

Answers to Page 1 Midterm problems

1. Rusting of iron and the decomposition of water are chemical changes.
2. Both homogeneous. Mixtures are heterogeneous.
3. Hydrogen is a gas that is found above group 1, because it often acts as it were a group one metal when bonding, due to 1 valence electron.
4. Multiple measurements that are the same means precise, but not accurate, which means measures correctly.
5. 37.6 grams (3 sf), 210 centimeters (2 sf)
6.  $2\text{Cr} + 3\text{O}_2 \rightarrow 2\text{CrO}_3$
7. 15 electrons, 15 protons, 17 neutrons
8. An isotope of phosphorous, only one atom has 15 electrons, which is phosphorous. The most common isotope of P is 31, but 32 amu is possible.
9. The masses are based upon Carbon-12, where one amu is equal to one twelfth the mass of C-12.

$$\begin{array}{r}
 10. \quad 0.910 \times 20 \text{ amu} = 18.2 \\
 \quad \quad 0.080 \times 21 \text{ amu} = 1.68 \\
 \quad \quad 0.010 \times 22 \text{ amu} = \underline{0.22} \\
 \quad \quad \quad \quad \quad \quad 20.10 \text{ -----} \rightarrow 20.1 \text{ amu with 3 sf}
 \end{array}$$

11. AMU, or atomic mass units
12. Grams
13. Skip this one, that's for sure.

14. Zinc nitrate formula is  $\text{Zn}(\text{NO}_3)_2$

$$\begin{array}{r}
 \text{Zn} \quad 1 \times 65 = 65 \\
 \text{N} \quad 2 \times 14 = 28 \\
 \text{O} \quad 6 \times 16 = \underline{96} \\
 \quad \quad \quad \quad \quad 189 \text{ grams/mole}
 \end{array}$$

15. Molar mass  $\text{K}_2\text{SO}_4$

$$\begin{array}{r}
 \text{K} \quad 2 \times 39 = 78 \\
 \text{S} \quad 1 \times 32 = 32 \\
 \text{O} \quad 4 \times 16 = \underline{64} \\
 \quad \quad \quad \quad \quad 174 \text{ g/mole}
 \end{array}$$

% composition by mass now

$$\begin{array}{r}
 \text{K} \quad [78/174] \times 100\% = 44.8\% \\
 \text{S} \quad [32/174] \times 100\% = 18.4\% \\
 \text{O} \quad [64/174] \times 100\% = \underline{36.8\%} \\
 \quad \quad \quad \quad \quad = 100.0\%
 \end{array}$$

16. Empirical formulas are "reduced" to smallest ratios. They are not always formulas for "real" chemical compounds. This is a "math" thing.  
 $\text{H}_2\text{O}$   $\text{CH}_4$   $\text{NaCl}$   $\text{C}_7\text{H}_{12}$  and  $\text{C}_2\text{H}_5\text{OH}$  are empirical.  $\text{C}_2\text{H}_6$  is not.

## Midterm Review Page 2 ANSWERS

1. Which reaction will occur spontaneously?  
 $\text{MgBr}_{2(\text{AQ})} + \text{Fe}_{(\text{S})} \rightarrow$  No, Fe below Mg on Table J      or       $\text{CoCl}_{2(\text{AQ})} + \text{Al}_{(\text{S})} \rightarrow$  Yes
2. What is the charge on the perchlorate ion? Table E says perchlorate is  $\text{ClO}_4^{-1}$  so, negative 1
3. Which substance will boil at  $90^\circ\text{C}$  when the vapor pressure is 150 kPa? Ethanol says Table H
4. Which element would have properties most similar to calcium? Magnesium, both group 2
5. Which isotope of carbon has 6 neutrons? C-12 has mass of  $12 = 6n^0, 6p^+$  and  $6e^-$  of no mass
6. 2.0 moles of a noble gas at STP has a mass of 80 amu. Which noble gas is it? Argon 40 g/mole
7. Which ion has 27 electrons?  $\text{Cu}^{+2}$  has 27 electrons while  $\text{Mn}^{+2}$  has just 23 electrons
8. Which element would form an ionic compound with bromine? Rubidium, a group one metal
9. How many valence electrons do the alkaline earth metals have?  
The group 2 metals all have 2 valence electrons
10. Which compound releases energy when it decomposes? aluminum oxide or nitrogen dioxide  
According to Table I, when aluminum oxide forms it's exothermic so its decomposition is endothermic. When nitrogen dioxide forms it's endothermic, so the reverse is exothermic.
11. Which compound has the same molar mass as ammonium thiocyanate? magnesium cyanide or lithium hydrogen carbonate  
 $\text{NH}_4\text{SCN}$  has a molar mass of 76 g/mole.  
 $\text{Mg}(\text{CN})_2$  has a molar mass of 76 g/mole.  $\text{LiHCO}_3$  has a molar mass of only 64 g/mole.
12. Which metal has the higher melting point? Table S Melting points: Li at 454 K, Be at 1551 K
13. guess again, nothing in this space but smiles
14. Which species has the same number of electrons as neon? chloride or sodium ion  
The  $\text{Na}^{+1}$  ion has 10 electrons like neon. The  $\text{Cl}^{-1}$  anion has 18 electrons, like argon.  
That's called being "isoelectric" to the noble gas, having the same electron configuration.
15. What is the mass number of the most common isotope of aluminum?  
26.98154 amu or 27 amu  
The average atomic mass of all aluminum isotopes is 26.98154, but the most common isotope is the one with the nearest whole number of amu's. Every atom has an exact whole number of amu units, because they all have whole neutrons and protons. It's their relative proportions that gives us these many significant figure atomic masses on the table.
16. On which isotope are all relative atomic masses based? O-16 or C-12, carbon 12 is the "gold standard" for all atomic masses (pardon my pun).

### Page 3 answers

1. this model is called the modern model, note the dots that represent the many locations for the electrons (the electron orbital or clouds)
2. Rutherford's gold foil experiment allowed him to describe the atom with a positive and dense nucleus, with the negative electrons flying around (somewhere) outside the atom. The atom's volume was mostly empty space because the alpha particles mostly shot right through the gold.
3. Precipitates usually indicate double replacement reactions when 2 solutions are mixed.
4. Table F shows CaS, calcium sulfide would precipitate
5. Table F shows SrSO<sub>4</sub> would precipitate. Usually sulfates are soluble, but not with strontium, it's an exception.
6. Table F shows that the copper II phosphate would precipitate out of solution.
7. That's a single replacement reaction, the aluminum will bump the iron out of solution and go into solution with the chloride. The filter will catch solid iron metal.
8. Into the flask goes the aqueous solution of aluminum chloride.
9. Copper has a lower activity level than the iron, so if copper were added to iron II chloride solution and then filtered, the iron II chloride solution would end up in the filter, and the copper would end up unchanged in the filter.
10. Solid to gas is a physical change
11. Decomposition of hydrogen peroxide is a chemical change.
12. The decomposition of water, or anything, is a chemical change.
13. skip
14. Phase change liquid to solid is a physical change.
15. Copper II sulfate
16. Silver carbonate
17. Ammonium sulfide
18. Manganese IV oxalate
19. Chromium VI cyanide
20. diphosphorous pentoxide or phosphorous V oxide
21. arsenic trichloride or arsenic III chloride