

1. Consider the following reaction:

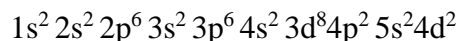


If 4.0 moles of liquid mercury (Hg) is reacted with excess oxygen, which of the following statements concerning this reaction is **true**?

- a) 726.4 kJ of heat is absorbed by the reaction.
 - b) 363.2 kJ of heat is absorbed by the reaction.
 - c) 363.2 kJ of heat is released by the reaction.
 - d) 726.4 kJ of heat is released by the reaction.
 - e) 181.6 kJ of heat is absorbed by the reaction.
 - f) 181.6 kJ of heat is released by the reaction.
2. How many of the following five statements (I-V) **correctly** describes 114.2 grams of octane (C_8H_{18})?

- I. The amount of octane that contains 1.00 mol of C_8H_{18} .
- II. The amount of octane that contains 18 atoms of hydrogen.
- III. The amount of octane that contains 18.14 grams of hydrogen.
- IV. The amount of octane that contains 12.01 grams of carbon.
- V. The amount of octane that contains $12 \times (6.022 \times 10^{23})$ atoms of carbon.

- a) 1 b) 2 c) 3 d) 4 e) 5 (All of the statements are true.)
3. Consider the combustion reaction of $\text{C}_{14}\text{H}_{26}\text{O}_{13}$, an organic compound. What is the sum of the coefficients of the reactants and products in the best balanced equation?
- a) 22 b) 36 c) 42 d) 50 e) 70
4. The +1 charged ion of an element has the following excited state electron configuration:



What is the identity of the ion?

- a) Br^+ b) Cl^+ c) In^+ d) Se^+ e) Kr^+
5. Which of the following arranges the elements H, Br, I, He, and Cl in order of **increasing** ionization energy?
- a) $\text{Br} < \text{I} < \text{He} < \text{Cl} < \text{H}$
 - b) $\text{I} < \text{Br} < \text{Cl} < \text{He} < \text{H}$
 - c) $\text{Cl} < \text{Br} < \text{I} < \text{H} < \text{He}$
 - d) $\text{I} < \text{Br} < \text{Cl} < \text{H} < \text{He}$
 - e) $\text{I} < \text{Br} < \text{He} < \text{Cl} < \text{H}$
 - f) $\text{Cl} < \text{Br} < \text{I} < \text{He} < \text{H}$

6. In which of the following are the ions Mg^{2+} , O^{2-} , Al^{3+} , and N^{3-} arranged in order of **increasing** size?

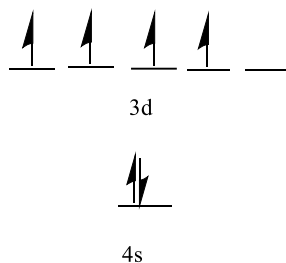
- a) $\text{Mg}^{2+} < \text{Al}^{3+} < \text{N}^{3-} < \text{O}^{2-}$
- b) $\text{Mg}^{2+} < \text{Al}^{3+} < \text{O}^{2-} < \text{N}^{3-}$
- c) $\text{Al}^{3+} < \text{Mg}^{2+} < \text{O}^{2-} < \text{N}^{3-}$
- d) $\text{O}^{2-} < \text{N}^{3-} < \text{Al}^{3+} < \text{Mg}^{2+}$
- e) $\text{O}^{2-} < \text{N}^{3-} < \text{Mg}^{2+} < \text{Al}^{3+}$
- f) $\text{Al}^{3+} < \text{Mg}^{2+} < \text{N}^{3-} < \text{O}^{2-}$

7. How many of the following is/are **correct** ground state electron configurations?

Fe: $[\text{Ar}]4s^23d^6$
At: $[\text{Xe}]6s^25d^{10}6p^5$
Ge: $[\text{Ar}]4s^23d^{10}4p^2$
S: $[\text{He}]3s^23p^4$
Sr: $[\text{Kr}]5s^2$

- a) 1 b) 2 c) 3 d) 4 e) 5 (All are correct.)

