Sample Exam 1 Solutions September 21, 2005
Chem 1310 Instructor: Dr. Williams

Note: This sample exam has 33 questions. The real exam has **20 questions**. Recent changes are in RED.
Changes made on 12/11 in blue.

1. "In every chemical operation an equal quantity of matter exists before and after the operation" is a statement of the law of

a. conservation of mass
b. multiple proportions
c. definite proportions
d. combining volumes
e. first casualty of war is truth
f. none of these
Answer: a

2. The ratio of the number of bismuth atoms to the number of oxygen atoms in $Bi_2(SO_4)_3$ is
a. 1:6
b. 2:7
c. 2:3
d. 2:1
e. none of these
Answer: a

3. An element has two naturally occurring isotopes. The first has a relative mass of 100.001 g/mol and an abundance of 65%, while the second has a relative mass of 89.997 g/mol. The chemical relative atomic mass of the element is therefore
a. 78.900
b. 93.500
c. 96.500
d. 121.00
e. none of these
Answer: c [(0.65*100.001)+.(35*89.997)=96.5]

4. The element gallium has two naturally occurring isotopes, having the following relative atomic masses: $^{69}Ga = 68.9257$ g/mol and $^{71}Ga = 70.9249$ g/mol. If the chemical relative atomic mass of gallium is 69.723, what is the fractional abundance of ^{69}Ga?
a. 0.223
b. 0.399
c. 0.499
d. 0.601
e. none of these
Answer: d

5. How many hydrogen atoms a there in 3.41g of NH_3?
a. 2.89 x 10^{22} atoms
b. 3.62 x 10^{22} atoms
c. 1.21 x 10^{23} atoms
d. 2.41 x 1 0^{23} atoms
e. none of these
Answer: e

6. How many moles of dioxane ($C_4H_8O_2$) are there in 5.80 g?
a. 0.0658 mol

b. 0.0707 mol
c. 0.0725 mol
d. 0.0804 mol
e. none of these
Answer: a

7. How many moles of water are present in 83.0 g of $Li_3PO_4 \cdot 12H_2O$?
a. 0.250 mol
b. 0.717 mol
c. 2.61 mol
d. 3.00 mol
e. none of these
Answer: d

8. Compute the percentage by mass of carbon in a compound with the empirical formula C_2H_2O.
a. 28.57%
b. 40.00%
c. 57.14%
d. 80.00%
e. none of these
Answer: c

9. What is the mass percentage of phosphorus in the biological compound, fructose-1,6-diphosphate, which has the molecular formula $C_6H_{14}O_{12}P_2$?
a. 9.11%
b. 18.2%
c. 22.4%
d. 27.3%
e. none of these
Answer: b

10. At 20°C the density of a liquid is 0.5 g cm^{-3}. If a laboratory worker needs 10 g of methanol for an experiment, what volume should she use?
a. 0.20 L
b. 0.020 L
c. 50 L
d. 5 L
e. none of these
Answer: b

Chapter 2

11. Consider the unbalanced chemical equation, $F_2 + H_2O \rightarrow OF_2 + HF$. When the reaction is balanced with smallest integer stoichiometric coefficients, the coefficient for H_2O is
a. 1
b. 2
c. 3
d. 4
e. none of these
Answer: a

12. In the balanced chemical reaction, $XeF_4(g) + 2 H_2O(g) \rightarrow Xe(g) + 4 HF(g) + O_2(g)$, what mass of water is required to react completely with 10 g of XeF_4?
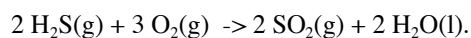a. 0.87 g
b. 1.20 g

c. 1.74 g
d. 2.40 g
e. none of these

moles of XeF_4: $(10 \text{ g})(131+(4\times19)\text{g/mol})^{-1} = 0.048\text{mol}$
moles of H_2O: $(2)(0.048 \text{ mol})(18 \text{ g/mol}) = 1.73 \text{ g}$
Answer: c

For the next two questions, consider the reaction between hydrogen sulfide gas (H2S) and oxygen to produce sulfur dioxide gas (SO2) and water according to the balanced equation,

$$2 \text{ H}_2\text{S(g)} + 3 \text{ O}_2\text{(g)} \rightarrow 2 \text{ SO}_2\text{(g)} + 2 \text{ H}_2\text{O(l)}.$$

All gas volumes are assumed to be measured under the same fixed conditions of temperature and pressure.

