Grade 11 Chemistry Exam Review Answers

1. Fill in the following chart with the number of electrons, protons, neutrons, atomic number, mass number, and the element notations

Atom	Atomic Number	Mass Number	# of Protons	# of neutrons	# of electrons
K^+	19	39.0983	19	20	18
Es	99	252	99	153	99
Mo	42	95.94	42	54	42
P^{3-}	15	30.97376	15	16	18
Al	**13**	26.98154	**13**	**14**	13
As	33	**75**	33	**42**	33
Pt	78	195.08	78	**117**	**78**
W	74	**184**	**74**	110	74
Es	**99**	**252**	99	153	99
Lr	103	**260**	103	**157**	103

2. Draw Bohr diagrams and Lewis dot diagrams for the following elements: Li, Ca, Al, C, P, O, F, K

3. Draw Bohr diagrams of the following **IONS**: Na^+, Mg^{2+}, B^{3+}, Si^{4+}, N^{3-}, S^{2-}, Cl^-.

4. Find the average atomic mass of P when the atomic mass with 15 neutrons is 30 is in 77% abundance and the atomic mass with 17 neutrons is 32 is in 23% abundance.
   AAM = (30 x 0.77) + (32 x 0.23) = 30.46 amu
5. Find the Average atomic mass of Ca when the element which has 20 neutrons is in 12% abundance and the element which has 21 neutrons is in 88% abundance.
   AAM = (40 x 0.12) + (41 x 0.88) = 40.88 amu
6. Find the average atomic mass of Cr if the atomic number is 24 and the two isotopes are; 18 neutrons at 97% abundance, and 19 neutrons at 3% abundance.
   AAM = (42 x 0.97) + (43 x 0.03) = 42.03 amu

7. What is ionization energy, electron affinity, and electronegaivity?
   Ionization Energy • The energy required to remove an electron from a gaseous atom
   Electron Affinity • The energy that accompanies the addition of an electron to a gaseous atom
   Electronegativity • The tendancy of an atom to attract electrons to itself when it is chemically combined with another element.
8. For the following elements decide which one has a larger atomic radius, electronegativity, ionization energy, and reactivity.

		Largest Atomic Radius	Largest Electronegativity	Largest Ionization Energy	Greatest Reactivity
O	Po	Po	O	O	O
B	N	B	N	N	N
Ni	Pt	Pt	Ni	Ni	Pt
Mg	Ra	Ra	Mg	Mg	Ra
K	Fe	K	Fe	Fe	K
Ag	Rb	Rb	Ag	Ag	Rb
Au	Cu	Au	Cu	Cu	Au
Hg	Zn	Hg	Zn	Zn	Hg
I	Cl	I	Cl	Cl	Cl
As	N	As	N	N	N

9. Describe how the atomic radius gets smaller as we add more electrons in a row.
   As you move to the right on the periodic table, you get more protons in the nucleus which will have a greater pulling force for the electrons, bringing them closer to the nucleus, therefore making a smaller atomic radius to the right.
10. Describe how the reactivity is linked to ionization energy for the metals and electron affinity for the non-metals. The lower the ionization energy, the more an atom wants to get rid of its electron, therefore the faster it will react making a greater reaction. Therefore the Lower the ionization energy, the greater the reactivity.
11. Which family of elements do the following elements belong?

Element	Family
He	Noble Gases
Ca	Alkaline Earth Metals
Pm	Lanthanides
Yb	Lanthanides
Np	Actinides
Fr	Alkali Metals

Element	Family
Cl	Halogens
Cs	Alkali Metals
Es	Actinides
I	Halogens
Sr	Alkaline Earth Metals
Xe	Noble Gases

12. What is the octet rule and what does it mean for any element that has its octet full.
    - All atoms are striving for a full outer orbital of electrons. Therefore, atoms will lose or gain electrons to get a full outer orbital of electrons
13. What is the bonding capacity of the following elements: P, S, Cl, K, B, N, O, F, Br, Si
    P→3, S→2, Cl→1, B→3, N→3, O→2, F→1, Br→1, Si→4
14. Define the following terms: alloy, metalloid, solution, hydrate
    Alloy: solid solution of metals
    Metalloid: Semi-metals – "staircase" line from the top of Group 13 to the bottom of Group 16
    Solution: a homogeneous mixture of a solvent and one or more solutes
    Hydrate: a compound that has a specific number of water molecules bonded to each formula unit

15. How is matter classified:

All matter is classified in two groups: mixtures and pure substances. Mixtures can be heterogenous (all components are vsible) and homogeneous (solutions). Pure substances are classified into elements and compounds.

16. Describe the difference between ionic bonds and covalent bonds. Be sure to include which type of elements are joined together for each type of bond, how strong the bond is, if the electrons are either transferred or shared.

Ionic Bonds	**Covalent Bonds**
Between a Metal (or NH_4^+) and a Non-Metal	Between 2 Non-Metals
Bond	Bond
Transfer of Electrons	Shares Electrons

17. Indicate whether the following are ionic or covalent bonds and draw the Lewis structures.
    a) LiF → Ionic Bond b) F_2 → Covalent c) MgS → Ionic Bond d) O_2 → Covalent

    e) AlF_3 → Ionic Bond f) CO_2 → Covalent g) H_2O → Covalent h) Mg_3N_2 → Ionic

18. Describe polar covalent, non-polar covalent, pure covalent, and ionic bond with respect to electronegativities.
    Pure covalent $\Delta=0$, non-polar covalent $0<\Delta<0.4$, polar covalent $0.4<\Delta<1.7$, ionic bond $\Delta>1.7$
19. Discuss polar vs non-polar substances and their ability to dissolve in different solvents.
    Polar dissolves in polar, Non-Polar dissolves in Non-Polar. Polar molecules have an overall difference in the charge while a non-polar molecule will not have a difference in charge.

