
Questions 1 – 15 cover Exam 1 material

1. In the _____ state(s), atoms or molecules are so closely packed that they have nearly fixed locations.
- A. liquid
B. combusted
C. gaseous
D. solid
-
2. Volume is an example of a/an _____ property.
- A. extensive
B. intensive
C. atomic
D. chemical
-
3. The total energy in a system is 133 J and the potential energy is 67 J. What is the **kinetic energy** in the system?
- A. 200 J
B. 115 J
C. 66 J
D. -62 J
-
4. The bond length of the single bond in H₂ is 72 pm. What is the length in μm?
- A. $7.2 \times 10^{-3} \mu\text{m}$
B. $7.2 \times 10^{-5} \mu\text{m}$
C. $7.2 \times 10^{-6} \mu\text{m}$
D. $7.2 \times 10^{-8} \mu\text{m}$
-
5. A gold ring displaces 1.37×10^{-3} L of water. Gold has a density of 19.30 g/cm^3 . What is the mass of the gold ring in pounds?
- A. 12.0 lb
B. $5.83 \times 10^{-2} \text{ lb}$
C. $2.64 \times 10^{-2} \text{ lb}$
D. $5.83 \times 10^{-5} \text{ lb}$
-

-
6. What is the answer, to the correct number of significant figures, to the following calculation?

$$\frac{(4.900 \times 10^3)}{(0.000690)(8.2500 \times 10^{14})}$$

- A. 8.61×10^{-9} C. 5.859×10^{21}
B. 9.000×10^{-9} D. 5.86×10^{21}
-
7. Which of the following postulates was **not** part of Dalton's atomic theory?
- A. Atoms of a given element share the same properties.
B. Elements are comprised of indivisible particles called atoms.
C. Atoms combine in whole-number ratios to form compounds.
D. Atoms of one element can be converted to atoms of another element.

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8. Which statement is **false** about Rutherford's gold foil experiment?
- A. Most alpha particles passed through the gold foil with little or no deflection.
B. Some alpha particles were deflected through very large angles.
C. The experiment proved that the plum-pudding model of the atom was incorrect.
D. The very high electron density in gold atoms deflected some alpha particles.

-
9. A ${}_{36}^{84}\text{Kr}$ atom has how many **neutrons**?
- A. 120 C. 36
B. 48 D. 12
-

10. There are two stable naturally occurring isotopes of copper: ^{63}Cu (mass = 62.93 amu) and ^{65}Cu (mass = 64.93 amu). The average atomic mass of copper is 63.55 amu. What is the natural abundance of ^{65}Cu ?

A. 64.93%

C. 31.00%

B. 50.00%

D. 1.38%

11. How many iron **atoms** are in 3.7 moles of Fe?

A. 1.6×10^{23} atoms

C. 2.2×10^{24} atoms

B. 6.0×10^{23} atoms

D. 4.6×10^{25} atoms

12. A vanadium cube contains 3.2×10^{25} atoms. What is the **edge length** of the cube? The density of vanadium is 6.0 g/cm^3 .

A. 7.7 cm

C. 21 cm

B. 14 cm

D. 45 cm

13. Which of the following is **not** an empirical formula?

A. $\text{HC}_2\text{H}_3\text{O}_2$

C. $\text{C}_{12}\text{H}_{22}\text{O}_{11}$

B. N_2O_3

D. $\text{C}_2\text{H}_5\text{OH}$

14. Which of the following statements is **true**?

A. A potassium atom shares an electron with a chlorine atom to form an ionic bond.

B. A potassium atom shares an electron with a chlorine atom to form a covalent bond.

C. A potassium atom transfers an electron to a chlorine atom to form a covalent bond.

D. A potassium atom transfers an electron to a chlorine atom to form an ionic bond.

15. Which of the following formula/name combinations is **incorrect**?

A. NO_2 , nitrogen dioxide

C. $\text{HCl}(aq)$, hydrochloric acid

B. NF_3 , nitrogen fluoride

D. N_2O , dinitrogen monoxide

Questions 16 – 30 cover Exam 2 material

16. What is the molecular mass of H_2O_2 ?

A. 4.38 amu

C. 34.01 amu

B. 17.12 amu

D. 68.02 amu

17. What is the mass percent of oxygen in NH_4OH ?

A. 66.59%

C. 41.16%

B. 45.66%

D. 14.41%

18. Analysis of a sample of a compound, containing only carbon, nitrogen, hydrogen, and oxygen, determined that it contained 20.0% C, 6.7% H, 46.6% N and the balance O. What is the **empirical formula** of the compound?

