COPPERBELT UNIVERSITY

CHEMISTRY DEPATMENT

CH110 TUTORIAL SHEET 1-INTRODUCTION 6 June 2015

Question 1

a) Classify each the following as a pure substance, or a mixture. If a mixture, indicate whether it is homogeneous or heterogeneous. (i) Nshima (ii) petrol (iii) beer (iv) copper (v) orange juice and (vi) oxygen gas.

Solutions

Name of substance	Type of substance	Homogeneous or Heterogeneous
1. Nshima	Mixture	Homogeneous?
2. Petrol	Mixture	Homogeneous
3. Beer	Mixture	Homogeneous
4. Copper	Pure substance	N/A
5. Orange juice	Mixture	Heterogeneous
6. Oxygen gas	Pure substance	N/A

b) In the process of attempting to characterize a substance, a chemist makes the following observations: The substance is **a silvery white metal**, it **melts at 649 °C** and boils at 1105 °C. Its **density at 20 °C is 1.738 g/cm^3**. The substance **burns in air**, producing an intense white light. It **reacts with chlorine** to give **a brittle white solid**. The substance can be **pounded into thin sheets and drawn into wires**. It is a **good conductor of electricity**. Which of these characteristics (in bold) are physical properties and which are chemical properties.

Solutions

Name of property	Property type (physical or chemical)
A silvery white metal (colour)	Physical
Melts at 639°C (melting point)	Physical
Density at 20°C is 1.738 g/cm^3	Physical
Burns in air	Chemical
Reacts with chlorine	Chemical
A brittle white solid	Physical
Pounded into thin sheets and drawn into wires	Physical
Good conductor of electricity	Physical

c) Learn the names and symbols of the first 36 elements of the periodic table by end of term one.

Solutions:

Write answers and mark yourself using the periodic table. Practice until you know answers

d) Label the following as either a physical or chemical process: (i) corrosion of an iron nail (ii) melting ice (iii) digesting a handful of groundnuts (iv) explosion of nitroglycerin (v) dissolving salt in water.

Solutions

Name of process	**Process type (physical or chemical)**
1. Corrosion of an iron nail	Chemical
2. Melting of ice	Physical
3. Digesting a handful of groundnuts	Chemical
4. Explosion of nitrogelycerin	Chemical
5. Dissolving salt in water	Physical

Question 2

a) Use appropriate prefixes to write the following measurements without exponents:
(i) 6.35×10^{-4}L (ii) 7.2×10^{-6} s (iii) $9.5\ 10^{-11}$ m (iv) 12.4×10^{-8} g (v) 10.1×10^{-2} K (vi) 5.2×10^{-9} m^3.

Solutions

Quantity as given	**Rewritten Quantity**
(i) 6.35×10^{-4} L	635 µL
(ii) 7.2×10^{-6} s	7.2 µs
(iii) $9.5\ 10^{-11}$ m	95 pm
(iv) 12.4×10^{-8} g	124 ng
(v) 10.1×10^{-2} K	10.1 cK
(vi) 5.2×10^{-9} m^3	5.2 nm^3

b) Use exponential notation to express the number 385,500 to (i) 1 significant figure (ii) 2significant figures (ii) 3 significant figures and (iv) 5 significant figures.

Solutions

(i) 4×10^5 (ii) 3.9×10^5 (iii) 3.86×10^5 (iv) 3.8550×10^5

c) Convert the following temperatures to Kelvin: (i) The melting point of sodium bromide (a salt) is 755 ^oC. (ii) Neon, a gaseous element at room temperature, melts at -248 ^oC.

Solutions

(i) 755 ^oC = 755 + 273.15 K = 1028.15 K (ii) -248 ^oC = -248 + 273.15 K = 25.15 K

d) A cube of osmium metal 1.500 cm on a side has a mass of 76.31 g at25 ^{o}C. What is its density in g/cm^{-3}?

Solution

$$Density = \frac{mass}{volume}$$

where mass = 76.31 g & volume = (cube's length)^3 = (1.500 cm)^3 = 3.375 cm^3

Thus

$$Density = \frac{76.31\ g}{3.375\ cm^3} = 22.61\ \text{g/cm}^3$$

Question 3

a) Indicate which of the following are exact numbers: (i) the mass of a paper clip (ii) the surface area of a 10 ngwee coin (iii) the number of grams in a kilogram (iv) the number of microseconds in an hour (iv) the mass of the tallest person your family.