20. Name the following compounds

NaF	Sodium Fluoride
CaF_2	Calcium Fluoride
CoO	Cobalt (II) Oxide
Mg_3N_2	Magnesium Nitride
$ZnBr_2$	Zinc Bromide
CO_2	Carbon Dioxide
$SnCl_2$	Tin (II) Chloride
CrF_2	Chromium (II) Fluoride
MnO_2	Manganese (IV) Oxide
MnS_2	Manganese (IV) Sulfide
Cu_3N_2	Copper (II) Nitride
SO_2	Sulfur Dioxide
$AsBr_3$	Arsenic Tribromide
CuO	Copper (II) Oxide
$AlBr_3$	Aluminum Bromide
Hg_2O	Mercury (I) Oxide
Br_2O	Dibromine Monoxide
FrH	Francium Hydride
SnS_2	Tin (IV) Sulfide
$MnCl_2$	Manganese (II) Chloride
Li_2O_2	Lithium Peroxide
CaO	Calcium Oxide
AlN	Aluminum Nitride
KH	Potassium Hydride
$BeBr_2$	Beryllium Bromide
SnS	Tin (II) Sulfide

LiBr	Lithium Bromide
$SnCl_4$	Tin (IV) Chloride
MgH_2	Magnesium Hydride
CO	Carbon Monoxide
$SbBr_5$	Antimony Pentabromide
Cu_2O	Copper (I) Oxide
Li_2O	Lithium Oxide
MnS_2	Manganese (IV) Sulfide
$MnCl_4$	Manganese (IV) Chloride
SrO	Strontium Oxide
HgO	Mercury (II) Oxide
CCl_4	Carbon Tetrachloride
Cu_3N	Copper (I) Nitride
CS_2	Carbon Disulfide
$NaBrO_2$	Sodium Bromite
$Ca(NO_3)_2$	Calcium Nitrate
$Fe(ClO)_2$	Iron (II) Hypochlorite
$HBrO_2$	Bromous acid
$HgCO_3$	Mercury (II) Carbonate
$Ba(ClO_4)_2$	Barium Perchlorate
Li_3PO_3	Lithium Phosphite
CuS	Copper (II) Sulfide
PbF_4	Lead (IV) Fluoride
$MgCO_3$	Magnesium Carbonate
$Al_2(SO_3)_3$	Aluminum Sulfite
$Ca_3(PO_3)_2$	Calcium Phosphite

21. Write the chemical formula for the following

Sodium Bromide	NaBr	Copper (II) Nitrite	$Cu(NO_2)_2$
Ferric Hydroxide	$Fe(OH)_3$	Magnesium Carbonate	$MgCO_3$
Iron (II) Sulfide	FeS	Potassium Sulfite	K_2SO_3
Barium Carbonate	$BaCO_3$	Lead (IV) Phosphate	$Pb_3(PO_4)_4$
Sodium Perchlorate	$NaClO_4$	Hypobromous Acid	HbrO
DiHydrogen Monoxide	H_2O	Bismuth (V) Sulfide	Bi_2S_5
Tin (IV) Fluoride	SnF_4	Manganese (IV) Oxide	MnO_2
Cesium Sulfite	Cs_2SO_3	Silver Iodite	$AgIO_2$
Sulfur Trioxide	SO_3	Calcium Chloride	$CaCl_2$
Aluminum hypobromite	$Al(BrO)_3$	Calcium Phosphate	$Ca_3(PO_4)_2$
Sodium Oxide	Na_2O	Lithium Phosphite	Li_3PO_3
Silver Perchlorate	$AgClO_4$	Zinc Chlorite	$Zn(ClO_2)_2$
Lithium Sulfate	Li_2SO_4	Carbon Tetrachloride	CCl_4
Cobalt (III) Hydroxide	$Co(OH)_3$	Calcium Hypobromite	$Ca(BrO)_2$
Magnesium Iodate	$Mg(IO_3)_2$	Potassium Sulfate	K_2SO_4
Nickel (II) Sulfate	$NiSO_4$	Antimony (V) Perbromate	$Sb(BrO_4)_5$
Calcium Phosphite	$Ca_3(PO_3)_4$	Silver Nitrate	$AgNO_3$

22. Balance the following equations.

a) $\mathbf{2}\ Na + \mathbf{2}\ H_2O \rightarrow \mathbf{2}\ NaOH + H_2$

b) $CaCO_3 + \mathbf{2}\ HCl \rightarrow CaCl_2 + H_2O + CO_2$

c) $Mg + \mathbf{2}\ HCl \rightarrow MgCl_2 + H_2$

d) $\mathbf{2}\ KClO_3 \rightarrow \mathbf{2}\ KCl + \mathbf{3}\ O_2$

e) $C_3H_8 + \mathbf{5}\ O_2 \rightarrow \mathbf{3}\ CO_2 + \mathbf{4}\ H_2O$

f) $\mathbf{2}\ Al + \mathbf{3}\ H_2SO_4 \rightarrow Al_2(SO_4)_3 + \mathbf{3}\ H_2$

g) $\mathbf{2}\ Fe_2O_3 + \mathbf{3}\ C \rightarrow \mathbf{4}\ Fe + \mathbf{3}\ CO_2$