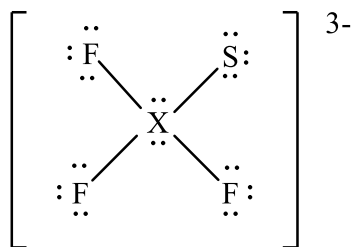
8. Consider the following partial energy level diagram for some element or ion (assume the 1s, 2s, 2p, 3s, and 3p orbitals are full of electrons):



Which of the following five statements about this energy level diagram is **true**?

- a) This represents the ground state electron configuration for Cr.
- b) This represents an excited state electron configuration for Cr.
- c) This represents a forbidden electron configuration for Cr.
- d) This represents the ground state electron configuration for Mn^+ .
- e) This is the ground state electron configuration for Fe^{2+} .

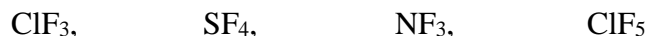
9. Ionization energies for an atom increase as each successive electron is removed. The increase in successive ionization energies is usually steady. However there are times when there is a big change between successive ionization energies. When should there be a big change in successive ionization energies for phosphorus, P?
- a) There is a big change in ionization energies between the second ionization energy and the third ionization energy.
 - b) There is a big change in ionization energies between the third ionization energy and the fourth ionization energy.
 - c) There is a big change in ionization energies between the fourth ionization energy and the fifth ionization energy.
 - d) There is a big change in ionization energies between the fifth ionization energy and the sixth ionization energy.
 - e) There is a big change in ionization energies between the sixth ionization energy and the seventh ionization energy.
10. Of the following bonds, which is the **most polar** bond while not being considered an ionic bond?
- a) MgS b) CH c) SeO d) F₂ e) AsF
11. Consider the following Lewis structure, where X is an unknown nonmetal:



Which of the following could be X in the Lewis structure?

- a) Se b) O c) Cl d) C e) F f) Si

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12. Draw the Lewis structures for the following four compounds:



How many of these four compounds is/are polar?

- a) 0 (none) b) 1 c) 2 d) 3 e) 4 (All are polar.)
13. How many of these compounds are matched to their **correct** molecular structure (shape)?
Note: these are the same four compounds as in the previous question.

ClF_3 : T-shaped

SF_4 : square planar

NF_3 : trigonal pyramidal

ClF_5 : square pyramidal

- a) 0 (none) b) 1 c) 2 d) 3 e) 4 (All are correct.)

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14. Consider the following carbon-oxygen bond length data:

<u>bond</u>	<u>length (pm)</u>
C–O	143
C=O	123
C≡O	109

Using these data, what is the expected carbon-oxygen bond length in CO_3^{2-} ?

- a) 109 pm b) 116 pm c) 123 pm
- d) 136 pm e) 143 pm
15. Which of the following statements is **not** part of Dalton's atomic theory?
- a) All elements are made up of atoms.
- b) Different atoms of the same element can have different masses.
- c) A given compound always has the same relative numbers and types of atoms.
- d) Chemical reactions involve the reorganization of atoms.
- e) Atoms are conserved in a chemical reaction.

16. An enzyme called alcohol dehydrogenase contains Zn^{2+} ions. A 100.0 g sample of alcohol dehydrogenase contains 0.327 g of Zn^{2+} . If one molecule of the enzyme has a mass of 1.328×10^{-19} g, how many zinc ions are present in one molecule of alcohol dehydrogenase?

a) 1 b) 2 c) 3
d) 4 e) 5

17. A hydrogen atom with an electron in the $n = 5$ energy level emits light having a wavelength of 434 nm and the electron goes to a lower energy level. What is the final energy level of the electron in this emission?

a) 1 b) 2 c) 3
d) 4 e) 6

18. Draw Lewis structures for the following four compounds:



How many of these four compounds only use single bonds and lone pairs to make a valid Lewis structure, i.e., contain no multiple bonds?

a) 0 (none) b) 1 c) 2 d) 3 e) 4 (all)

19. A 38.49 g sample of a metal with a density of 6.78 g/mL is placed in a graduated cylinder. An unknown liquid is added to the cylinder to fill it to the 90.0 mL mark. If the total mass of the cylinder's contents is 112.7 g, what is the density of the liquid? (Assume the metal is not soluble in the liquid.)