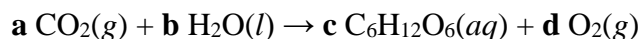
A. $\text{CH}_4\text{N}_2\text{O}$

C. CH_4N

B. $\text{C}_2\text{H}_9\text{N}_5\text{O}_2$

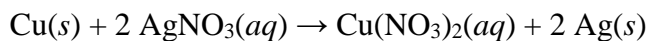
D. CH_3NO

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19. Balance the reaction equation describing the biological formation of glucose ($C_6H_{12}O_6$) with the lowest set of whole number coefficients. What is the coefficient (**d**) of $O_2(g)$?



- A. 1
B. 3
C. 6
D. 12

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20. In the reaction below, you used 0.03397 moles of Cu to produce Ag. After running the reaction, you found that it had produced 6.55 g of Ag. What is the percent yield?

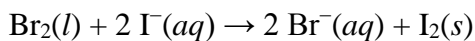


- A. 100.%
B. 89.3%
C. 74.2%
D. 6.55%

-
21. A stock solution is prepared by dissolving 12.5 g of NaCl in enough water to prepare 150.0 mL of solution. What volume of this stock solution will be used to prepare 250.0 mL of a 0.500 M solution of NaCl?

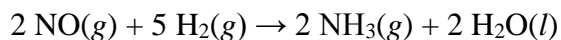
- A. 87.7 mL
B. 83.3 mL
C. 60.0 mL
D. 23.4 mL
-

22. Which species is **reduced** in the reaction below, which proceeds completely to the right?



- | | |
|---------------------|----------------------|
| A. $\text{Br}_2(l)$ | C. $\text{Br}^-(aq)$ |
| B. $\text{I}^-(aq)$ | D. $\text{I}_2(s)$ |

23. What **volume** of H_2 (2.02 g/mol) at standard pressure and temperature will react with 15.0 g of NO (30.01 g/mol) according to the following reaction equation?



- | | |
|-----------|-----------|
| A. 17.1 L | C. 42.0 L |
| B. 28.0 L | D. 49.4 L |

24. A mixture of N_2 , O_2 , and Ar has mole fractions of 0.65, 0.25, and 0.10, respectively. What is the **pressure of O_2** if the total pressure of the mixture is 3.9 atm?

- | | |
|-------------|-------------|
| A. 0.39 atm | C. 0.98 atm |
| B. 0.67 atm | D. 2.5 atm |

25. Based on kinetic molecular theory, which of the following is **true** regarding collisions between gas molecules?

- A. Intermolecular collisions are elastic.
 - B. The total energy of the system is reduced as a result of every intermolecular collision.
 - C. Gas molecules never collide.
 - D. Colliding gas molecules stick together.
-

26. $\text{CH}_4(g)$, methane, will most closely follow the ideal gas law under which of the following conditions of pressure and temperature?

A. 25 atm and 0 °C

C. 25 atm and 300 °C

B. 0.25 atm and 0 °C

D. 0.25 atm and 300 °C

27. The combustion of propane (C_3H_8) is an exothermic reaction. Which of the following statements is true for this combustion reaction?

A. The surroundings absorb heat from the system.

B. The system absorbs heat from the surroundings.

C. There is no net heat transfer between the system and its surrounding.

D. The heat exchanged is not dependent on the amount of combusted propane.

28. For ΔE of a system to be negative, what must be true?

A. $q = w$

C. $+w > -q$

B. $+q > -w$

D. $-w > +q$

29. A block of silver ($C_s = 0.235 \text{ J/g}\cdot^\circ\text{C}$) at 65 °C and a block of aluminum ($C_s = 0.903 \text{ J/g}\cdot^\circ\text{C}$) at 25 °C of equal mass are placed in thermal contact with one another. What is the final temperature of the blocks?