h) $\mathbf{4}\ NH_3 + \mathbf{5}\ O_2 \rightarrow \mathbf{4}\ NO + \mathbf{6}\ H_2O$

i) $\mathbf{2}\ Fe(OH)_3 + \mathbf{3}\ H_2SO_4 \rightarrow Fe_2(SO_4)_3 + \mathbf{6}\ H_2O$

j) $CaC_2 + \mathbf{2}\ H_2O \rightarrow Ca(OH)_2 + C_2H_2$

k) $CH_3OH + O_2 \rightarrow CO + \mathbf{2}\ H_2O$

l) $\mathbf{5}\ FeCl_2 + KMnO_4 + \mathbf{8}\ HCl \rightarrow \mathbf{5}\ FeCl_3 + KCl + MnCl_2 + \mathbf{4}\ H_2O$

m) $\mathbf{3}\ Cu + \mathbf{8}\ HNO_3 \rightarrow \mathbf{3}\ Cu(NO_3)_2 + \mathbf{2}\ NO + \mathbf{4}\ H_2O$

23. Define the law of conservation of mass → In any physical or chemical reaction, matter is not created nor destroyed, it is conserved.
24. Define the law of definite proportions →In any chemical compound, the elements are always combined in the same proportion by mass.
25. Define the law of constant composition → The percent by mass of an element in a compound is always a constant.
26. What type of reaction are the following unbalance equations. Balance them

a) $2\ Na + 2\ H_2O \rightarrow 2\ NaOH + H_2$	Single Displacement
b) $Mg + 2\ HCl \rightarrow MgCl_2 + H_2$	Single Displacement
c) $2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$	Decomposition
d) $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$	Combustion
e) $2\ Al + 3\ H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3\ H_2$	Single Displacement
f) $2\ Fe_2O_3 + 3\ C \rightarrow 4\ Fe + 3\ CO_2$	Single Displacement
g) $2\ Fe(OH)_3 + 3\ H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 6\ H_2O$	Neutralization
h) $3\ H_2 + N_2 \rightarrow 2\ NH_3$	Synthesis
i) $CH_3OH + O_2 \rightarrow CO_2 + 2\ H_2O$	Combustion
j) $BaSO_4 + 2\ NaCl \rightarrow BaCl_2 + Na_2SO_4$	Double Displacement
k) $2\ H_2 + O_2 \rightarrow 2\ H_2O$	Synthesis

27. Complete the following reactions. Remember to balance them.
    a) $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$
    b) $Cu + AgNO_3 \rightarrow CuNO_3 + Ag$
    c) $Mg + 2\ HCl \rightarrow MgCl_2 + H_2$
    d) $2\ Li + 2\ H_2O \rightarrow 2\ LiOH + H_2$
    e) $Na_2CO_3 + CuSO_4 \rightarrow CuCO_3 + 2\ Na^+ + SO_4^{2-}$
    f) $(NH_4)_2SO_4 + CaCl_2 \rightarrow CaSO_4 + 2\ NH_4^+ + 2\ Cl^-$
    g) $KOH + Co(NO_3)_2 \rightarrow Co(OH)_2 + 2\ K^+ + 2\ NO_3^-$
    h) $Na_2S + Pb(NO_3)_2 \rightarrow PbS + 2\ Na^+ + 2\ NO_3^-$
    i) $Zn + Pb(NO_3)_2 \rightarrow Zn(NO_3)_2 + Pb$
    j) $Ag + CuSO_4 \rightarrow$ No Reaction
    k) $2\ Al + 3\ NiCl_2 \rightarrow 2\ AlCl_3 + 3\ Ni$
    l) $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$
    m) $MgS + Cu(ClO_4)_2 \rightarrow CuS + Mg^{2+} + 2\ ClO_4^-$
    n) $Ba(OH)_2\ ZnSO_4 \rightarrow BaSO_4 + Zn(OH)_2$
    o) $KBr + AgOH \rightarrow AgBr + K^+ + OH^-$
    p) $3\ CaS + Ni_2(SO_4)_3 \rightarrow 3\ CaSO_4 + Ni_2S_3$

28. For the following pairs of aqueous solutions write the balanced chemical equation, total ionic equation and net ionic equation.
    a) sodium sulfide and iron (II) sulfate
    $Na_2S_{(aq)} + FeSO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + FeS_{(s)}$
    $Na^+_{(aq)} + S^{2-}_{(aq)} + Fe^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow Na^+_{(aq)} + SO_4^{2-}{}_{(aq)} + FeS_{(s)}$
    $Fe^{2+}_{(aq)} + S^{2-}_{(aq)} \rightarrow FeS_{(s)}$
    b) cesium phosphate and calcium bromide
    $2Cs_3PO_{4(aq)} + 3CaBr_{2(aq)} \rightarrow 6CsBr_{(aq)} + Ca_3(PO_4)_{2(s)}$
    $6Cs^+_{(aq)} + 2PO_4^{3-}{}_{(aq)} + 3Ca^{2+}_{(aq)} + 6Br^-_{(aq)} \rightarrow 6Cs^+_{(aq)} + 6Br^-_{(aq)} + Ca_3(PO_4)_{2(s)}$
    $3Ca^{2+}_{(aq)} + 2PO_4^{3-}{}_{(aq)} \rightarrow Ca_3(PO_4)_{2(s)}$

    c) ammonium iodide and silver nitrate
    $NH_4I_{(aq)} + AgNO_{3(aq)} \rightarrow NH_4NO_{3(aq)} + AgI_{(s)}$
    $NH_4^+{}_{(aq)} + I^-_{(aq)} + Ag^+_{(aq)} + NO_3^-{}_{(aq)} \rightarrow NH_4^+{}_{(aq)} + NO_3^-{}_{(aq)} + AgI_{(s)}$
    $Ag^+_{(aq)} + I^-_{(aq)} \rightarrow AgI_{(s)}$
    d) potassium carbonate and iron (II) nitrate