Solutions

(iv) The number of microseconds in an hour because not obtained by measurement!

b) What is the number of significant figures in the following measured quantities:

(i) 325 km (ii) 0.0520 g (iii) 7.0500 x 10^{-3} m^3 (iv) 340.00 K

Solutions

(i) 3 (ii) 3 (iii) 5 (iv) 5

c) Round each of the following numbers to four significant figures:

(i) 102.53070 (ii) 656,980 (iii) 0.008543210 (iv) 0.0353551

Solutions

(ii) 102.5 (ii) 6.570×10^5 (iii) 8.543×10^{-3} (iv) 3.536×10^{-2}

d) Carry out the following calculations and express the answer to the appropriate number of significant figures:

(i) 12.0550 + 9.05 (ii) 257.2 – 19.789 (iii) (0.0045 x 21,000.00) +(2813 / 1.2)

Solutions

(i) 12.0550 + 9.05 = 21.105 Answer should have 2 decimals & is 21.11

(ii) 257.2 – 19.789 = 237.411 Answer should have 1 decimal & is 237.4

(iii) (0.0045 x 21,000.00) + (2813 / 1.2) = $\{(4.5 \times 10^{-3}) \times (2.100000 \times 10^4)\} + \frac{2813}{1.2}$

= {4.5×2.100000× 10} + 2344.166

= 94.500+2344.166 = 2438.66

Answer must have two significant figures & is 2.4×10^3

Question 4

a) Perform the following conversions:

(i) 0.076 L to mL (ii) 6.88 x 10^5 ns to s (iii) 500 days to seconds (iv) 22.50 gal/min to L/s (v) 0.510 in./ms to km/hr

(1 gal = 3.7854 L, 1 in. = 2.54 cm)

Solutions

(i) Since 1 L = 1000 mL then 0.076 L = 76 mL

(ii) Since 1 s= 1×10^9ns then 6.88×10^5 ns =6.88×10^5 ns$\times \frac{1\ \text{s}}{1\times10^9\ \text{ns}}$= 6.88×10^{-4} s

(iii) Since 1 day = 1 day × 24 hrs/day × 60 minutes/hr × 60 seconds/minute

= 86400 seconds

Then 500 days = 500 days × 86400 seconds/day = 43 200 000 seconds.

(iv) 22.50 gal/min = 22.50 gal/min×3.7854 L/gal = 22.50 ×3.7854 L/min

But 1 L/min = 1 L/min$\times \frac{1\ min}{60\ s} = \frac{1\ \text{L}}{60\ \text{s}}$

So that 22.50 ×3.7854 L/min =$22.50 \times 3.7854 \times \frac{1\ \text{L}}{60\ \text{s}}$

$=\frac{22.50 \times 3.7854\ \text{L}}{60\ \text{s}}$= 1.4195 L/s

Since the answer should have 4 significant figures it is 1.420 L/s

(v) Since 1 in = 1 in × 2.54 cm/in and 1 km = 1×10^5 cm

Then 1 in = $2.54\ \text{cm} \times \frac{1\ \text{km}}{1\times10^5\text{cm}} = 2.54 \times 10^{-5}\text{km}$

Since 1 hr = 1 hr $\times \frac{60\ min}{1\ hr} \times \frac{60\ s}{1\ min} \times \frac{1000\ ms}{1\ s} = 3\ 600\ 000\ ms$

Then 1 ms = $\frac{1}{3\ 600\ 000}\ hr$

So that 0.510 in./ms = $\frac{0.0510\times2.54\times10^{-5}km}{\frac{1}{3\ 600\ 000}\ hr}$

$= 5.10 \times 10^{-2} \times 2.54 \times 10^{-5} \times 3\ 600\ 000$km/hr

$= 4.66344$km/hr

Since the answer should have three significant figures it is 4.66 km/hr

b) The speed of light in vacuum is 2.998 x 10^8 ms^{-1}. Calculate its speed in km/hr.

Solution

Since 1 m = 1×10^{-3} km and 1 s = 1/3600 hr

Then $2.998 \times 10^8 ms^{-1} = 2.998 \times 10^8 \times 1 \times 10^{-3}\ \frac{km}{s} \times \frac{1}{\frac{1hr}{3600\ s}}$

$=2.998 \times 10^5 \times 3600\ \frac{km}{hr}$

$=2.998 \times 10^5 \times 3.6 \times 10^3\ \frac{km}{hr}$

$=2.998 \times 3.6 \times 10^8\ \frac{\text{km}}{\text{hr}}$ = 1.079×10^9km/hr

c) The density of air at ordinary atmospheric pressure and 25 ^{o}C is 1.19 g/L. What is the mass of air in kilograms in a room that measures 3.0 m x 5.0 m?

