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1. **(7 points)** In the process of attempting to characterize a substance a chemist makes the following observations:

a) Distinguish between the difference between a physical and chemical property.

b) Identify the physical properties with a **P**, and the chemical properties with **C.**

 (1) The substance is a silvery white, lustrous metal.   (2) It melts at 649°C and boils at 1105°C.   (3) Its density is 1.738 g/cm3.   (4) It burns in air, producing an intense white light.   (5) It reacts with chlorine gas to give a brittle, crystalline solid.

Physical properties are characterized by measurement and description. The matter is not changed if crushed or cut, because no bonds are broken. Chemical properties refer to how the matter changes when the matter is reacted. Bonds are broken and new bonds are formed, creating new matter from the old. Statements 1, 2, & 3 are physical properties of this metal. They describe the appearance of the metal and its physical behavior that can be measured without destroying the metal. Statements 4 & 5 describe two typical reactions of the metal, burning in an atmosphere of chlorine gas to create a salt, and burning in an atmosphere of oxygen to create an oxide and light.

2. **(4 points)** Classify each of the following as an element [E], a compound [C] or a mixture [M]

a) **M**   muddy water that settles on standing

b) **M**   A filtered cup of coffee , no cream, no sugar

c) **M**   blood

d) **M**   Chocolate Chip Cookie

e) **C**   Salt (NaCl)

f) **M**   A bowl of beef noodle soup

g) **E**   Aluminum foil

h) **E**   Liquid bromine

Elements are the building blocks of matter. They consist of a single type of atom. We have elements (not many) in our homes, and I am not talking about elements of style. Aluminum foil made from a block of aluminum that is pressed to a desired thickness. A compound is a substance composed of more than one type of atom, like NaCl. Molecules are made when two or more atoms combine to form a substance using strong attractive forces. Bromine is an element, and a molecule. A mixture is composed of two or

more different types of matter that can be separated by physical means into their individual components. Blood is a mixture because it contains cells and such.

3. **(4 points)** Clarify the following confusing statements using the appropriate units of either °C, °F or K for temperature, oz, liters, or gal for volume, and ft, km, or mi for distance. For each value, only one of the units makes sense. [Hint: how far is 3000 ft compared to 3000 mi?] Explain your choices.

"I was thirsty today. I drank 8 of coke in 3 minutes. Then I ran 20 in about half a minute to catch a bus. Inside the bus it was hot. I think it was 90 because the air conditioning was not working and people were sweating."

I drank 8 oz of coke in 3 minutes. 8 liters is a lot. The human body holds about 5 liters of blood, so I think it would tax my fluids and kidneys to drink so much, so fast. The same can be said for 8 gal. Since a gallon is about 4 L, I would say the process would be worse than drinking 8 L. (This information is on the equation sheet in front of the exam)

I ran 20 ft in about half a minute to catch a bus. 20 Km, and 20 mi seem like an excessive distance to run in half a minute, since there are 5280 ft in a mile, so I would have to be the Flash or something. So big can of NOPE!

If the inside of the bus was hot and we are still alive, the temperature could be close to 90°F. That value seems reasonable. 90°C is close to the boiling point of water; we would be par-boiled (normal body temp is about 37°C). 90K would be very cold, and we would be frozen solid, since this value is -183°C. YIKES

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4. **(4 points)** These values are not written in the most appropriate metric prefix. Re write them please. Show the math and reasoning you used to support your answer.

a) 1.234×10^{12} nL

1.234×10^{12} nL	10^{-9}L	1 kL	12.34 kL
	1 nL	10^{3}L	

b) 9.73×10^{9} pg

9.73×10^{9} pg	10^{-12}g	1 mg	0.973 mg
	1 pg	10^{-3}g	

c) 7.564×10^{17} nm^3

7.564×10^{17} nm^3	$(10^{-9}$m$)^3$	$(1$mm$)^3$	0.7564 mm^3
	1 nm^3	$(10^{-3}$m$)^3$	

5. **(6 points)** Indicate which of the following are exact numbers or inexact numbers by designating your choice with an (E) or (I):

a) __I__ the mass of a paper clip

b) __I__ the surface area of a dime

c) __E__ The number of pennies in a nickel

d) __I__ The temperature of the surface of the sun

e) __E__ The number of toes on your feet .