$K_2CO_{3(aq)} + Fe(NO_3)_{2(aq)} \rightarrow 2KNO_{3(aq)} + FeCO_{3(s)}$
$2K^+_{(aq)} + CO_3^{2-}{}_{(aq)} + Fe^{2+}_{(aq)} + 2NO_{3(aq)} \rightarrow 2K^+_{(aq)} + 2NO_{3(aq)} + FeCO_{3(s)}$
$Fe^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow FeCO_{3(s)}$

e) aluminum nitrate and sodium phosphate
$Al(NO_3)_{(aq)} + Na_3PO_{4(aq)} \rightarrow NaNO_{3(aq)} + AlPO_{4(s)}$
$Al^{3+}_{(aq)} + NO_3^-{}_{(aq)} + Na^+_{(aq)} + PO_4^{3-}{}_{(aq)} \rightarrow Na^+_{(aq)} + NO_3^-{}_{(aq)} + AlPO_{4(s)}$
$Al^{3+}_{(aq)} + PO_4^{3-}{}_{(aq)} \rightarrow AlPO_{4(s)}$

29. What is the molar mass of the following.
    a) NH_3 = 14 + 3(1) = 17 g/mol
    b) $AgNO_3$ = 107.868 + 14 + 3(16) = 170 g/mol
    c) H_2O = 2(1) + 16 = 18 g/mol
    d) $C_6H_{12}O_6$ = 6(12) + 12(1) + 6(16) = 180 g/mol
    e) $AlCl_3$ = 27 + 3(35.45) = 133.35 g/mol
    f) $Mg(BrO_4)_2$ = 24.3 + 2(79.9) + 8(16) = 312.1 g/mol
    g) $Fe_2(CO_3)_3$ = 2(55.845) + 3(12) + 9(16) = 291.69 g/mol
    h) CO_2 = 12 + 2(16) = 44 g/mol
30. How many moles of $AlBr_3$ are there if there is:
    a) 4.6 grams n=m/M n=4.6/266.7 n=0.0172 mol
    b) 3.9 grams n=m/M n=3.9/266.7 n=0.0146 mol
    c) 2.3 X 10^6g n=m/M n=2.3 X 10^6/266.7 n=8625 mol
31. How many grams of B_2S_3 is there if there is:
    a) 3.8 moles m=nM n=3.8 X 117.6 m=447 g
    b) 2.9 moles m=nM n=2.9 X 177.6 m=341 g
    c) 7.3 X 10^4 m=nM n=7.3X10^4 X 177.6 m=8.59 X 10^6 g
32. How many atoms of He are there if there are:
    a) 4.7 moles =4.7 x 6.022x10^{23} =2.83 X 10^{24} atoms
    b) 2.9 moles =2.9 x 6.022x10^{23} =1.75 X 10^{24} atoms
    c) 8.6 moles =8.6 x 6.022x10^{23} =5.18 X 10^{24} atoms
33. How many atoms of O is there in:
    a) 7.8 moles of $AgNO_3$ =7.8 X 6.022x10^{23} X 3 =1.4 X 10^{25} atoms
    b) 9.2 moles of CO_2 =9.2 X 6.022x10^{23} X 2 =1.1 X 10^{25} atoms
    c) 3.3 moles of O_2 =3.3 X 6.022x10^{23} X 2 =4.0 X 10^{24} atoms
34. Calculate the percentage by mass of each element in the following compounds.
    a) CH_4 %C=1(12)/(1(12)+4(1)) X 100% =75%
       %H=4(1)/(1(12)+4(1)) X 100% =25%
    b) C_3H_8 %C=3(12)/(3(12)+8(1) X 100% =81%
       %H=8(1)/(3(12)+8(1) X 100% =19%
    c) $NaHCO_3$ %Na=23/(23+1+12+3(16)) X 100% =27.4%
       %H=1/(23+1+12+3(16)) X 100% =1.2%
       %C=12/(23+1+12+3(16)) X 100% =14.3%
       %O=3(16)/(23+1+12+3(16)) X 100% =57.1%
35. Iron and oxygen combine to form two different compounds. The formulas of the compounds are FeO and Fe_2O_3. Calculate the percentage by mass of iron and oxygen in each compound.
    FeO %Fe=55.845/55.845+16 X 100% =77.7%
    %O=16/55.845+16 X 100% =22.3%
    Fe_2O_3 %Fe=2(55.845)/(2(55.845)+(3)16 X 100% =70%
    %O=3(16)/(2(55.845)+(3)16 X 100% =30%
36. Ammonium nitrate, NH_4NO_3, and ammonium sulphate, $(NH_4)_2SO_4$, are both used as fertilizers. Show by calculation which compound has the greater percentage by mass of nitrogen.
    NH_4NO_3 %N=2(14)/(14+4(1)+14+3(16) X 100% =35%
    $(NH_4)_2SO_4$ %N=2(14)/(2(14)+8(1)+32+4(16) X 100% =21.2%
37. Determine the empirical formula of each of the following compounds. The percentage composition by mass is given.
    a) 85.7% carbon, 14.3% hydrogen
    Assume 100g C n=m/M =85.7/12 =7.14
    H n=m/M =14.3/1 =14.3
    Divide both by 7.14 CH_2
    b) 52.9% aluminum, 47.1% oxygen

