

Chemistry 150

Exam 1

Be sure to put your name on each page. This page can be removed from your exam so that you will have a Periodic Table handy throughout the exam, it does not need to be turned in. Show all your work for non-multiple choice problems which require any sort of calculation, no credit will be given for answers without work shown. If you have shown a significant amount of work or multiple drawings for a problem, draw a box around what you consider your final answer.

Avogadro's Number = 6.022×10^{23} units/mol

$32.00^\circ\text{F} = 0.000^\circ\text{C} = 273.15\text{K}$

1 foot = 12 inches

1 inch = 2.54cm (exactly)

1 pound = 453.6 g = 16 ounces

1 gallon = 3.785L

1 amu = 1.6605×10^{-24} g

Masses of subatomic particles:

Proton $1.00728\text{amu} = 1.6726 \times 10^{-24}$ g

Neutron $1.00866\text{amu} = 1.6749 \times 10^{-24}$ g

Electron $0.000549\text{amu} = 9.1094 \times 10^{-28}$ g

$R = 0.08206 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$

1 H 1.0079																	2 He 4.0026				
3 Li 6.941	4 Be 9.0122															5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305															13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.88	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80				
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29				
55 Cs 132.91	56 Ba 137.33	71 Lu 174.97	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)				
87 Fr (223)	88 Ra 226.03	103 Lr (260)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (269)	111 Rg (272)	112 Cn (277)	113	114	115	116	117	118				

57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.94	70 Yb 173.04
89 Ac 227.03	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (258)	101 Md (258)	102 No (259)

Multiple Choice: Circle the letter of the most correct response. (4pts. per question)

- Under what conditions is a gas *most* “ideal”?
 - Low temperature, low pressure
 - High temperature, low pressure**
 - 25°C, 1.00atm
 - High temperature, high pressure
 - Low temperature, high pressure
- Which mass is *largest*?
 - 0.112mg
 - 1.62x10⁸ µg**
 - 7.25g
 - 9.37x10⁻⁹ kg
 - 4.38x10⁻⁷ g
- Different isotopes of an element:
 - Have the same number of protons**
 - Have the same charge
 - Have the same number of electrons
 - Have the same mass number
 - Have the same number of neutrons
- Which of the following formulas is *least ionic*?
 - BaF₂
 - HgO
 - NO₂**
 - NiI₂
 - Mn₂S₃
- The volume of a gas:
 - Increases as the temperature increases**
 - Is constant as the amount of gas is increased
 - Is always a constant
 - Increases as the pressure increases
 - Increases as the kinetic energy decreases
- Which of the following sets of elements contains a metal, a metalloid/semi-metal and a nonmetal?
 - As, O, Rb**
 - Fe, He, Pb
 - N, O, Se
 - F, Ar, Ti
 - K, Mo, U
- Which of the following polyatomic ions has the *most oxygen atoms*?
 - sulfate**
 - hydroxide
 - azide
 - chlorite
 - carbonate
- Which of the following organic molecules has the *most carbon atoms*?
 - Methyl amine
 - Hexene**
 - Butanol
 - Ethane
 - Propyne
- Which of the following is *not* a correct gas law relationship?
 - PV = nRT
 - n₁T₁ = n₂T₂
 - V₁n₁ = V₂n₂**
 - P₁V₁ = P₂V₂
 - P₁ / T₁ = P₂ / T₂

10. Complete each row of the following table (3pts per box):

Symbol	Number of Protons	Number of Neutrons	Number of Electrons	Atomic Number	Mass Number	Charge
Na	11	13	12	11	24	-1
C	6	8	9	6	14	-3
Hf	72	103	68	72	175	+4
Sb	51	72	51	51	123	0

Short Problems: Show your work, your final answer must be written in the “Answer” box to receive full credit. (8pts each)

11. What is the formula weight of rubidium carbonate? (Atomic # of rubidium = 37)

$$\text{Rb}_2\text{CO}_3$$
$$2(85.468\text{g/mol}) + 1(12.011\text{g/mol}) + 3(15.999\text{g/mol}) = 230.944\text{g/mol}$$

Answer 11:

12. How many silicon atoms are present in a 18.372g sample of silicon (Atomic # = 14)?

$$\{ (18.372\text{g Si}) / (28.086\text{g/mol Si}) \} (6.022 \times 10^{23} \text{ Si atoms/mol Si}) = 3.939 \times 10^{23} \text{ Si atoms}$$

