34 Which symbol represents a particle that has the same total number of electrons as S^{2-} ?
- (1) O^{2-} (3) Se^{2-}
(2) Si (4) Ar

Unit 1 - Atomic Concept

Base your answers to questions 51 and 52 on the diagram below, which represents an atom of magnesium-26 in the ground state.

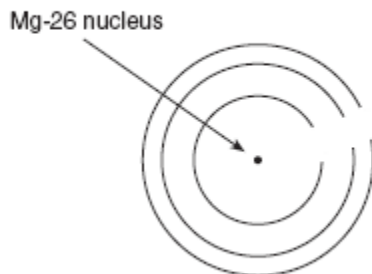


51 What is the total number of valence electrons in an atom of Mg-26 in the ground state? [1]

52 On the diagram *in your answer booklet*, write an appropriate number of electrons in *each* shell to represent a Mg-26 atom in an excited state. Your answer may include additional shells. [1]

51 _____

52



65 In the early 1900s, experiments were conducted to determine the structure of the atom. One of these experiments involved bombarding gold foil with alpha particles. Most alpha particles passed directly through the foil. Some, however, were deflected at various angles. Based on this alpha particle experiment, state *two* conclusions that were made concerning the structure of an atom. [2]

65 Conclusion 1: _____

Conclusion 2: _____

Unit 1 - Atomic Concept

January 2005

- 1 As an electron in an atom moves from the ground state to the excited state, the electron
- (1) gains energy as it moves to a higher energy level
 - (2) gains energy as it moves to a lower energy level
 - (3) loses energy as it moves to a higher energy level
 - (4) loses energy as it moves to a lower energy level
- 2 Which subatomic particle will be attracted by a positively charged object?
- (1) proton
 - (2) neutron
 - (3) electron
 - (4) positron
- 3 Which conclusion is based on the "gold foil experiment" and the resulting model of the atom?
- (1) An atom is mainly empty space, and the nucleus has a positive charge.
 - (2) An atom is mainly empty space, and the nucleus has a negative charge.
 - (3) An atom has hardly any empty space, and the nucleus has a positive charge.
 - (4) An atom has hardly any empty space, and the nucleus has a negative charge.
- 4 Which two particles have approximately the same mass?
- (1) proton and neutron
 - (2) proton and electron
 - (3) neutron and electron
 - (4) neutron and positron
- 13 When a lithium atom forms an Li^+ ion, the lithium atom
- (1) gains a proton
 - (2) gains an electron
 - (3) loses a proton
 - (4) loses an electron
- 14 Which Lewis electron-dot diagram represents a boron atom in the ground state?
- (1) $\cdot\text{B}$
 - (2) $:\dot{\text{B}}$
 - (3) $:\ddot{\text{B}}\cdot$
 - (4) $:\ddot{\text{B}}:$
- 31 What is the total number of neutrons in the nucleus of a neutral atom that has 19 electrons and a mass number of 39?
- (1) 19
 - (2) 20
 - (3) 39
 - (4) 58
- 36 How many electrons are in an Fe^{2+} ion?
- (1) 24
 - (2) 26
 - (3) 28
 - (4) 56
- 42 For most atoms with an atomic number less than 20, nuclear stability occurs when the ratio of neutrons to protons is 1:1. Which of the following atoms would be most likely to have an unstable nucleus?
- (1) ${}^4_2\text{He}$
 - (2) ${}^{12}_6\text{C}$
 - (3) ${}^{16}_7\text{N}$
 - (4) ${}^{24}_{12}\text{Mg}$

Unit 1 - Atomic Concept

Base your answers to questions 66 and 67 on the information below.

Naturally occurring elemental carbon is a mixture of isotopes. The percent composition of the two most abundant isotopes is listed below.

- 98.93% of the carbon atoms have a mass of 12.00 atomic mass units.
- 1.07% of the carbon atoms have a mass of 13.00 atomic mass units.