Assume 100g Al n=m/M =52.9/27 =1.96
O n=m/M =47.1/16 =2.94
Divide by 1.96 and multiply by 2 Al_2O_3

c) 62.6% lead, 8.4% nitrogen, 29.0% oxygen
Assume 100g Pb n=m/M =62.6/207.2 =0.302
N n=m/M =8.4/14 =0.6
O n=m/M =29/16 =1.81
Divide by 0.3 PbN_2O_6

38. A compound of carbon, hydrogen, and chlorine consists of 49.0%, 2.75% hydrogen, and 48.3% chlorine by mass. What is the empirical formula of the compound?
Assume 100g C n=m/M =49/12 =4.08
H n=m/M =2.75/1 =2.75
Cl n=m/M =48.3/35.45 =1.36
Divide by 1.36 C_3H_2Cl

39. Chemical analysis of rubbing alcohol show that it consists of 59.97% carbon, 13.35% hydrogen, and 26.68% oxygen by mass. What is the empirical formula of rubbing alcohol?
Assume 100g C n=m/M =59.97/12 =5
H n=m/M =13.35/1 =13.35
O n=m/M =26.68/16 =1.67
Divide by 1.67 C_3H_8O

40. Chemical analysis of one of the constituents of gasoline showed that it consists of 92.29% C and 7.71% H by mass. If the molecular mass of the compound is 78 g/mol, determine its molecular formula.
Assume 100g C n=m/M =92.29/12 =7.7
H n=m/M =7.71/1 =7.71
Divide by 7.7 CH
78 = X (12 + 1) X = 6 C_6H_6

41. A compound of silicon and fluorine was analyzed and found to consist of 33.0% silicon and 67.0% fluorine by mass. The molecular mass of the compound was determined by experiment to be 170 g/mol. What is the molecular formula of the compound?
Assume 100g Si n=m/M =33/28 =1.18
F n=m/M =67/19 =3.5
Divide by 1.18 SiF_3
170 = X (28+3(19)) X = 2 Si_2F_6

42. Glucose is an important source of energy for organisms. Analysis of a sample of glucose shows that it consists of 39.95% carbon, 6.71% hydrogen, and the remainder oxygen. In a separate experiment, the molar mass of glucose is found to be 180 g/mol. Determine the molecular formula of glucose.
Assume 100g C n=m/M =39.95/12 =3.33
H n=m/M =6.71/1 =6.71
O n=m/M =53.34/16 =3.33
Divide all by 3.33 CH_2O
180 = X (12+2(1)+16) X=6 $C_6H_{12}O_6$

43. $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$
a) What mass of oxygen is required to react with 1200 g of ethanol
C_2H_5OH n=m/M =1200/2(12)+6(1)+16 =26.09 mol of C_2H_5OH
n of C_2H_5OH/n of C_2H_5OH = n of O_2/n of O_2 26.09/1=X/3 n of O_2=78.3 mol
O_2 m = n X M =78.3 X 2(16) =2504 g of O_2

b) If 655 g of water is produced, what mass of ethanol is burned?
H_2O n=m/M =655/2(1)+16 =36.39 mol
n of H_2O/n of H_2O = n of C_2H_5OH/n of C_2H_5OH 36.39/3=X/1 n of C_2H_5OH=12.13 mol
C_2H_5OH m = n X M =12.13 X (2(12)+6(1)+16) =558 g

44. Sodium Hydroxide, when mixed with hydrochloric acid, will produce Sodium Chloride and Water.
a) Write the balanced equation for the reaction.
b) What mass of sodium hydroxide must be used to produce 225 g of Sodium Chloride
$NaOH + HCl \rightarrow NaCl + H_2O$
NaCl n=m/M =225/23+35.45 =3.85 mol
nNaCl/nNaCl = nNaOH/nNaOH 3.85/1=x/1 =3.85 mol of NaOH
NaOH m=nM =(3.85)(23+1+16) =154 g of NaOH
$4FeS + 7O_2 \rightarrow 2Fe_2O_3 + 4SO_2$

45. The sulphur dioxide produced in this reaction, and in other reactions similar in it, is responsible for much of the acid rain that falls on North America. What mass of iron(III) oxide can be obtained by the roasting of 774 g of the sulphide ore? What mass of sulphur dioxide is produced?

FeS n=m/M =774/55.845+32 =8.81 mol of FeS

n of FeS/n of FeS = n of Fe_2O_3/ n of Fe_2O_3 8.81/4 = X/2 n of Fe_2O_3=4.4 mol

Fe_2O_3 m=nXM =4.4 X (2(55.845)+3(16)) =703.5 g

n of FeS/n of FeS = n of SO_2/n of SO_2 8.81/4 = X/4 n of SO_2 = 8.81 mol

SO_2 m=nXM =8.81 X (32+2(16)) =563.8 g

46. Solid carbon dioxide (dry ice) may be used for refrigeration. Some of this carbon dioxide is obtained as a by-product when hydrogen is produced from methane in the following reaction.

$CH_4 + 2H_2O \rightarrow CO_2 + 4H_2$

a) What mass of carbon dioxide should be obtained from the complete reaction of 1250 g of methane?

