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Chemistry 107 : Exam 3A

The 100 pts exam consists of 10 questions and students have 2 hours to complete the exam. Answers must be written in the box provided or else no credit is provided. Use the empty space provided to do your work. A periodic table and formulas are provided at the end. Additional scratch paper will be provided. Fill in your name along with your student ID number.

Problem 1 : True/False Determine whether the statement is true or false. (10 pts)

(a) The theoretical yield is determined based on the amount of the limiting reagent.

(b) The mass before and after the reaction is conserverd.

(c) An example of an exothermic reaction is melting ice into water.

(d) Suppose two objects are at thermal equilibrium. Then, there is no flow of heat between the objects.

(e) Fluorine has the highest electronegativity.

(f) Exothermic reactions releases heat.

(g) The Bohr model of an atom can accurately describe the atomic spectra of large atoms.

(h) When an electron in the hydrogen atom falls from $n = 2$ to $n = 1$, then light is being absorbed.

(i) In a continuous spectrum, the energy of the electron is not quantized.

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Problem 2 : Thermal Equilibrium (12 pts)

(a) Suppose 150.0g of water at 95°C is mixed with 50.00g of water at 15°C. The specific heat of water is 4.184 J/(g °C). At thermal equilibrium, what is the final temperature ? Report to 4 significant figures.

(b) Describe using illustrations and/or equations to show how thermal equilibrium is achieved.

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Problem 3 : Nomenclature Provide either the molecular formula or compound name for the following. (6 pts)

(a) Sulfur monoxide

(b) $MgCrO_4$

(c) $HClO_2$

(d) $Cu_3(PO_4)_2$

(e) H_2CO_3

(f) Chlorine trifluoride

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Problem 4 : Preparing Solutions A scientist is making $CuSO_4$ solution for his experiments. The available solute is $CuSO_4 \cdot 5H_2O$ (Molar mass = 249.68 g/mol). Answer the following questions and report to 3 significant figures. (8 pts)

(a) The scientist prepares 2L stock solution of 3M $CuSO_4$. Determine what mass (in g) of $CuSO_4 \cdot 5H_2O$ needed to prepare the solution.

(b) The scientist only has 250mL volumetric flask available to dilute the 3M $CuSO_4$ stock solution to 0.75M $CuSO_5$ What volume in L of stock solution is needed to dilute to prepare 250.mL of 1.5M $CaCl_2$?

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Problem 5 : Photosynthesis - the Chloroplast Photosynthesis is a vital process providing organisms oxygen and food. Plants performs this vital process using a protein called chlorophyll a. The protein absorbs mainly light at 430nm (violet) and and 662nm (red). Answer the following questions and report to 3 significant figures. (8 pts)

(a) Determine the energy in J of the violet (430nm) and red light (662nm) that chlorophyll a absorbs.

(b) How much energy is contained in one mole of photons for violet and red lights ?

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Problem 6 : Energy from a Laser In 2021, HiLASE Center broke the world record developing the strongest high-energy laser that emits a wavelength of 1030nm. Answer the following questions and report to 3 significant figures. (12 pts)

(a) Determine the energy of a single photon from 1030nm.

(b) A single laser pulse emits 145 Joules of energy. Determine how many photons that is.

(c) Compute the energy in J/mol of a mole of photon at 1030nm. Compare this energy to part b).

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Problem 7 : Drawing Lewis Structures Draw the Lewis structures for the following compounds, identify the geometric shape, and whether the compound is polar or nonpolar. If there are resonance structures, then include them in your answer.(12 pts)

(a) CO_2

(b) SCN^-

(c) BF_3

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Problem 8 : Periodic Properties Rank the following periodic properties. (8 pts)

(a) Rank elements from highest to lowest first ionization energy : F, Li, He, Mg, I

(b) Rank elements from highest to lowest electronegativity : Li, Be, Se, O, F

(c) Rank elements from largest to smallest atomic radius : He, H, K, F, I

(d) Ranking ions from largest to smeallest atomic radius : N^{3-}, I^{-}, Li^{+}, F^{-}, O^{2-}

Problem 9 : Electron Configuration Determine the electron configurations for the following. (14 pts)

(a) Mg

(b) S

(c) Al^{3+}

(d) Cr

(e) Zn^{2+}

(f) Fe^{2+}

(g) Ag^{+}

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Problem 10 : Combustion Reaction Propane (C_3H_8) is a colorless and odorless gas. It is commonly used for grilling. Per year, the US uses approximately 10.0 billion ($\times 10^9$) gallons of propane per year. This is equivalent to 1.86×10^{10} kg propane. Answer the following questions and report to 3 significant figures. (10 pts)

(a) Write the balanced chemical equation including states of the combustion reaction of propane (C_3H_8).

(b) In the presence of excess oxygen gas, determine the amount of carbon dioxide is produced in g ? Report in scientific notation.

(c) The combustion reaction of methane releases 2220.0 kJ/mol. Is this an exothermic or endothermic reaction ? How much heat is generated per year from propane usage ? Report in scientific notation.

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Chemistry 107 : Appendix 1 - Periodic Table

1 H Hydrogen 1.008																		2 He Helium 4.003
3 Li Lithium 6.94	4 Be Beryllium 9.012												5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305												13 Al Aluminum 26.982	14 Si Silicon 28.085	15 P Phosphorus 30.974	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078		21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.630	33 As Arsenic 74.922	34 Se Selenium 78.97	35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62		39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium [97]	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	53 Te Tellurium 127.60	53 I Iodine 126.904	54 Xe Xenon 131.293
55 Cs Cesium 132.905	56 Ba Barium 137.327	* 57 - 70	71 Lu Lutetium 174.967	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	78 Ir Iridium 192.217	79 Pt Platinum 195.084	80 Au Gold 196.997	81 Hg Mercury 200.592	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [210]	86 Rn Radon [222]
87 Fr Francium [223]	88 Ra Radium [226]	** 89 - 102	103 Lr Lawrencium [262]	104 Rf Rutherfordium [267]	105 Db Dubnium [270]	106 Sg Seaborgium [269]	107 Bh Bohrium [270]	108 Hs Hassium [270]	109 Mt Meitnerium [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [281]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [289]	116 Lv Livermorium [293]	117 Ts Tennessine [293]	118 Og Oganesson [294]

*Lanthanide series	57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.242	61 Pm Promethium [145]	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.045
**Actinide series	89 Ac Actinium [227]	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium [237]	94 Pu Plutonium [244]	95 Am Americium [243]	96 Cm Curium [247]	97 Bk Berkelium [247]	98 Cf Californium [251]	99 Es Einsteinium [252]	100 Fm Fermium [257]	101 Md Mendelevium [258]	102 No Nobelium [259]

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Chemistry 107 : Apppendix 2 - Formulas and Constants

$$
\begin{aligned}
q &= mC\Delta T \\
E &= \frac{hc}{\lambda} = h\nu \\
h &= 6.626 \times 10^{-34} \text{J s} \\
c &= \lambda\nu \\
c &= 3.00 \times 10^{8} \text{m/s} \\
N_A &= 6.022 \times 10^{23}
\end{aligned}
$$