Question 5

a) Explain the difference between (i) law and theory (ii) precision and accuracy and (iii) homogeneous and heterogeneous mixture

Solutions

(i) A **law** is a generally observed behavior formulated into a statement while a **theory** is a set of assumptions put forth to explain some aspect of the observed behavior of matter.

(ii) **Precision** the degree of agreement among several measurements of the same quantity; the reproducibility of a measurement while **accuracy** the agreement of a particular value with the true value.

(iii) The main characteristic of a mixture is that it has *variable composition.* Mixturescan be classified as **homogeneous** (having visibly indistinguishable parts) or**heterogeneous** (having visibly distinguishable parts).

b) What is a hypothesis?

A **hypothesis** isone or more assumptions put forth to explain the observed behavior of nature.

Question 6

a) Which (if any) of the following can be determined by knowing the number of protons in a neutral element? Explain your answer:

(i) the number of neutrons in the neutral element
(ii) the number of electrons in the neutral element
(iii) the name of the element

Solutions

(i) Number of neutrons in the neutral element because if the isotope of the element is specified since number of nucleons (or mass number A) is the sum of the neutrons (N) and protons (P) in the isotope.

(ii) Number of electrons in the neutral element is equal to the number of protons.

b) Explain the law of conservation of mass, the law of definite proportion, and the law of multiple proportions.

Solutions

Law of conservation of mass states thatmass is neither created nor destroyed in chemical reaction.

Law of definite proportion states that a given compound always contains exactly the same proportion of elements by mass.

Law of multiple proportions isa law stating that when two elements form a series of compounds, the ratios of the masses of the second element that combine with one gram of the first element can always be reduced to small whole numbers.

c) Distinguish between the following terms.
(i)molecule versus ion (ii) covalent bonding versus ionic bonding (iii) molecule versus compound (iv) anion versus cation.

Solutions

(i) molecule versus ion:
A molecule is a bonded collection of two or more atoms of the same or different elements while an ion is an atom or a group of atoms that has a net positive or negative charge

(ii) covalent bonding versus ionic bonding
Covalent bonding is a type of bonding in which electrons are shared by atoms while ionic bonding the electrostatic attraction between oppositely charged ions, that is, between cations and anions.

(iii) molecule versus compound
A molecule is a covalent bonded group of two or more atoms while a compound is substance that has mode of more than one element. This can be ionic or covalently bonded.

(iv) anion versus cation
An anion is negatively charged ion while a cation is a positively charged ion.

d) Which of the following statements is(are) *true?* For the false statements, correct them.

Solutions:

(i) Most of the known elements are metals **-True**
(ii) Element 118 should be a non-metal**-True** (Specifically, should a noble gas!)
(iii) Hydrogen has mostly metallic properties**–False. It has mixed properties.**
(iv) A family of elements is also known as a period of elements**– False, Group.**
(v) When an alkaline earth metal, A, reacts with a halogen, X, the formula of the covalent compound formed should be A_2X.**–False. Should be AX_2**

Question7

a) A sample of chloroform is found to contain 12.0 g of carbon, 106.4 g of chlorine, and 1.01 g of hydrogen. If a second sample of chloroform is found to contain 30.0 g of carbon, what is the total mass of chloroform in the second sample?

Solution:

Sample No.	C Mass (g)	Cl Mass (g)	H Mass (g)	$CHCl_3$ Mass
1	12.0	106.4	1.01	12.0+106.4+1.01=119.5
2	30 (=12×2.5)	(106.4×2.5)	(1.01×2.5)	119.5×2.5=298.8

b) Write the atomic symbol (^A_ZX) for each of the followingisotopes.

Solutions:

(i) Z = 8, number of neutrons = 9**– Atomic symbol is $^{17}_{8}\mathbf{O}$**

(ii) the isotope of chlorine in which *A*= 37**– Atomic symbol is** $\mathbf{^{37}_{17}Cl}$

(iii) *Z* = 27, *A* = 60**– Atomic symbol is** $\mathbf{^{60}_{27}Co}$

(iv) number of protons = 26, number of neutrons = 31**– Atomic symbol is** $\mathbf{^{57}_{26}Fe}$

(v) the isotope of I with a mass number of 131**– Atomic symbol is** $\mathbf{^{131}_{53}I}$

(vi) *Z*= 3, number of neutrons = 4**– Atomic symbol is** $\mathbf{^{7}_{3}Li}$

c) For each of the following sets of elements, label each as eithernoble gases, halogens, alkali metals, alkaline earth metals, or transition metals.