- 66 In the space provided *in your answer booklet*, show a correct numerical setup for calculating the average atomic mass of carbon. [1]
- 67 Describe, in terms of *subatomic particles found in the nucleus*, one difference between the nuclei of carbon-12 atoms and the nuclei of carbon-13 atoms. The response must include both isotopes. [1]

66

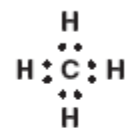
67

August 2004

- 1 Which of these phrases best describes an atom?
- (1) a positive nucleus surrounded by a hard negative shell
 - (2) a positive nucleus surrounded by a cloud of negative charges
 - (3) a hard sphere with positive particles uniformly embedded
 - (4) a hard sphere with negative particles uniformly embedded
- 2 Which statement is true about a proton and an electron?
- (1) They have the same masses and the same charges.
 - (2) They have the same masses and different charges.
 - (3) They have different masses and the same charges.
 - (4) They have different masses and different charges.

- 3 The atomic mass of an element is the weighted average of the masses of
- (1) its two most abundant isotopes
 - (2) its two least abundant isotopes
 - (3) all of its naturally occurring isotopes
 - (4) all of its radioactive isotopes

- 10 Given the Lewis electron-dot diagram:



Which electrons are represented by all of the dots?

- (1) the carbon valence electrons, only
- (2) the hydrogen valence electrons, only
- (3) the carbon and hydrogen valence electrons
- (4) all of the carbon and hydrogen electrons

Unit 1 - Atomic Concept

- 33 When compared with the energy of an electron in the first shell of a carbon atom, the energy of an electron in the second shell of a carbon atom is
- (1) less
 - (2) greater
 - (3) the same
- 34 What is the total number of electrons found in an atom of sulfur?
- (1) 6
 - (2) 8
 - (3) 16
 - (4) 32
- 35 Which electron configuration represents the electrons of an atom in an excited state?
- (1) 2-8-1
 - (2) 2-8-6
 - (3) 2-8-17-6
 - (4) 2-8-18-5
- 36 The nucleus of an atom of cobalt-58 contains
- (1) 27 protons and 31 neutrons
 - (2) 27 protons and 32 neutrons
 - (3) 59 protons and 60 neutrons
 - (4) 60 protons and 60 neutrons

Base your answers to questions 70 through 72 on the information below.

Potassium ions are essential to human health. The movement of dissolved potassium ions, $K^+(aq)$, in and out of a nerve cell allows that cell to transmit an electrical impulse.

- 70 What is the total number of electrons in a potassium ion? [1]
- 71 Explain, in terms of *atomic structure*, why a potassium ion is smaller than a potassium atom. [1]
- 72 What property of potassium ions allows them to transmit an electrical impulse? [1]
- 70 _____ electrons
- 71 _____

- 72 _____

June 2004

- 1 The modern model of the atom is based on the work of
- (1) one scientist over a short period of time
 - (2) one scientist over a long period of time
 - (3) many scientists over a short period of time
 - (4) many scientists over a long period of time
- 2 Which statement is true about the charges assigned to an electron and a proton?
- (1) Both an electron and a proton are positive.
 - (2) An electron is positive and a proton is negative.
 - (3) An electron is negative and a proton is positive.
 - (4) Both an electron and a proton are negative.
- 3 In the wave-mechanical model, an orbital is a region of space in an atom where there is
- (1) a high probability of finding an electron
 - (2) a high probability of finding a neutron
 - (3) a circular path in which electrons are found
 - (4) a circular path in which neutrons are found
- 4 What is the charge of the nucleus in an atom of oxygen-17?
- (1) 0
 - (2) -2
 - (3) +8
 - (4) +17

Unit 1 - Atomic Concept

- 11 Which change occurs when a barium atom loses two electrons?
- (1) It becomes a negative ion and its radius decreases.
 - (2) It becomes a negative ion and its radius increases.
 - (3) It becomes a positive ion and its radius decreases.
 - (4) It becomes a positive ion and its radius increases.
- 34 How many electrons are contained in an Au^{3+} ion?
- (1) 76
 - (2) 79
 - (3) 82
 - (4) 197
- 35 Which electron configuration represents the electrons of an atom in an excited state?
- (1) 2-4
 - (2) 2-6
 - (3) 2-7-2
 - (4) 2-8-2

Base your answers to questions 59 through 61 on the data table below, which shows three isotopes of neon.