CH_4 n=m/M =1250/(12+4(1)) =78.125 mol

n of CH_4/n of CH_4 = n of CO_2/n of CO_2 78.125/1=X/1 n of CO_2=78.125 mol

CO_2 m=nXM =78.125 X (12+2(16)) =3437.5 g

b) If the actual yield obtained is 3000 g, what is the percentage yield?

%yield = Experimental/Theoretical X 100% =3000/3437.5 X 100% =87.3%

47. Ammonium nitrate is an important compound used both as a fertilizer and as an explosive. It is produced by reacting ammonia with concentrated nitric acid.

$NH_3 + HNO_3 \rightarrow NH_4NO_3$

a) What mass of ammonium nitrate can theoretically be produced from the reaction of 375.0 g of ammonia with excess nitric acid?

NH_3 n=m/M =375/(14+3(1)) =22.06 mol

n of NH_3/n of NH_3 = n of NH_4NO_3/n of NH_4NO_3 22.06/1=X/1 n of NH_4NO_3=22.06 mol

NH_4NO_3 m=nXM =22.06 x (2(14)+4(1)+3(16)) =1764.7 g

b) If the percentage yield is 88.5%, what mass of ammonium nitrate is actually obtained?

%yield = Experimental/Theoretical X 100% 0.885=Experimental/1764.7 =1561.8 g

48. Finish the following equations taking into account the solubility rules. Circle all spectator ions(the ones that remain as ions)

a) $NaI + Pb(NO_3)_2 \rightarrow PbI_2 + 2Na^+ + 2NO_3^-$

b) $CaCl_2 + NaCO_3 \rightarrow CaCO_3 + 2Na^+ + 2Cl^-$

c) $BaBr_2 + Na_2SO_4 \rightarrow BaSO_4 + 2Na^+ + 2Br^-$

d) $CuSO_4 + K_2CO_3 \rightarrow CuCO_3 + 2K^+ + SO_4^{2-}$

e) $NH_4OH + FeI_2 \rightarrow Fe(OH)_2 + 2NH_4^+ + 2I^-$

49. What is the difference between an arrhenius acid/base and a Bronsted-Lowry acid/base.

Arrhenius Acid • Any substance that increases the hydronium ion concentration in neutral water

Arrhenius Base • Any substance that increases the hydroxide ion concentration in neutral water

Bronsted-Lowry Acid • Any substance that acts as a proton donor

Bronsted-Lowry Base • Any substance that acts as a proton acceptor

50. What is the concentration of a solution of 3.7 moles of CH_4

a) 1L c=n/V =3.7/1 =3.7 mol/L

b) 7L c=n/V =3.7/7 =0.529 mol/L

c) 450 mL c=n/V =3.7/0.45 =8.22 mol/L

51. What is the volume of 5.8 moles of a solution of NaCl

a) 4.5 moles/L V=n/c =5.8/4.5 =1.29 L

b) 2.9 moles/L V=n/c =5.8/2.9 =2 L

52. What is the concentration of a solution of 8L of 4.7 moles/L, if it is diluted to 200L.

$c_1V_1=c_2V_2$ (4.7)(8) = (200)c_2 =0.188 mol/L

53. What is the concentration of a solution of 200 mL of 3.2 mol/L, if it is diluted to 1L.

$c_1V_1=c_2V_2$ (0.2)(3.2) = (1)c_2 =0.64 mol/L

54. What is the concentration of sulfate ions in the solution that has 4.0 g of ammonium sulfate dissolved in 350 mL of water?

$(NH_4)_2SO_4 \rightarrow 2\ NH_4^+ + SO_4^{2-}$

moles of ammonium sulfate: n=m/M n= 4.0g/ 132g/mol n = 0.0303 mol

moles of ammonium sulfate = moles of sulate

c = n/V c = 0.0303 mol/ 0.350 L c = 0.0866 mol/L

55. If you perform an acid base titration and place 50 mL of 0.25 mol/L acetic acid into an Erlenmyer and read the burette initially at 3.5 mL and at the endpoint at 25.2 ml, what is the concentration of the base?

