

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

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

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|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| 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 |

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|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| 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 *least* “ideal”?
 - Low temperature, low pressure
 - High temperature, low pressure
 - 25°C, 1.00atm
 - High temperature, high pressure
 - Low temperature, high pressure**
- Which distance is *smallest*?
 - 0.112mm
 - 9.37×10^{-9} km
 - 4.38×10^{-7} m**
 - 1.62×10^8 μ m
 - 7.25m
- Different isotopes of an element:
 - Have the same number of electrons
 - Have the same mass number
 - Have the same number of protons**
 - Have the same charge
 - Have the same number of neutrons
- Which of the following formulas is *most ionic*?
 - NiI₂
 - Mn₂S₃
 - BaF₂**
 - HgO
 - NO₂
- The volume of a gas:
 - Decreases as the temperature increases
 - Is constant as the amount of gas is increased
 - Is always a constant
 - Decreases 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?
 - N, O, Se
 - F, Ar, Ti
 - As, O, Rb**
 - Fe, He, Pb
 - K, Mo, U
- Which of the following polyatomic ions has the *most oxygen atoms*?
 - phosphate**
 - hydroxide
 - cyanide
 - hypochlorite
 - nitrate
- Which of the following organic molecules has the *fewest carbon atoms*?
 - Butanol
 - Ethane
 - Propyne
 - Methyl amine**
 - Hexene
- Which of the following is *not* a correct gas law relationship?
 - $PV = nRT$
 - $n_1T_1 = n_2T_2$
 - $V_1n_1 = V_2n_2$**
 - $P_1V_1 = P_2V_2$
 - $P_1 / T_1 = P_2 / T_2$

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 |
|-----------|-------------------|--------------------|---------------------|---------------|-------------|-----------|
| N | 7 | 8 | 10 | 7 | 15 | -3 |
| Ca | 20 | 19 | 20 | 20 | 39 | 0 |
| Bi | 83 | 125 | 80 | 83 | 208 | +3 |
| Mg | 12 | 13 | 12 | 12 | 25 | 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 strontium nitrate? (Atomic # of strontium = 38)

$$\text{Sr}(\text{NO}_3)_2 \rightarrow 87.62 + 2(14.007) + 6(15.999) = 211.628$$

Answer 11:

$$211.628 \text{ g/mol}$$

12. How many sodium atoms are present in a 14.683g sample of sodium (Atomic # = 11)?

$$(14.683\text{g})(1\text{mol}/22.990\text{g})(6.022 \times 10^{23} \text{ atoms/mol}) = 3.846 \times 10^{23} \text{ Na atoms}$$

Answer 12:

$$3.846 \times 10^{23} \text{ Na atoms}$$

13. What is the mass in grams of 0.972mols of aluminum (Atomic # = 13)?

$$(0.972\text{mols Al})(26.982 \text{ g/mol}) = 26.2\text{grams}$$

Answer 13:

$$26.2\text{grams}$$

14. What is the mass in grams of a sample of krypton (Atomic # = 36) that contains 4.37×10^{22} Kr atoms?

$$(4.37 \times 10^{22} \text{ Kr atoms})(1\text{mol}/6.022 \times 10^{23} \text{ Kr atoms})(83.80 \text{ g/mol}) = 6.08\text{g}$$

Answer 14:

$$6.08\text{g}$$

15. A new Ford F-150 has a 36.49 gallon fuel tank. What is this volume in milliliters?

$$(36.49\text{gal})(3.785 \text{ L/gal})(1000 \text{ mL/L}) = 1.381 \times 10^5 \text{ mL}$$

Answer 15:

$$1.381 \times 10^5 \text{ mL}$$

16. What is the volume of 3.372mols of ideal gas at 17.14°C and 0.4629atm pressure?

$$(0.4629\text{atm})V = (3.372\text{mols})(0.08206 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K})(17.14+273.15\text{K})$$
$$V = 173.5\text{L}$$

Answer 16:

$$173.5\text{L}$$

17. You have a 24.17L sample of gas at 45.71°C and 1.002atm. What is the volume of this gas if the temperature is decreased to 3.65°C?

$$V_1 / T_1 = V_2 / T_2$$
$$(24.17\text{L}) / (45.71+273.15\text{K}) = V_2 / (3.65+273.15\text{K})$$
$$V_2 = 20.98\text{L}$$

Answer 17:

$$20.98\text{L}$$

Fall 2011

Problem:

18. You are working in a food production facility and have found an unlabelled barrel. From inventory records, you know that it is either fructose which has a molecular weight of about $180^{\text{g/mol}}$ or ethyl benzoate which has a molecular weight of about $150^{\text{g/mol}}$. You send a sample for analysis and receive the following results: %C = 71.98, %H = 6.711, %O = 21.31. What is the *empirical* formula of this substance? What is the molecular weight of this empirical formula? Does the barrel contain fructose or ethyl benzoate? Explain. (15pts)

$$\text{C} \rightarrow 71.98\text{g}/12.011^{\text{g/mol}} = 5.993\text{mols} \rightarrow 4.5 \rightarrow 9$$

$$\text{H} \rightarrow 6.711\text{g}/1.0079^{\text{g/mol}} = 6.658\text{mols} \rightarrow 5 \rightarrow 10$$

$$\text{O} \rightarrow 21.31\text{g}/15.999^{\text{g/mol}} = 1.332\text{mols} \rightarrow 1 \rightarrow 2$$

$$\text{Empirical formula} = \text{C}_9\text{H}_{10}\text{O}_2 \rightarrow 150.176^{\text{g/mol}}$$

Since the molecular formula must be a multiple of the empirical formula, the barrel must contain ethylbenzoate.