Isotope	Atomic Mass (atomic mass units)	Percent Natural Abundance
^{20}Ne	19.99	90.9%
^{21}Ne	20.99	0.3%
^{22}Ne	21.99	8.8%

- 59 In terms of *atomic particles*, state one difference between these three isotopes of neon. [1]
- 60 Based on the atomic masses and the natural abundances shown in the data table, in the space provided in *your answer booklet*, show a correct numerical setup for calculating the average atomic mass of neon. [1]
- 61 Based on natural abundances, the average atomic mass of neon is closest to which whole number? [1]

59 _____

60

61 _____

Unit 1 - Atomic Concept

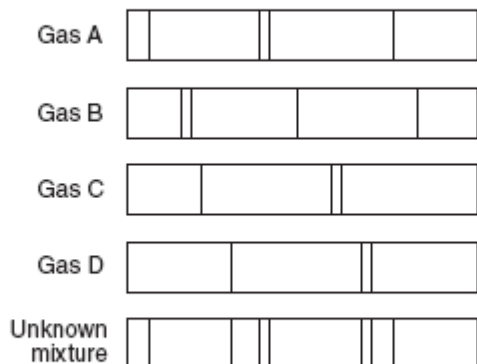
January 2004

- 1 A neutral atom contains 12 neutrons and 11 electrons. The number of protons in this atom is
- (1) 1 (3) 12
(2) 11 (4) 23
- 2 Isotopes of an element must have different
- (1) atomic numbers
(2) mass numbers
(3) numbers of protons
(4) numbers of electrons
- 18 Which statement best explains why most atomic masses on the Periodic Table are decimal numbers?
- (1) Atomic masses are determined relative to an H-1 standard.
(2) Atomic masses are determined relative to an O-16 standard.
(3) Atomic masses are a weighted average of the naturally occurring isotopes.
(4) Atomic masses are an estimated average of the artificially produced isotopes.
- 33 What is the total number of electrons in a Cr^{3+} ion?
- (1) 18 (3) 24
(2) 21 (4) 27
- 62 In the space provided in *your answer booklet*, draw a Lewis electron-dot structure for an atom of phosphorus. [1]
- 37 What is the correct Lewis electron-dot structure for the compound magnesium fluoride?
- (1) $\text{Mg} : \ddot{\text{F}} :$ (3) $[\ddot{\text{F}}:]^- \text{Mg}^{2+} [\ddot{\text{F}}:]^-$
- (2) $\text{Mg}^+ [\ddot{\text{F}}:]^-$ (4) $:\ddot{\text{F}}:\text{Mg}:\ddot{\text{F}}:$
- 48 Which electron configuration represents an atom of chlorine in an excited state?
- (1) 2-8-7 (3) 2-8-6-1
(2) 2-8-8 (4) 2-8-7-1

Unit 1 - Atomic Concept

Base your answers to questions 63 and 64 on the information and the bright-line spectra represented below.

Many advertising signs depend on the production of light emissions from gas-filled glass tubes that are subjected to a high-voltage source. When light emissions are passed through a spectroscope, bright-line spectra are produced.



63 Identify the *two* gases in the unknown mixture. [2]

64 Explain the production of an emission spectrum in terms of the *energy states of an electron*. [1]

63 _____ and _____

64 _____

August 2003

1 Which electron transition represents a gain of energy?

- (1) from 2nd to 3rd shell
- (2) from 2nd to 1st shell
- (3) from 3rd to 2nd shell
- (4) from 3rd to 1st shell

2 Which particles are found in the nucleus of an atom?

- (1) electrons, only
- (2) neutrons, only
- (3) protons and electrons
- (4) protons and neutrons

3 What is the total number of valence electrons in an atom of sulfur in the ground state?

- (1) 6
- (2) 8
- (3) 3
- (4) 4

4 An electron has a charge of

- (1) -1 and the same mass as a proton
- (2) +1 and the same mass as a proton
- (3) -1 and a smaller mass than a proton
- (4) +1 and a smaller mass than a proton

12 Which Lewis electron-dot structure is drawn correctly for the atom it represents?



13 What occurs when an atom of chlorine forms a chloride ion?

- (1) The chlorine atom gains an electron, and its radius becomes smaller.
- (2) The chlorine atom gains an electron, and its radius becomes larger.
- (3) The chlorine atom loses an electron, and its radius becomes smaller.
- (4) The chlorine atom loses an electron, and its radius becomes larger.