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Differentiate between exact and inexact and explain your choices with complete sentences.

Exact numbers are values that are counted or are used as a definition to define connections between measurement systems. They do not change the number of significant figures of a value.

Inexact numbers arise from measurement. They have a degree of uncertainty and are based on the precision of the tool used for the measurement. They have inherent error. Therefore, the value is known only to a certain degree and is based on the 'goodness' of the tool and the skill of the user.

6. **(5 points)** Indicate the number of significant figures in each of the following measured quantities:
   a) 8.1441 mg   **5**

   b) 0.00050 m^2 **2**

   c) 6,480,100 s   **5**

   d) −15.20°C   **4**

   e) 10.0800 x 10^{-2}cg   **6**

7. **(5 points)** Perform the following calculation and report your answer with the correct significant figures and units.
   a) 2.17 g + 4.32 g + 401.278 g + 21.826 g

       2.17
       4.32
     401.278
     $\underline{21.826}$
     429.594

   b) 2.156 934 X 10^{114} M°C + 2.314 276 X 10^{115} M°C + 2.954 681 X 10^{116}M°C

      2.156 934 X 10^{114} M°C + 2.314 276 X 10^1 X 10^{114} M°C + 2.954 681 X 10^2 X 10^{116}M°C
      2.156 934 X 10^{114} M°C + 23.14 276 X 10^{114} M°C + 295.4 681X 10^{114}M°C
      =320.7977|94 X 10^{114}M°C
      =3.207 678 X 10^{116}M°C

8. **(5 points)** 25 family members attended my birthday party. I served each member 3 hamburgers, 22 French fries, 2 cans of soda, and 1 piece of cake. The piece of cake was 1.5 in long, 1.5 in wide, and 1.5 in high. I collected 1 bag of recyclable material with a mass of 112 kg and 2 bags of compostable material each with a mass of 201 kg.

Of the following values 3, 22, 2, 1.5, 112 presented in the paragraph above, which are exact numbers? Explain

3 hambergers, 22 french fries (independent of size!), 2 cans of soda (or 2 bags of compostables) are all exact because they are values that are counted. Exact numbers are values thatare counted or used as a universal definition. They have no error when physically counted.

1.5 in and 112 kg are measured values and are inexact because measured values have a degree of inprecision which leads to guessing and error. They are imprecise.

9. **(5 points)** Write the correct symbol, with both superscript and subscript (nuclide symbol) for the ions and atoms listed below:
a) The ion that has 30 protons and 36 neutrons and a +3 charge?

$$^{66}_{30}Zn^{3+}$$

b) The nuclide symbol for the element that has 79 electrons and 118 neutrons?

$$^{187}_{79}Au$$

c) The nuclide symbol for a bromine-80 atom.

$$^{85}_{35}Br$$

10.   **4 points)** Recently surfaced is " The Periodic Table of Rejected Elements," constructed by Gerber and Schwartz, noted table-ologists. There is something wrong with the name, the symbol or both. As a hint, they have included the atomic number, which is the only thing correct in this periodic table. Please correct the errors by writing BOTH the name and symbol.

Artistic elements:

27   Mondrianium (Ma) **Co, cobalt**

3   Picasso (Pi) **Li, lithium**

24   Hopper (Hp) **Cr, chromium**

37   Celinedion (Cd) **Rb, rubidium**

11.   In the opening scenes of the movie Raiders of the Lost Ark, Indiana Jones tries to remove a gold idol from a mass sensitive booby-trapped pedestal. He replaces the idol with a bag of sand of approximately equal volume to that of the idol. (Density of gold = 19.32g/mL; Density of sand = 1.91 g/mL) The idol has a radius of 7.50 cm. Volume of a sphere = (4/3) πr³

a) **(4 points) What** is the mass of the gold idol? What is the mass of sand bag? Did Indiana Jones have a reasonable chance for not activating the mass sensitive booby trap? Explain in one or two brief sentences.