a) 0.880 g/mL b) 6.78 g/mL c) 1.21 g/mL
d) 1.34 g/mL e) 1.25 g/mL

20. Three different objects were weighed using a different type of balance for each object. The masses of the three objects were 156.893 g, 1.214 g and 2.4581 kg. What is the total mass of the three objects together to the correct number of significant figures?

a) 2616.207 g b) 2616.21 g c) 2616.2 g
d) 2616 g e) 2620 g

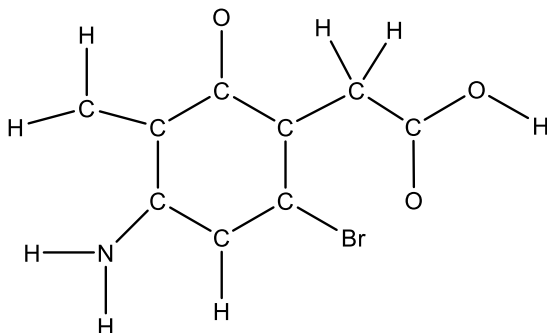
21. Which of the following only contain alkaline earth halide compounds?

- a) NaI, KBr, LiF b) CaF₂, MgBr₂, SrI₂ c) PbI₂, PbBr₂, CdF₂
d) MgO, MgS, CaO e) Al₂O₃, In₂O₃, Ga₂S₃

22. How many of the following five formulas are **incorrect**?

- AlSO₃, NaPO₄, MgCl₂, H₂SO₄, ZnCl₃
a) 1 b) 2 c) 3 d) 4 e) 5 (All are incorrect formulas.)

23. Complete a Lewis structure for the following organic compound:



How many C, N, and O atoms in this organic compound exhibit approximate 109° bond angles as predicted by VSEPR?

- a) 2 b) 3 c) 4
d) 5 e) 6

24. Which of the following molecules or ions has the **smallest** bond angle?

- a) SO₃ b) SF₂²⁻ c) PF₂⁻
d) ClO₂⁺ e) COS

25. The first ionization energy for sulfur is 1005 kJ/mol. What is the longest wavelength of light capable of ionizing a sulfur atom?

- a) 119 nm b) 185 nm c) 314 nm
d) 0.12 nm e) 95.6 nm

26. Gamma ray photons are higher in energy than microwave photons. Which of the following statements (a-c) concerning gamma rays and microwaves is/are **true**?
- a) Gamma rays have a higher frequency than microwaves.
 - b) Gamma rays have a longer wavelength than microwaves.
 - c) Gamma rays travel faster than microwaves.
 - d) Two of the statements (a-c) are true.
 - e) None of the statements (a-c) are true.
27. Which of the following has the same number of neutrons as ^{85}Rb ?
- a) ^{85}Kr b) ^{87}Rb c) ^{85}Sr d) ^{86}Kr e) ^{86}Sr
28. How many of the following four atoms have 2 unpaired electrons in the ground state?
- Hf (element #72), Ds (element #110), C (element #6), Se (element #34)
- a) 0 (none) b) 1 c) 2
 - d) 3 e) 4 (all)
29. Consider the elements nitrogen, phosphorus, oxygen, sulfur, fluorine, and chlorine. Which of these elements has the **smallest** ionization energy?
- a) nitrogen b) phosphorus c) oxygen
 - d) sulfur e) fluorine f) chlorine
30. The electron in a hydrogen atom is excited from the $n = 1$ energy state to the $n = 2$ energy state. Which of the following statements concerning this electronic transition for hydrogen is **false**?
- a) The $n = 2$ energy state is called an excited state.
 - b) The electron in the $n = 2$ energy state is further from the nucleus on average than the electron in the $n = 1$ energy state.
 - c) The wavelength of light absorbed if the electron goes from the $n = 2$ to the $n = 3$ energy state will be longer than the wavelength of light absorbed for the $n = 1$ to $n = 2$ electronic transition.
 - d) It takes more energy to ionize (completely remove) an electron from the $n = 2$ energy state than from the ground state.
 - e) The wavelength of light absorbed to excite an electron from the $n = 1$ to $n = 2$ energy state is identical to the wavelength of light emitted for the $n = 2$ to $n = 1$ electronic transition.