Unit 1 - Atomic Concept

36 What is the total number of neutrons in an atom of an element that has a mass number of 19 and an atomic number of 9?

- (1) 9 (3) 19
 (2) 10 (4) 28

44 Which is an electron configuration for an atom of chlorine in the excited state?

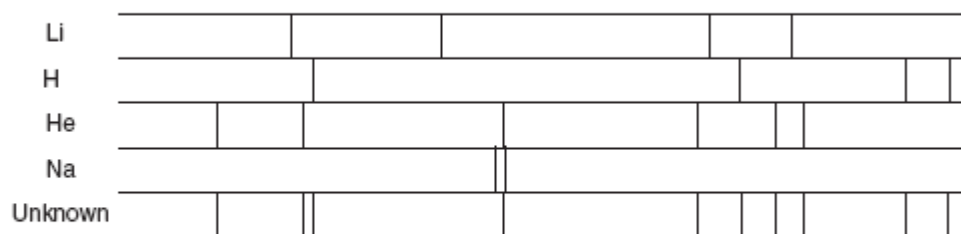
- (1) 2-8-7 (3) 2-8-6-1
 (2) 2-8-8 (4) 2-8-7-1

40 Which particle has the same electron configuration as a potassium ion?

- (1) fluoride ion (3) neon atom
 (2) sodium ion (4) argon atom

Base your answers to questions 63 and 64 on the diagram below, which shows bright-line spectra of selected elements.

Bright-Line Spectra



63 Identify the *two* elements in the unknown spectrum. [2]

64 Explain how a bright-line spectrum is produced, in terms of *excited state*, *energy transitions*, and *ground state*. [2]

63 _____ and _____

64 _____

Unit 1 - Atomic Concept

65 The table below gives information about two isotopes of element X.

Isotope	Mass	Relative Abundance
X-10	10.01	19.91%
X-11	11.01	80.09%

Calculate the average atomic mass of element X.

- Show a correct numerical setup in the space provided in *your answer booklet*. [1]
- Record your answer. [1]
- Express your answer to the correct number of significant figures. [1]

65

Average atomic mass of element X: _____ amu

June 2003

- The atomic number of an atom is always equal to the number of its
 - protons, only
 - neutrons, only
 - protons plus neutrons
 - protons plus electrons
- Which subatomic particle has no charge?
 - alpha particle
 - beta particle
 - neutron
 - electron
- When the electrons of an excited atom return to a lower energy state, the energy emitted can result in the production of
 - alpha particles
 - isotopes
 - protons
 - spectra
- The atomic mass of an element is calculated using the
 - atomic number and the ratios of its naturally occurring isotopes
 - atomic number and the half-lives of each of its isotopes
 - masses and the ratios of its naturally occurring isotopes
 - masses and the half-lives of each of its isotopes
- The region that is the most probable location of an electron in an atom is
 - the nucleus
 - an orbital
 - the excited state
 - an ion
- What is represented by the dots in a Lewis electron-dot diagram of an atom of an element in Period 2 of the Periodic Table?
 - the number of neutrons in the atom
 - the number of protons in the atom
 - the number of valence electrons in the atom
 - the total number of electrons in the atom
- The nucleus of an atom of K-42 contains
 - 19 protons and 23 neutrons
 - 19 protons and 42 neutrons
 - 20 protons and 19 neutrons
 - 23 protons and 19 neutrons
- What is the total number of electrons in a Cu^+ ion?
 - 28
 - 29
 - 30
 - 36

Unit 1 - Atomic Concept

Base your answers to questions 51 and 52 on the electron configuration table shown below.