Volume of the idol and the sandbag that Indiana Jones used:

$$V = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi(7.50cm)^3 = 1767.1cm^3$$

Mass of sand				Mass of gold		
1,767. 1cm³ sand	1.91g sand	1mL sand		1,767.1 cm³ Au	19.32 g Au	1ml Au
	1mL sand	1 cm³			1 mL Au	1 cm³ Au
3,375.2 g sand => 3.38 X10³g sand 3.38 kg sand				34,141 g Au, => 3.41 X10⁴ g, 34.1 kg Au		

Indie triggered the trap because he convused volume with density and mass. Density is the ratio of the volume to the mass. Sand has a lower density than gold. Since the volumes were the same, the mass becomes important. For the

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same volume, gold delivers more mass than sand. Indie wound need 10X the volume of sand to be safe from the trap, since the mass of the sand was 1/10th that of gold.

b) **(4 points)** In a later scene he and an unscrupulous guide play catch with the idol. What is the mass of the idol in units of pounds? (2.205 lb = 1 kg) Is playing catch with it a possibility for the average (couch-potato) person? (For reference: a bag of sugar weighs 5 lbs, imagine running and tossing this at the same time.)

34,141 g Au,	1 lb
	453.592 g Au

75.267 lb Au => 75.3 lb Au. Being the average couch-potato person, I can barely imagine tossing a 5.0 lb bag of sugar while walking let alone running. So something that is 15x heavier than a bag of sugar, no, not at all.

12. **(7 points)** Copper can be drawn into thin wires. How many kilometers of 34gauge wire (diameter = 6.304 X 10-3 in) can be produced from the copper in 5.1256 lb of covellite, an ore that is 66.013% copper by mass. The volume of a cylinder is $\pi r2h$, d_{Cu} = 8.95g/cm³.
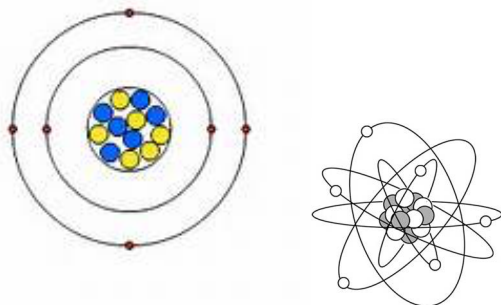
5.126 lb ore	453.592 g̶ ̶o̶r̶e̶	6.6103 g̶ ̶C̶u̶	1cm³ Cu	= 171.481 cm³ Cu
	1 l̶b̶ ̶o̶r̶e̶	100.00 g̶ ̶o̶r̶e̶	8.95 g C̶u̶	

Diameter/2 = r; 6.304 X10⁻³ in/2 = 0.003151 in

171.481 c̶m̶³ Cu	·←leaving 1 cm on top	1 i̶n̶²	10⁻²m̶	1 km	= 8.52 km
π	(0.003151 in)²	(2.54 c̶m̶)²	1c̶m̶	10³m̶	

13.   **(5 points)** Draw the microscopic picture that represents an isotope of carbon with a mass number of 13 amu. Accptable:

14.   **(6 points)** Each of the statements given below is true, but Dalton might have had trouble explaining some of them with his atomic theory. Give an explanation why the following statements are true, yet were not explained in Dalton's atomic theory.

a) Ethyl alcohol and dimethyl ether have the same composition by mass (52% carbon, 13% hydrogen and 35% oxygen) yet the two have different melting points, boiling points, and solubility in water.

Dalton did not have the ablity to determine structure. In lecture, we discussed how isomers (compounds with the same formula, but different structures) have different physical properties. The composition of these compounds is the same, per Dalton, but the structure is not.

b) Burning wood leaves an ash that is only a small fraction of the mass of the original wood.

If Dalton had the means to capture the gases that escaped when wood is burned, he would be able to weigh all the products. Then he would show that, indeed, mass is conserved in a chemical reaction, because matter is conserved.

c) Atoms can be broken down into smaller, subatomic particles.

