US 110 Exam 1. Jordan, Fall 2003

Name Key

By submitting this exam, I affirm that I have neither given nor received unauthorized aid on this assignment.

You must show all work for credit. Express each answer to the correct number of significant figures.

Useful information: 1 m = 1.094 yd, $°C = \frac{5}{9}(°F - 32)$ $°F = \frac{9}{5}(°C) + 32$, 1 in =2.54 cm, 1 kg = 2.2 lbs 1mL = 1cm³, % yield = $\frac{\text{actual}}{\text{theoretical}} \times 100\%$

(1)(2 points) Which statement concerning the structure of the atom is correct?

(A) Protons and neutrons have most of the mass and occupy most of the volume of the atom.

(B) Electrons have most of the mass and occupy most of the volume of the atom.

(C) Electrons have most of the mass but occupy very little of the volume of the atom.

(D) Protons and neutrons have most of the mass but occupy very ~~little of the volume of~~ the atom.

(2)(2 points) An atom of strontium–90 (Sr) contains

(A) 38 electrons, 38 protons, 52 neutrons.

(B) 38 electrons, 38 protons, 90 neutrons.

(C) 52 electrons, 52 protons, 38 neutrons.

(D) 52 electrons, 38 protons, 38 neutrons.

(3)(6 points) What is the empirical formula for the substance with this analysis:

Elemental Analysis
Na 54.0%
B 8.50%
O 37.5%

Assume 100g
54.0g ÷ 23.0 g/mole = 2.35 mole Na 2.35 ÷ 0.787 = 2.98
8.50g ÷ 10.8 g/mole = 0.787 mole B 0.787 ÷ 0.787 = 1
37.5g ÷ 16.0 g/mole = 2.34 mole O 2.34 ÷ 0.787 = 2.97

Atomic Molar Masses
B 10.8 g·mol⁻¹
Na 23.0 g·mol⁻¹
O 16.0 g·mol⁻¹

3/4 1/3 3/0

(A) Na_3BO_3

(B) Na_4BO_4

(C) $Na_2B_2O_3$

(D) NaB_2O_2

(13)(4 points) How would you prepare 100.0 mL of a 0.100 M solution of NaOH from a 0.235 M stock solution? 100mL = 0.100L

$0.100L\left(\frac{0.100\ mol}{L}\right) = 0.0100\ mol\ NaOH$

$0.0100\ mol \div \frac{0.235\ mol}{L} = 0.0426L = 42.6mL$

Dilute 42.6mL of 0.235M NaOH to 100mL.

(14) Fill in the following table (4 points)

	Formula	Name
a	KClO	potassium hypochlorite
b	H_2SO_3	sulfurous acid
c	PF_5	phosphorus penta fluoride
d	Cu_2O	copper (I) oxide

Extra Credit: (4 points)
In *An Outline of Science*:

(a) Caution is urged when evaluating information from new techniques. Faraday called such knowledge

(a) "trendy" knowledge

(b) "doubtful" knowledge

(c) "cool" knowledge

(d) "bad" knowledge

(b) A discussion of scientific symbols was presented. When a concept is used, but has not been exactly defined and/or observed, it is merely a symbol and not reality. As an example, for a long time the atom was merely a symbol (Dalton didn't exactly know what it was, but it was very useful). Then, the atom became a reality. Another common symbol was discussed which is now reality. What was it?

Gene

(11)(4 points) Rhenium only consists of two naturally occurring isotopes. If the following information represents the abundance and mass of the two isotopes, what is the average molecular weight that should go on the periodic table (this will not be the actual mass on the periodic table).

mass = 185.955 amu, abundance = 37.40%

mass = 188.959 amu, abundance = 62.60%

$0.3740(185.955\text{amu}) + 0.6260(188.959\text{amu}) = 187.84\text{amu}$

(12)(6 points) Acid rain destroys statues (made of $CaCO_3$) according to the following equation.

$CaCO_3 + 2HCl \text{ ----> } CaCl_2 + CO_2 + H_2O$ $\quad CaCO_3$ FW = 100.09 g/mol

A 10.0 g sample of $CaCO_3$ is reacted with 0.200 moles of HCl.

(a) Which reagent is the limiting reagent?

$10.0\text{g} \div 100.09\text{g/mol} = 0.0999\text{ moles } CaCO_3$

$0.0999\text{mol} \times \frac{2\text{mol HCl}}{1\text{mol } CaCO_3} = 0.1998\text{mol}$ $\quad CaCO_3$ is limiting

(b) How much of the excess reagent remains (in moles)?

$2.00\text{mol} - 1.998 = 0.010\text{ mol}$

(c) If the amount of $CaCl_2$ that formed was 10.0 g, what is the % yield? $0.0999\text{mol } CaCO_3 \times \frac{1\text{mol } CaCl_2}{1\text{mol } CaCO_3} = 0.0999\text{mol } CaCl_2$

Theoretical yield $= 0.0999\text{mol } CaCl_2 \times 110.98\text{g/mol} = 11.08\text{g } CaCl_2$

% yield $= \frac{10.0\text{g}}{11.08\text{g}} \times 100\% = \boxed{90.3\%}$

(8)(4 points) In movies, you often see thieves stuffing large bars of gold into backpacks. The density of gold is 19.31 g/mL. If a bar of gold has the dimensions of 30.0 cm x 10.0 cm x 5.00 cm, what is the mass of a bar of gold (in kg)?

$1mL = 1cm^3$ $30.0cm \times 10.0cm \times 5.00cm = 1500\ cm^3$

$1500cm^3 \times 19.31 g/cm^3 = 28,960\ g = 29.0kg$

(9) Whose experiment resulted in the modern view of the atom (with the small nucleus)? What was the experiment? Ernest Rutherford.

He shot α particles at gold foil. He found that some of them bounced back at sharp angles. This led him to conclude that the atom had a small positively charged center.

(10)(4 points) Classify the following as either element, compound, heterogeneous mixture, or homogeneous mixture.

(a) krypton element

(b) ink in a ball point pen homogeneous solution

(c) mashed potatoes(with lumps) heterogeneous mixture

(d) niobium element

$1m = 1.097yd$

$1.097yd \times \frac{3ft}{1yd} = 3.29ft = 1m$

(4)(4 points) Conversions

(a) Convert 344 ft^2 of carpet to m^2

$344ft^2 \times \left(\frac{1m}{3.29ft}\right)^2 = 31.8m^2$

$\frac{1m^2}{31.8ft^2}$

(b) What is 0 °F in °C?

$0°F = \frac{9}{5}(°C) + 32$

$-32°F = \frac{9}{5}(°C)$

$-18 = °C$

(5)(2 points) Balance the following equation

$(NH_4)_2CO_3 \rightarrow 2NH_3 + CO_2 + H_2O$

(6)(2 points) Complete the equation by switching the cations and anions of the reagents, then balance the equation (metathesis reaction)

$Ca_3(PO_4)_2 + 2Al(ClO)_3 \rightarrow 3Ca(ClO)_2 + 2AlPO_4$

(7)(5 points) List 4 points of Dalton's Atomic theory including the one that was later found to be incorrect (and circle the one that was incorrect).

All matter is composed of atoms

Atoms of the same type are an element

Atoms of the same type have the same mass