13. How much H_2S will be required to react completely with 6.1 g of O_2?
a. 2.7 g
b. 4.3 g
c. 6.5 g
d. 8.7 g
e. none of these
Answer: b
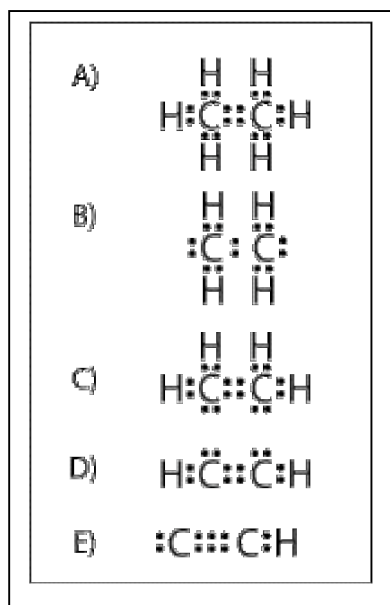$[(6.1 \text{ g O}_2)/(32 \text{ g / mol O}_2)](2 \text{ mol H}_2\text{S/3 mol O}_2) (34 \text{ g /mol H}_2\text{S}) = 4.3 \text{ g}$

14. What volume of SO_2 can be produced from the complete reaction of 8.9 L of O_2?
a. 2.0 L
b. 3.0 L
c. 8.9 L
d. 13 L
e. none of these
Answer: e

15. Which one of these dot structures is correct?

a. Structure A
b, Structure B
c. Structure C

e. Structure D

f. none of these

answer: f

16. If 18.0 g of CaC_2 reacts to produce 0.200 mol of C_2H_2, the percentage yield of the reaction is

[for problems 16 and 17 assume (i) STP and (ii) the reaction is $CaC_2 + H2 \rightarrow C_2H_2 + Ca^{2+}$.]

a. 36%

b. 58%

c. 80%

d. 90%

e. none of these

Answer: e

17. If the percentage yield of C_2H_2 is known to be 80.0%, what volume of $C_2H_2(g)$ is expected to be produced from 64 g of CaC_2 (g)?

[see previous note]

a. 14 L

b. 18 L

c. 22 L

d. 28 L

e. none of these

Answer: b [22.4 x 0.8 = 17.9]

18. Solid manganese dioxide (MnO_2) reacts with hydrochloric acid [HCl(aq)] to yield manganese (II) chloride ($MnCl_2$), gaseous chlorine (Cl_2) and water. Assuming the reaction proceeds until the limiting reagent is consumed, how much Cl_2 is produced when 18 g of MnO_2 is added to 89 mL of 1.3 M HCl?

a. 0.71 g

b. 1.4 g

c. 2.0 g

d. 2.9 g

e. 3.9 g

[Answer: c (**answers revised 12/11**)

(i) balance the reaction: $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$

(ii) Find the limiting reagent:

MnO_2: 18 g/ 87 g/mol = 0.21 moles

HCl: (0.089 L)(1.3 mol/L) = 0.12 moles

Since 4 moles of HCl react with 1 mole of MnO_2, you have to divide the number of moles of HCl by 4 to get the number of moles of MnO_2 consumed. So, HCl is the limiting reactant because 0.12 moles of HCl will consume 0.03 moles of MnO_2. The reaction will use up all the HCl before it uses up the MnO_2.