Dalton lived before the "atomic" age, so he could not have known that atoms were made of smaller particles. However, when the atom is broken apart, the function or unique chemical nature of that atom is destroyed. So in a way, Dalton is correct that matter is not infinitely divisible.

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15.   **(4 points)** What is the formula for caffeine: 8 carbons; 10 hydrogens, 4 nitrogens and 2 oxygens?

$$C_8H_{10}N_4O_2$$

16.   **(5 points)** In Chapter 2, we studied the basic architecture of the atom. Answer the following by identifying the true and false statements. Correct the false statements and make then true. Use a complete sentence for full credit.

a) [T] [F] The atomic number indicates the number of electrons and neutrons.

The atomic number indicates the number of protons and the number of electrons because atoms are electronically neutral. For that to happen, the number of electrons must equal the number of protons

b) [T] [F] Protons and electrons reside in the atomic nucleus.

Protons and neutrons reside in the nucleus. Protons and neutrons have the most mass of the three particles important in chemistry. The nucleus is the most massive part of the atom, so that is where one would find the most massive particles.

c) [T] [F] The electron and the proton have about the same mass to three significant figures, 1.00 amu.

Electrons and protons are not the same mass. The mass of the electron is 1/2000 an amu, while the proton is about 1.00amu. The neutron is also 1.00 amu.

d) [T] [F] The charge of the proton and the neutron are equal but opposite in sign.

The proton and the electron have charges that are equal but opposite in sign. The neutron does not have a charge.

e) [T] [F] The electron has most of the mass and comprises the volume of the atom.

The electron is not massive. The nucleus has most of the mass. this is where the protons and neutrons are found. The electron comprises the volume of the atom. We think of electrons in an atom as a misty cloud. We will see more about this in chapter 6.

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17. **(5 points)** Two isotopes of element Q (not its real symbol) are ^{97}Q (23.4 % abundance) and ^{94}Q (76.6% abundance). ^{97}Q is 8.082 times heavier than ^{12}C (12.000 000 amu) and ^{94}Q is 7.833 times heavier than ^{12}C. What is the weight atomic mass of element Q?

0.766 X 7.833 X 12.00 amu + 0.234 X 8.082 X12.000 amu =

72.00 amu + 22.69 amu = 94.69 amu=> **94.7 amu**

18. (5 points) Give one example (atomic symbol and name) for each of the following:

   a. A transition element, which is ferromagnetic besides Fe. **The ferromagnetic elements are part of the 8B triad: Ni, Co.**

   b. The halogen that is a solid

   Iodine is the halogen that is a solid, I. Fluorine and chlorine are gasous; and bromine is a liquid.

   c. The main group (representative) element in the third period and 4th group

   The main group element in the third period and 4th gourp is Si, silicon.

   d. An alkali metal in the fourth period

   The alkali metal in the 4th period is K, potassium

   e. An alkaline earth metal in the second period

   The alkaline earth metal in the 2nd period is Be, beryllium

19. **(6 points)** Torbernite is a mineral structurally similar to mica, The formula unit is $Cu(UO_2)_2(PO_4) \cdot 10H_2O$. [There are 10 waters in the formula]

a) What is formula mass of torbernite? Use the following atomic masses for your calculation.

Cu-63.546 amu **x1**	63.456	amu
U-238.02891 amu **x 2**	476.057|82	amu
O-15.9994 amu **x15**	287.989|2	amu
P-30.973762 amu **x1**	30.973|762	amu
H-1.00794 amu **x 20**	20.158|8	amu
	878.725|582	amu
	878.726 amu	

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b) What is this mass in grams of one formula unit?