A. between 45 °C and 65 °C

C. between 25 °C and 45 °C

B. 45 °C

D. less than 25 °C

30. How much expansion work is done to inflate a weather balloon from 2.0 L to 17.0 L against 714 torr external pressure? (i.e., What is w ?) $101.3 \text{ J} = 1.000 \text{ L atm}$

A. 14 kJ

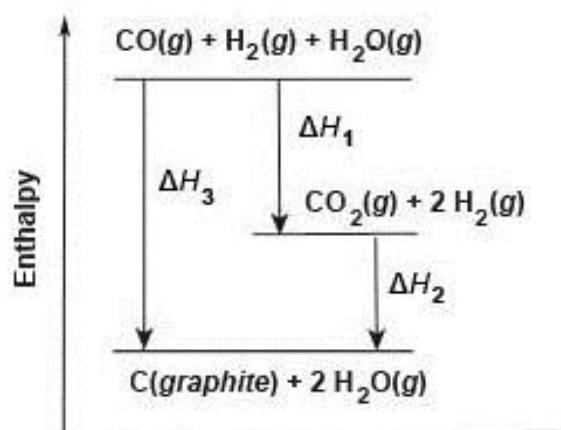
C. -2.4 kJ

B. 11 kJ

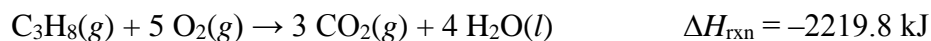
D. -1.4 kJ

Questions 31 – 45 cover Exam 3 material

31. According to the diagram on the right, which statement is **false** at constant pressure?



- A. The enthalpy change for the reaction $\text{CO}(g) + \text{H}_2(g) \rightarrow \text{C}(\text{graphite}) + \text{H}_2\text{O}(g)$ is equal to $\Delta H_1 + \Delta H_2$.
- B. The enthalpy change for the reaction $\text{CO}_2(g) + \text{H}_2(g) \rightarrow \text{CO}(g) + \text{H}_2\text{O}(g)$ is equal to $\Delta H_3 + \Delta H_2$.
- C. The enthalpy change for the reaction $\text{CO}_2(g) + 2 \text{H}_2(g) \rightarrow \text{C}(\text{graphite}) + 2 \text{H}_2\text{O}(g)$ is equal to $\Delta H_3 - \Delta H_1$.
- D. The reaction $\text{CO}(g) + \text{H}_2\text{O}(g) \rightarrow \text{CO}_2(g) + \text{H}_2(g)$ is exothermic.
-
32. What is ΔH°_f for propane (C_3H_8) given the following information?



$$\Delta H^\circ_f(\text{CO}_2(g)) = -393.5 \text{ kJ/mol}$$

$$\Delta H^\circ_f(\text{H}_2\text{O}(l)) = -285.8 \text{ kJ/mol}$$

- A. -1540.5 kJ/mol C. 103.9 kJ/mol
- B. -103.9 kJ/mol D. 1540.5 kJ/mol
-

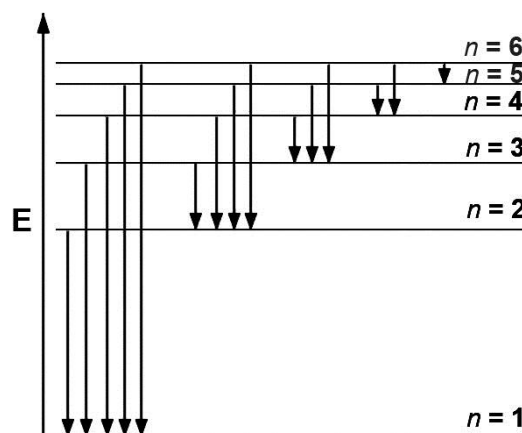
33. For which of the following reaction equations does $\Delta H^\circ_{\text{reaction}} = \Delta H^\circ_{\text{formation}}$ of K_2CO_3 ?