(ii) The final answer: The number of moles of MnO_2 produced is (0.089L)(1.3mol/L)(1/4 mol Cl_2/mol HCl)(70g/mol)=2.02 grams]

Chapter 3

19. In which of the following atoms is the number of valence electrons equal to six?

a. P (5 valence electrons $3s^2 3p^2$)

b. Se (6 valence electrons $4s^2 4p^4$)

c. Sb (5 valence electrons $5s^2 5p^5$)

d. all of these

e. none of these

[don't count the d electrons]

Answer: b

20. In which of the following atoms is the number of core electrons equal to 54?

a. Ba

b. Ra

c. Xe
d. all of these
e. none of these
Answer: a
Comment: It seems to me that c is also a correct answer. Since the shell is full all electrons are core electrons. Xe has no valence electrons. What do you think?

Chapter 4.

21. Which of the following pairs of substances should be miscible in all proportions?
a. $C_2H_5OH(l)$ (ethanol) & $H_2O(l)$
b. $KNO_3(s)$ & $H_2O(l)$
c. $CCl_4(l)$ & $H_2O(l)$
d. $CCl_4(l)$ & $O_2(g)$
e. none of these
Answer: a

22. When calcium hydroxide is neutralized with sulfurous acid, the salt produced is
a. CaS
b. $CaSO_2$
c. $CaSO_3$
d. $CaSO_4$
e. none of these
Answer: c

23. When perchloric acid is neutralized with lithium hydroxide, the salt produced is
a. LiCl
b. LiClO
c. $LiClO_2$
d. $LiClO_3$
e. none of these
Answer: e

24. The oxidation number of the arsenic atom in Na_3AsO_3 is
a. +1
b. +3
c. +5
d. +7
e. none of these
Answer: b

25. The oxidation number of the fluorine atom in F_2 is
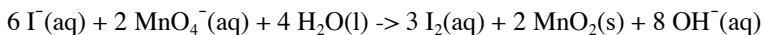a. −1
b. −0.5
c. +0.5
d. +1
e. none of these
Answer: e

26. The respective oxidation numbers of the nitrogen atoms in NH_4NO_3 are
a. +5 and +5
b. +5 and +3
c. −3 and +3
d. −3 and +5
e. none of these
Answer: d

For questions the next two questions, consider the reaction,

$6\ I^-(aq) + 2\ MnO_4^-(aq) + 4\ H_2O(l) \rightarrow 3\ I_2(aq) + 2\ MnO_2(s) + 8\ OH^-(aq)$

27. The element oxidized is
a. iodine
b. hydrogen
c. magnesium
d. oxygen
e. none of these
Answer: a

28. The element reduced is
a. iodine
b. hydrogen
c. magnesium
d. oxygen
e. none of these
MnO4-: Mn ox state is 7
MnO2: Mn ox state is 4
Since Mn is reduced, but is not listed above, so the answer is e.
Answer: e

For Chapter 16, you need to understand the principle quantum number only. The following questions are beyond what you need to know for this exam.

29. Which of the following is an acceptable value for the magnetic quantum number when $l = 3$?
a. −2
b. 0
c. −1/2
d. None of these is acceptable.
e. More than one of these are acceptable.
Answer: e

30. Which of the following is not a valid value for the magnetic quantum number of a 4p orbital?
a. 2
b. 1
c. 0
d. −1
e. All of these are valid.
Answer: a

Chaper 17

31. The electron configuration for sulfur is
a. $1s^2 2s^2 2p^6 3s^2$
b. $1s^2 2s^2 2p^6 3s^2 3p^1$
c. $1s^2 2s^2 2p^6 3s^2 3p^4$
d. $1s^2 2s^2 2p^6 3s^2 3p^5$
e. none of these
Answer: c

Chapter 5

32. The pressure of 450 mL of a gas is 1.0 atm. If the volume is reduced until the pressure of the gas is 5.0 atm, the resulting volume will be
a. 75 mL
b. 90 mL
c. 45 mL
d. 2.3 L
e. none of these
Answer: b

33. If a solution containing 4.0 g of sodium hydroxide is exactly neutralized by 80 mL of an aqueous sulfuric acid solution, the molarity of the sulfuric acid must have been
a. 0.00013 M
b. 0.0013 M
c. 1.3 M
d. 13 M
e. none of these
Answer: e