$c_AV_A=c_BV_B$ (50)(0.25) = (25.2-3.5)c_2 =0.576 mol/L

56. If the hydronium ion concentration of a solution is 2.5×10^{-6}, what is the hydroxide ion concentration, the pH, and the pOH.
    $[H^+][OH^-]=1 \times 10^{-14}$ $[OH^-]=4 \times 10^{-9}$ mol/L
    $pH = -\log[H^+]$ pH = 5.6 $pOH = -\log[OH^-]$ pOH = 8.4
57. If the hydroxide ion concentration of a solution is 4.7×10^{-4}, what is the hydronium ion concentration, the pH, and the pOH.
    $[H^+][OH^-]=1 \times 10^{-14}$ $[H^+]=2.13 \times 10^{-11}$ mol/L
    $pH = -\log[H^+]$ pH = 10.67 $pOH = -\log[OH^-]$ pOH = 3.33
58. If the pH of a solution is 3.4, what is the pOH, the hydroxide concentration, and the hydronium ion concentration.
    pH + pOH = 14 pOH = 10.6
    $[H^+]=10^{-pH}$ $[H^+] = 3.98 \times 10^{-4}$ mol/L $[OH^-]=10^{-pOH}$ $[OH^-] = 2.5 \times 10^{-11}$ mol/L
59. If the pOH of a solution is 8.4, what is the pH, the hydroxide concentration, and the hydronium ion concentration?
    pH + pOH = 14 pH = 5.6
    $[H^+]=10^{-pH}$ $[H^+] = 2.5 \times 10^{-6}$ mol/L $[OH^-]=10^{-pOH}$ $[OH^-] = 3.98 \times 10^{-9}$ mol/L
60. Describe Boyle's Law, Charle's Law, and the Pressure-Temperature Law.
    Boyle's Law • Pressure is inversely proportional to Volume • $P_1V_1=P_2V_2$
    Charle's Law • Volume is directly proportional to Temperature • $V_1/T_1=V_2/T_2$
    Pressure-Temperature Law • Pressure is directly proportional to Temperature • $P_1/T_1=P_2/T_2$
61. What is the difference between STP and SATP?
    STP • Standard Temperature and Pressure P=101.3 kPa, T= 0^oC
    SATP • Standard Ambient Temperature and Pressure P=100 kPa, T=25^oC
62. What is the volume of 1 mol of a gas at STP (Molar Volume) 22.4 L
63. What is the pressure of He if it begins at 78^oC with a pressure of 56 kPa and then gets changed to a temperature of 109^oC.
    $P_1/T_1=P_2/T_2$ $P_1/109+273.15 = 56/78+273.15$ P_1=60.5 kPa
64. What is the Temperature of O_2 gas if it starts at 45^oC and a volume of 7L and ends at a volume of 30L?
    $V_1/T_1=V_2/T_2$ $7/45+273.15 = 30/T_2$ T_2=1363.5 K
65. What would be the new temperature of a gas that begins at 56^oC with a pressure of 90 kPa and changes to a pressure of 207 kPa.
    $P_1/T_1=P_2/T_2$ $90/56+273.15 = 207/T_2$ T_2=757 K
66. What would be the volume of He if it begins at 4^oC at of volume of 8L and the temperature then increases by 7^oC.
    $V_1/T_1=V_2/T_2$ $8/4+273.15 = V_2/7+273.15$ V_2=8.09 L
67. What would be the pressure of F_2 gas if the initial pressure was 67 kPa and the volume increased from 4L to 9L.
    $P_1V_1=P_2V_2$ $(67)(4) = P_2(9)$ P_2=29.8 kPa
68. What is the initial volume of Cl_2 if it ends with a volume of 6L. The initial pressure is 145 kPa with a temperature of 70^oC and ends with a pressure of 200 kPa with a temperature of 45^oC.
    $P_1V_1/T_1=P_2V_2/T_2$ $(145)V_1/70+273.15 = (200)(6)/45+273.15$ V_1=8.93 L
69. $2KClO_3 \rightarrow 2KCl + 3O_2$
    Balance the following equation before starting the question.
    During the formation of 35 g of potassium chloride, what volume of oxygen gas was produced when measured at 10^oC and 100 kPa.
    KCl n=m/M =35/(39.1+35.45) n=0.469 mol of KCl
    n of KCl/n of KCl = n of O_2/n of O_2 0.469/2=X/3 x=0.704 mol of O_2
    O_2 PV=nRT (100)V=(0.704)(8.314)(10+273.15) V=16.6 L
70. What is the pressure of F_2 gas if it starts at a volume of 4L and ends at a volume that is increased by 8L and a pressure of 78Kpa.
    $P_1V_1=P_2V_2$ $P_1(4)=(78)(12)$ P_1=234 kPa
71. A sample of gas has a volume of 150mL at 260K and 92.3 kPa. What will the new volume be at 376K and 123 kPa?
    $P_1V_1/T_1=P_2V_2/T_2$ $(92.3)(0.150)/260 = (123)(V_2)/376$ V_2=163mL
72. In a large syringe, 48 mL of ammonia gas at STP is compressed to 24 mL and 110 kPa. What must the new temperature of the gas be?
    $P_1V_1/T_1=P_2V_2/T_2$ $(101.3)(0.048)/(273) = (110)(0.024)/T_2$ T_2 = 148
73. What is the pressure of Ne if it begins at 100kPa, 8L, and 33^oC that changes to 2L at 56^oC.
    $P_1V_1/T_1=P_2V_2/T_2$ $(100)(8)/(33+273.15) = P(2)/(56+273.15)$ P=430 kPa
74. What is the temperature of Ar if there is 3.6 g, 560 kPa, and 7.4L. Remember R=8.31 kPa L/mol K

n=m/M n=3.6/39.95 n=0.0901 mol
PV=nRT (560)(7.4)=(0.0901)(8.314)T T=5532 K

75. A balloon contains 2.0 L of He gas at STP. How many moles of He are present?
PV = nRT n = PV/RT n = (101.3)(2.0)/(8.314)(273) n= 0.089

76. $N_2 + 3H_2 \rightarrow 2NH_3$
How many moles of the following are required to manufacture 5.0 mol of ammonia?
a) Nitrogen
$nNH_3/nNH_3 = nN_2/nN_2$ $5/2 = nN_2/1$ $nN_2=2.5$ mol
b) Hydrogen
$nNH_3/nNH_3 = nH_2/nH_2$ $5/2 = nH_2/3$ $nH_2=7.5$ mol

77. $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
How many moles of oxygen are required to react with
a) 3.0 mol of propane
$nC_3H_8/nC_3H_8 = nO_2/nO_2$ $3/1 = nO_2/5$ $nO_2=15$ mol
b) 20.0 mol of propane
$nC_3H_8/nC_3H_8 = nO_2/nO_2$ $20/1 = nO_2/5$ $nO_2=100$ mol
c) 0.2 mol of propane
$nC_3H_8/nC_3H_8 = nO_2/nO_2$ $0.2/1 = nO_2/5$ $nO_2=1$ mol