878.726 amu	1.660 X 10^{-24}g	=1.459 158X 10^{-21} g/ Formula unit
1 formula unit	1 amu	

20. **(5 points)** In Chapter 2, we are introduced to the periodic table. Answer the following by identifying the true and false statements. Correct the false statements and make then true by writing a complete sentence, not crossing out and repairing the answer.

a) In the modern periodic table, the elements are arranged in order of increasing atomic mass. [T] **[F]**

   Elements are arranged by atomic number in the periodic table.

b) Elements in a period have similar chemical properties [T] **[F]**

   Elements in a family have similar properties

c) Elements can be classified as either metalloids or non metals. [T] [F]

   Elements can be classified as metals, non metals, and sometimes, metalloids.

d) Non-metals are ductile, malleable, lustrous solids (for the most part) that are good conductors of heat. [T] **[F]**

   Metals are ductile, malleable, lustrous solids (Hg is a liquid) that are good conductors of heat.

e) Aluminum is a metalloid. [T] **[F]**

   Aluminum is near the region of the periodic table that has metalloids. It is not a metalloid. Aluminum has all of the properties of a metal, and none that make it a metalloid.

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21.   **(3 points)** Predict the formula formed from the following pairs of elements. DO NOT NAME THE COMPOUND!

a)   Ra and S   **RaS**

b)   K and N   **K₃N**

c)   Mg and P   **Mg₃P₂**

22.   **(5 points)** Balance the following equations, for this question, if the coefficient is 1[one], put that in the line as well. You will lose points if you leave the lines blank:

a) **2** CCl_4 +   **1** O_2 $\rightarrow$ **2** $COCl_2$ +   **2** Cl_2

b) **1** $C_9H_8O_4$ +   **9** $O_2 \rightarrow$ **4** H_2O + **9** CO_2

c) **1** Mg_2C_3 +   **4** $H_2O \rightarrow$ **2** $Mg(OH)_2$ + **1** C_3H_4

d) Do any of these reactions represent the decomposition process? Explain in one or two sentences why or why not.

None of the above reactions represent a decomposition. A decomposition occurs when a (only one) reactant breaks down to form many smaller, stable products. The first and third reactions are REDOX reactions. although we will study this type of reaction in chapter 4, you did not need to know that to answer this question. The second reaction is a combustion.

23.   **[5 points]** An element A (not it's real symbol) is in the family that has the most striking display of changing metallic character going down a column.

Factoids about element A: It was considered a minor factor in the down fall of Rome because citizens of Rome (and Greece) used it's acetate salt as a sweetening agent.

In Victorian times it was used to solder cans of food, to the detriment of Franklin's expedition, which set off in 1848 to find the Northwest Passage. The permanently frozen graves of the members were discovered in 1980; autopsies of the bodies showed deadly concentrations of this element in the tissues.

It was an additive in gasoline, which led to its presences in the atmosphere. Because it is very malleable, it was used to seal wine bottles at one time.

Currently, (no pun intended) it is used as electrodes in car batteries, by Superman's foes to shield them from his x-ray vision, and by your dentist to shield you from x-rays. It forms two oxides AO and AO_2. There are a lot of clues leading to the identity of element A.

What is element A? What are the formulas of the two oxides? What did the members of Franklin's expedition die from? Give a short sentence explaining your choice.

Element A is lead, Pb. There are a plethora of clues in the problem, some of which were discussed in lecture (including the Franklin expedition unfortunate demise). The most obvious clue is the lead shield that dentists and doctors use to protect patients from excess radiation.

The formulas of the two oxides are PbO and PbO$_2$.

The members of the Franklin expedition died from lead poisoning due to using lead solder to seal cans. The lead leached into the food and they succumbed to the effects of excess lead: madness, pain in the nerve endings, stomach cramps, and death. The worst part of the ordeal was the starvation that occurred forcing members to resort to cannibalism. All in all, none on this trip had a good time.

24. Which of the following would have the greatest metallic character? Explain your choice with one BRIEF sentence.

a) Li or Be **Li would be the most metallic because metallic character decreases across a row. Since Li is in group 1A and Be is in Group 2A, to the left of Li, it must be less metallic than Li**

b) F or I: **I would be more metallic than F. Metallic character decreases down a family. Iodine is below fluorine in the halogens (group 7A), so it would have more metallic character.**