- A. $2 \text{K}^+(aq) + \text{CO}_3^{2-}(aq) \rightarrow \text{K}_2\text{CO}_3(s)$
- B. $2 \text{K}(g) + \text{CO}_3(g) \rightarrow \text{K}_2\text{CO}_3(s)$
- C. $2 \text{K}(s) + \text{C}(\text{graphite}) + 3/2 \text{O}_2(g) \rightarrow \text{K}_2\text{CO}_3(s)$
- D. $2 \text{K}(s) + \text{C}(\text{diamond}) + \text{O}_3(g) \rightarrow \text{K}_2\text{CO}_3(s)$

34. Light of energy sufficient to eject photoelectrons shines on four different metal surfaces. Which of the following metals will have photoelectrons ejected with the **lowest** kinetic energy?

- A. Cs
- B. Al
- C. Mg
- D. Ca

35. Which transition of the hydrogen electron will emit the **longest wavelength** of light?



- A. $n = 6$ to $n = 1$
- B. $n = 6$ to $n = 5$
- C. $n = 5$ to $n = 4$
- D. $n = 2$ to $n = 1$

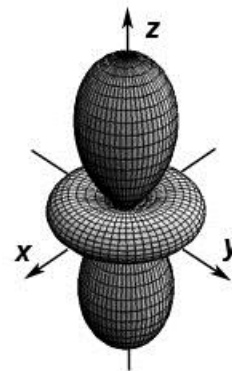
36. Select the **true** statement about the quantum-mechanical description of an atom.

- A. Each atomic orbital can hold only two electrons.
 - B. Superimposing the electron density in a filled set of s , p and d orbitals results in a two-dimensional distribution of electron density.
 - C. The spin of an electron is determined primarily by l , the angular momentum quantum number.
 - D. An orbital describes the elliptical orbit that an electron follows around the nucleus.
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37. Identify the **true** statement about Heisenberg's uncertainty principle.
- A. The more accurately you know the position of an electron, the less accurately you know the velocity.
 - B. Both the position and velocity of an electron can be accurately known at the same time.
 - C. Neither the position nor velocity of an electron can be accurately known at any time.
 - D. The electron behaves as both a particle and wave.

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38. Which of the following is a valid set of quantum numbers (n, l, m_l, m_s) for an electron in a p orbital?
- A. (4, 3, 3, $-1/2$)
 - B. (4, 1, 3, $1/2$)
 - C. (3, 1, $-1, 1/2$)
 - D. (1, 1, 1, $1/2$)

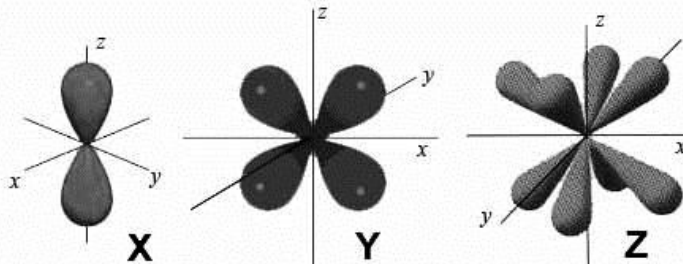
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39. Which of the following statements is **false** for the orbital at right?



- A. It has a higher energy than a p orbital with the same principal quantum number.
 - B. It can be filled by two electrons, according to the Pauli exclusion principle.
 - C. It is described by the angular momentum number $l = 2$.
 - D. It is usually occupied by electrons for second-row elements (Li–Ne).
-
40. Which orbitals do the **valence** electrons of a ground-state aluminum atom occupy?

- A. $2s, 2p$
 - B. $3s, 3p$
 - C. $3s, 3p, 2d$
 - D. $3s, 3p, 3d$
-

41. What are the angular momentum quantum numbers (l) for the orbitals at right?

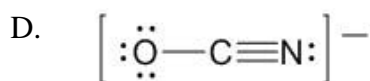
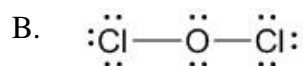
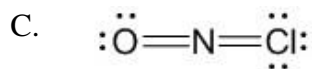
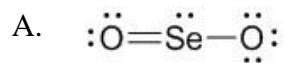