78. $4FeS + 5O_2 \rightarrow 2 Fe_2O_3 + 4SO_2$
If I have 4.l5 g of Iron Sulfide, how many grams of Iron (III) Oxide will be made?
FeS n=m/M =4.15/55.845+32 =0.0472 mol
$NFeS/nFeS = nFe_2O_3/nFe_2O_3$ 0.0472/4 = X/2 =0.0236 mol of Fe_2O_3
Fe_2O_3 m=nxM =(0.0236)(2(55.845)+3(16)) =3.77 g

79. $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3 H_2O$
If I have 3.8 g of oxygen, how much water will be made?
O_2 n=m/M =3.8/2(16) =0.119 mol
$nO_2/nO_2=nH_2O/nH_2O$ 0.119/3=x/3 =0.119 mol of H_2O
H_2O m=nxM =(0.119)(2(1)+16) =2.14 g

80. $2Na + Cl_2 \rightarrow 2NaCl$
If I have 4.5 g of sodium and 6.4 grams of chlorine, which is the limiting reactant and which is in excess?
Na n=m/M =4.5/23 =0.196 mol
$nNa/nNa = nCl_2/nCl_2$ 0.196/2=x/1 =0.098 mol of Cl_2
Cl_2 m=nxM =(0.098)(35.45)(2) =6.95 g
Since we have 6.4 g of Cl_2 which is lower than 6.95g, Cl_2 is the limiting reactant and Na is in excess

81. $2Al + 3Br_2 \rightarrow 2AlBr_3$
If I have 3.2 g of aluminum and 5.4 g of bromine, which is the limiting reactant and which is in excess?
Al n=m/M =3.2/26.98 =0.119 mol
$nAl/nAl=nBr_2/nBr_2$ 0.119/2=x/3 =0.178 mol of Br_2
Br_2 m=nxM =(0.178)(2(79.9)) =28.42 g of Br_2
Since we have 5.4 g of Br_2 which is less than 28.42 g, Br_2 is the limiting reactant and Al is in excess

82. $CH_4 + 2H_2O \rightarrow CO_2 + 4H_2$
What mass of carbon dioxide should be obtained from the complete reaction of 1250 g of methane and 2000 g of water?
CH_4 n=m/M =1250/12+4(1) =78.125 mol
$nCH_4/nCH_4 = nH_2O/nH_2O$ 78.125/1=x/2 =156.25 mol of H_2O
H_2O m=nM =(156.25)(2(1)+16) =2812.5 g of H_2O
Since we have 2000g of water which is less than 2812.5, H_2O is the limiting reactant
H_2O n=m/M =2000/2(1)+16 =111.1 mol
$nH_2O/nH_2O = nCO_2/nCO_2$ 111.1/2=x/1 =55.6 mol of CO_2
CO_2 m=nM =(55.6)(12+2(16)) =2444 g of CO_2

83. $2N_2H_4 + 7O_2 \rightarrow 4HNO_3 + 2H_2O$
If I have 4.3 g of N_2H_4 and 6.8 g of O_2, what will the percent yield be if in a Reaction, I get 4.9 g of HNO_3 produced?
N_2H_4 n=m/M =4.3/(2(14)+4(1)) =0.134 mol
$nN_2H_2/nN_2H_2 = nO_2/nO_2$ 0.134/2=x/7 =0.470 mol of O_2
O_2 m=nM =(0.47)(2(16)) =15.05 g
Since we have 6.8 g of O_2 which is less than 15.05g O_2 is the limiting reagent
O_2 n=m/M =6.8/2(16) =0.2125 mol
$nO_2/nO_2 = nHNO_3/nHNO_3$ 0.2125/7=x/4 =0.121 mol of HNO_3

HNO_3 m=nM =(0.121)(1+14+3(16)) =7.65 g of HNO_2
%yield = Experimental/Theoretical X 100% %yield=4.9/7.65 x 100% =64%

84. Consider the following reaction:

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

a) If 1.5 L of propane gas are burned in a barbecue what volume of carbon dioxide is produced and what volume of oxygen is consumed? (Assume all gases are at STP)

b) If 35 g of propane gas is burned in a barbecue what volume of water vapor is produced assuming SATP?

c) If 35 g of propane gas is burned in a barbecue what volume of oxygen gas is consumed at SATP?

a) volume to volume = mass to mass
1 mol C_3H_8/ 3 mol CO_2 = 1.5 L / x x = 4.5 L of carbon dioxide
1 mol C_3H_8/ 5 mol O_2 = 1.5 L / x x = 7.5 L of oxygen

b) n = m/M n = 35g/ 44g/mol n = 0.795 mol
1 mol C_3H_8/ 4 mol H_2O = 0.795 mol / x x = 3.18 mol
PV = nRT V = nRT/P V = 78.8 L

c) n = m/M n = 35g/ 44g/mol n = 0.795 mol
1 mol C_3H_8/ 5mol O_2 = 0.795 mol / x x = 3.95 mol
PV = nRT V = nRT/P V = 97.9 L

85. Excess Pb(II) reacts with 25 mL of 1.5 M hydrofluoric acid to produce hydrogen gas at 22°C and 88.5 kPa. How many liters of dry hydrogen gas are collected?

$Pb + 2\ HCl \rightarrow PbCl_2 + H_2$
Moles of HCl: n = cV n = 1.5 mol/L x 0.025L n = 0.0375 mol
2 mol HCl/ 1 mol H_2 = 0.0375 mol / x n = 0.01875 mol
PV = nRT V = nRT/P V = 519.6 L