Solutions

(i) Ti, Fe, Ag **- Transition metals**

(ii) Mg, Sr, Ba **– Alkaline metals**

(iii) Li, K, Rb**– Alkali metals**

(iv) Ne, Kr, Xe**– Noble gases**

(v) F, Br, I**– Halogens**

d) For each of the following ions, indicate the number of protons and electrons the ion contains.

(i) Ba^{2+}(ii) Zn^{2+}(iii) N^{3-} (iv) Rb^{+}(v) Co^{3+}(vi) Te^{2-}(vii) Br^{-}

Solutions

Ion	Number of protons (Z_p)	Number of electrons (Z_e)
(i) $\mathbf{Ba^{2+}}$	56	54
(ii) $\mathbf{Zn^{2+}}$	30	28
(iii) $\mathbf{N^{-3}}$	7	10
(iv) $\mathbf{Rb^{+}}$	37	36
(v) $\mathbf{Co^{3+}}$	27	24
(vi) $\mathbf{Te^{2-}}$	52	54
(vii) $\mathbf{Br^{-}}$	35	36

Question 8

a) Name the compounds in parts (i)-(iv) and write the formulas for the compounds in parts (v)- (viii):

Solutions

(i) NaBr**- Sodium Bromide**

(ii) Rb_2O **- Rubidium Oxide**

(iii) CaS**- Calcium Sulphide**

(iv) AlI_3**- Aluminium Iodide**

(v) strontium fluoride **- SrF_2**

(vi) aluminum selenide **- Al_2Se_3**

(vii) potassium nitride **- K_3N**

(viii) magnesium phosphide**–Mg_3P_2**

b) Name the compounds in parts (i)-(iv) and write the formulas for the compounds in parts (v)-(viii):

Solutions

(i) Hg_2O - **Mercury (I) Oxide**
(ii) $FeBr_3$**–Iron (III) Bromide**
(iii) CoS- **Cobalt (II) Sulphide**
(iv) $TiCl_4$- **Titanium Chloride**
(v) tin(II) chloride - **$SnCl_2$**
(vi) cobalt(III) iodide- **CoI_3**
(vii) chromium(VI) sulphide - **CrS_3**
(viii) mercury(II) oxide- **HgO**

c) Name each of the following compounds:

Solutions

(i) $BaSO_3$**– Barium Sulphite**
(ii) $KMnO_4$**– Potassium Permanganate**
(iii) $NaNO_2$**– Sodium Nitrite**
(iv) $K_2Cr_2O_7$**– Potassium Dichromate**

d) Write the formula for each of the following compounds:

Solutions

(i) chromium(III) hydroxide **– $Cr(OH)_3$**
(ii) lead(IV) carbonate - **$Pb(CO_3)_2$**
(iii) magnesium cyanide- **$Mg(CN)_2$**
(iv) ammonium acetate**– $NH_4C_2H_3O_2$**

e) Knowing the names of similar chlorine oxyanions and acids,deduce the names of the following: IO^-, IO_2^-, IO_3^- and IO_4^-; HIO, HIO_2, HIO_3, and HIO_4.

Solutions

Ions		**Acids**	
Chemical Formula	**Name**	**Chemical Formula**	**Name**
IO^-	Hypoiodite	HIO	Hypoiodous Acid
IO_2^-	Iodite	HIO_2	Iodous Acid
IO_3^-	Iodate	HIO_3	Iodic Acid
IO_4^-	Periodate	HIO_4	Hyperiodic Acid

f) Write the formula for each of the following compounds:

Solutions

(i) sulphur difluoride**– SF_2**
(ii) sulphur hexafluoride**– SF_6**
(iii) sodium dihydrogen phosphate**– NaH_2PO_4**
(iv) lithium nitride**– Li_3N**
(v) chromium(III) carbonate**– $Cr_2(CO_3)_3$**
(vi) Bromous acid **– $HBrO_2$**
(vii) dinitrogen pentoxide**– N_2O_5**

g) Give the name or chemical formula, as appropriate, for each of the following binary molecular substances:

Solutions

(i) SF_6 **- Sulphur hexafluoride**

(ii) IF_5 **– Iodine pentafluoride**

(iii) XeO_3 **– Xenon trioxide**

(iv) dinitrogen tetroxide **- N_2O_4**

(v) hydrogen cyanide **- HCN**

(vi) tetraphosphorushexasulphide **P_4S_6**