Element	Electron Configuration
X	2-8-8-2
Y	2-8-7-3
Z	2-8-8

51 What is the total number of valence electrons in an atom of electron configuration X? [1]

52 Which electron configuration represents the excited state of a calcium atom? [1]

51 _____

52 _____ 60 As a neutral sulfur atom gains two electrons, what happens to the radius of the atom? [1]

60 _____

61 After a neutral sulfur atom gains two electrons, what is the resulting charge of the ion? [1] 61 _____

67 John Dalton was an English scientist who proposed that atoms were hard, indivisible spheres. In the modern model, the atom has a different internal structure.

a Identify one experiment that led scientists to develop the modern model of the atom. [1]

b Describe this experiment. [1]

c State one conclusion about the internal structure of the atom, based on this experiment. [1]

67 *a* _____

b _____

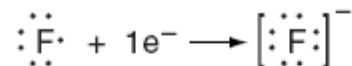
c _____

Unit 1 - Atomic Concept

January 2003

- 1 Which statement best describes electrons?
- (1) They are positive subatomic particles and are found in the nucleus.
 - (2) They are positive subatomic particles and are found surrounding the nucleus.
 - (3) They are negative subatomic particles and are found in the nucleus.
 - (4) They are negative subatomic particles and are found surrounding the nucleus.
- 2 During a flame test, ions of a specific metal are heated in the flame of a gas burner. A characteristic color of light is emitted by these ions in the flame when the electrons
- (1) gain energy as they return to lower energy levels
 - (2) gain energy as they move to higher energy levels
 - (3) emit energy as they return to lower energy levels
 - (4) emit energy as they move to higher energy levels
- 7 From which of these atoms in the ground state can a valence electron be removed using the *least* amount of energy?
- | | |
|--------------|--------------|
| (1) nitrogen | (3) oxygen |
| (2) carbon | (4) chlorine |
- 9 An atom of carbon-12 and an atom of carbon-14 differ in
- (1) atomic number
 - (2) mass number
 - (3) nuclear charge
 - (4) number of electrons

- 14 Given the equation:



This equation represents the formation of a

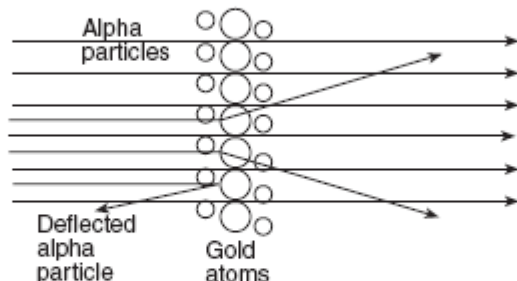
- (1) fluoride ion, which is smaller in radius than a fluorine atom
 - (2) fluoride ion, which is larger in radius than a fluorine atom
 - (3) fluorine atom, which is smaller in radius than a fluoride ion
 - (4) fluorine atom, which is larger is radius than a fluoride ion
- 36 Hydrogen has three isotopes with mass numbers of 1, 2, and 3 and has an average atomic mass of 1.00794 amu. This information indicates that
- (1) equal numbers of each isotope are present
 - (2) more isotopes have an atomic mass of 2 or 3 than of 1
 - (3) more isotopes have an atomic mass of 1 than of 2 or 3
 - (4) isotopes have only an atomic mass of 1

Unit 1 - Atomic Concept

Base your answers to questions 62 through 64 on the information and diagram below.

One model of the atom states that atoms are tiny particles composed of a uniform mixture of positive and negative charges. Scientists conducted an experiment where alpha particles were aimed at a thin layer of gold atoms.

Most of the alpha particles passed directly through the gold atoms. A few alpha particles were deflected from their straight-line paths. An illustration of the experiment is shown below.



62 Most of the alpha particles passed directly through the gold atoms undisturbed. What does this evidence suggest about the structure of the gold atoms? [1]

63 A few of the alpha particles were deflected. What does this evidence suggest about the structure of the gold atoms? [1]

64 How should the original model be revised based on the results of this experiment? [1]

62 _____

63 _____

64 _____