Answer 12:

13. What is the mass in grams of 0.8493mols of mercury (Atomic # = 80)?

$$(0.8493\text{mols Hg}) (200.59\text{g/mol Hg}) = 170.4\text{g}$$

Answer 13:

14. What is the mass in grams of a sample of argon (Atomic # = 18) that contains 4.187×10^{24} Ar atoms?

$$\{ (4.187 \times 10^{24} \text{ Ar atoms}) / (6.022 \times 10^{23} \text{ Ar atoms/mol Ar}) \} (39.948\text{g/mol Ar}) = 277.8\text{g}$$

Answer 14:

15. An acre of wheat yields 2429 pounds of wheat. What is this mass in milligrams?

$$(2429 \text{ pounds}) (453.6\text{g/pound}) (1000\text{mg/g}) = 1.102 \times 10^9 \text{ mg}$$

Answer 15:

16. What is the volume of 5.613mols of ideal gas at 13.34°C and 2.813atm pressure?

$$PV = nRT$$
$$(2.813\text{atm}) V = (5.613\text{mol}) (0.08206 \text{ L}\cdot\text{atm/mol}\cdot\text{K}) (286.49\text{K})$$
$$V = 46.91\text{L}$$

Answer 16:

17. You have a 43.582L sample of gas at 12.51°C and 0.978atm. What is the volume of this gas if the pressure is increased to 2.348atm?

$$P_1V_1 = P_2V_2$$
$$(0.978\text{atm}) (43.582\text{L}) = (2.248\text{atm}) V_2$$
$$V_2 = 18.2\text{L}$$

Answer 17:

Problem:

18. You have found a bottle in your lab that contains an unknown mixture of cobalt(II) nitrate and cobalt(III) nitrate. You send the sample for analysis and receive the following results: %Co = 27.729; %N = 16.326; %O = 55.944. Does the sample contain more cobalt(II) nitrate or more cobalt(III) nitrate? What percent of the sample is cobalt(III) nitrate? Explain. (15pts)

Start by determining the percent composition of $\text{Co}(\text{NO}_3)_2$ and $\text{Co}(\text{NO}_3)_3$

$\text{Co}(\text{NO}_3)_2$
$182.941 \frac{\text{g}}{\text{mol}}$
$\% \text{Co} = (58.933 \frac{\text{g}}{\text{mol}}) / (182.941 \frac{\text{g}}{\text{mol}}) =$ $32.214\% \text{ Co}$
$\% \text{N} = \{2(14.007 \frac{\text{g}}{\text{mol}})\} / (182.941 \frac{\text{g}}{\text{mol}}) =$ $15.313\% \text{ N}$
$\% \text{O} = \{6(15.999 \frac{\text{g}}{\text{mol}})\} / (182.941 \frac{\text{g}}{\text{mol}}) =$ $52.473\% \text{ O}$

$\text{Co}(\text{NO}_3)_3$
$244.945 \frac{\text{g}}{\text{mol}}$
$\% \text{Co} = (58.933 \frac{\text{g}}{\text{mol}}) / (244.945 \frac{\text{g}}{\text{mol}}) =$ $24.060\% \text{ Co}$
$\% \text{N} = \{3(14.007 \frac{\text{g}}{\text{mol}})\} / (244.945 \frac{\text{g}}{\text{mol}}) =$ $17.155\% \text{ N}$
$\% \text{O} = \{9(15.999 \frac{\text{g}}{\text{mol}})\} / (244.945 \frac{\text{g}}{\text{mol}}) =$ $58.785\% \text{ O}$

NOTE: We really only needed the %Co to answer this question.

Since the measured %Co in the mixed sample is closer to the %Co in cobalt(III) nitrate, the sample must contain more cobalt(III) nitrate than cobalt(II) nitrate. How much more?

This is a “weighted average” problem. There are only 2 components, so let’s say that the fraction of the sample that’s cobalt(III) nitrate is “x” and the fraction of the sample that’s cobalt(II) nitrate is “1-x”.

$$(\text{value of mixed sample}) = (\text{fraction of A})(\text{value of A}) + (\text{fraction of B})(\text{value of B})$$

$$27.729 \% \text{Co} = (1-x)(32.214 \% \text{Co}) + (x)(24.060 \% \text{Co})$$

$$x = 0.5500$$

The sample is 55.00% cobalt(III) nitrate