- A. $X = 0, Y = 1, Z = 2$ C. $X = 2, Y = 3, Z = 4$
B. $X = 1, Y = 2, Z = 3$ D. $X = 3, Y = 2, Z = 1$
-
42. How many **unpaired** electrons does a ground-state phosphorus atom have?
- A. 2 C. 4
B. 3 D. 5
-
43. In a multielectron atom, an electron in which principal quantum shell is the **most** shielded from the nuclear charge?
- A. $n = 1$ C. $n = 3$
B. $n = 2$ D. $n = 4$
-
44. Which of the following cations has the **largest** radius?
- A. Al^{3+} C. Na^+
B. Ca^{2+} D. K^+
-
45. Which of the following lists the atoms in order of **increasing** ionization energy (smallest to largest)?
- A. $\text{Si} < \text{P} < \text{N} < \text{F}$ C. $\text{Be} < \text{Li} < \text{Mg} < \text{Na}$
B. $\text{N} < \text{P} < \text{Si} < \text{Al}$ D. $\text{I} < \text{Te} < \text{Sb} < \text{Sn}$
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49. Select the **false** statement about covalent bonds.
- A. Electrons are shared between atoms in a covalent bond.
 - B. Multiple pairs of electrons can be shared between two atoms.
 - C. Covalent bonds are directional.
 - D. Covalent bonds are always polar.

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50. Which of the following bonds is the **most** polar?
- A. C–H in CH₄
 - B. C–Cl in CCl₄
 - C. B–F in BF₃
 - D. N–O in NO

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51. Which Lewis dot structure is **incorrect**?



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52. Which of the following is **true** for ground-state CO₃²⁻?
- A. It has three resonance structures.
 - B. It is fully described by a single Lewis dot structure.
 - C. It has two long and one short C–O bonds.
 - D. The carbon in the molecule CO₃²⁻ has a positive formal charge.
-

53. Which molecule or ion **violates** the octet rule?



54. Which of the following carbon-carbon bonds is the **shortest**?



D. The carbon-carbon bonds in C_2H_6 , C_2H_4 and C_2H_2 all have the same length.

55. Based on VSEPR theory, what is the **electron geometry** (electron group geometry) of BCl_3 ?

A. t-shaped

C. tetrahedral

B. trigonal planar

D. trigonal pyramidal

56. Based on VSEPR theory, what is the **molecular geometry** of BrF_4^+ ?

A. seesaw

C. trigonal bipyramidal

B. t-shaped

D. octahedral



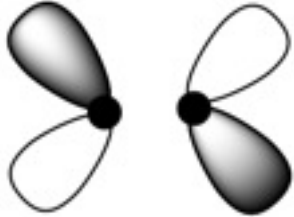

57. Which of the following is a **polar** molecule or ion?

- A. I_3^-
- B. CO_2
- C. CCl_4
- D. PF_3

58. What is the hybridization on the carbon atom in CH_3Cl ?

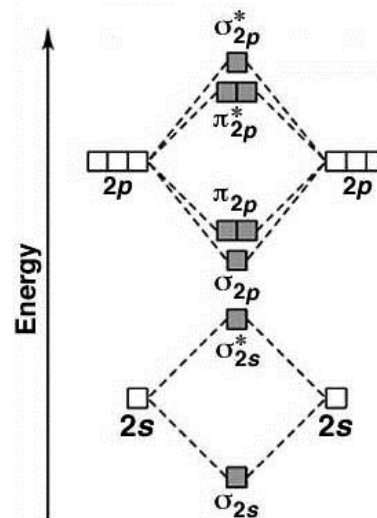
- A. sp
- B. sp^2
- C. sp^3
- D. sp^4

59. Which of the following figures depicts a sigma antibonding (σ^*) molecular orbital?

- A. 
- B. 
- C. 
- D. 

60. What is the **bond order** of O_2^{2+} ?

- A. 0
- B. 2
- C. 2.5
- D. 3



Answer Key:

1. D
2. A
3. C
4. B
5. B
6. A
7. D
8. D
9. B
10. C
11. C
12. A
13. A
14. D
15. B
16. C
17. B
18. A
19. C
20. B
21. A
22. A
23. B
24. C
25. A
26. D
27. A
28. D
29. C
30. D
31. B
32. B
33. C
34. C
35. B
36. A
37. A
38. C
39. D

- 40. B
- 41. B
- 42. B
- 43. D
- 44. D
- 45. A
- 46. B
- 47. A
- 48. C
- 49. D
- 50. C
- 51. C
- 52. A
- 53. D
- 54. C
- 55. B
- 56. A
- 57. D
- 58. C
- 59. D
- 60. D