Record

Answer Key
11/24/25

Exam 4 Test Prep

Chapter 1

Find the mass of 250.0mL of benzene. The density of benzene is 0.8765g/mL.

$D = \frac{m}{V}$ $\quad V \cdot D = \frac{m}{V} \cdot V$ $\quad m = V \cdot D$

$= (250.0\text{mL})(0.8765\text{g/mL})$

$= 219.1\text{g}$

Determine the number of sig figs for each number:

0.025 2 $\quad$ 6.20×10^3 3 $\quad$ 100 1

Determine if it is a pure element, pure substance, or mixture (homogenous or heterogeneous):

Brass	Magnesium	Water	Soil
Homogenous mixture	Pure element	Pure substance	Heterogenous mixture

Chapter 2

Calculate how many protons, neutrons, and electrons for each compound:

79 - 34 = 45

Name	Protons	Neutrons	Electrons	
Selenium - 79	34	45	34	
Carbon-12 ← mass #	6	6	6	
F^{3-}	9	10	12	9+3=12
Ca^{2+}	20	20	18	20-2=18

Write the formula for the following compounds:

Mg^{2+} O^{2-} — Magnesium oxide — MgO

Na^{+} PO_4^{3-} — Sodium phosphate — Na_3PO_4

S^{2-} Br^{-} — Sulfur dibromide — SBr_2

Name the following compounds:

NO_2 nitrogen dioxide

$MgBr_2$ magnesium bromide

Chapter 3 Part 1:

Balance the chemical equation:

$H_3PO_4 + \underline{3}\ KOH \longrightarrow \underline{\ }\ K_3PO_4 + \underline{3}\ H_2O$

H = ~~4~~ 6	H = ~~2~~ 6
PO_4 = 1	PO_4 = 1
K = ~~1~~ 3	K = 3
O = ~~1~~ 3	O = ~~1~~ 3

Iodine is 80.0% ^{127}I, 17.0% ^{126}I, and 3.00% ^{128}I. Calculate the average atomic mass of iodine.

$^{127}I = 127 \times 0.80 = 101.6$

$^{126}I = 126 \times 0.17 = 21.42$

$^{128}I = 128 \times 0.03 = 3.84$

+

127 amu

Calculate the percent composition of calcium in Ca_3P_2?

↳ mw = 182.182 g

$$\frac{(3 \times 40.078\ g\ Ca)}{182.182\ g} \times 100 = 66\%$$

Chapter 3 Part 2:

$2\ KClO_3 \longrightarrow 2\ KCl + 3\ O_2$ ↗ MW = 122.545 g

How many grams of O_2 will be formed from 3.76 grams of $KClO_3$?

$$\frac{3.76\text{ g } KClO_3}{1} \times \frac{1\text{ mol } KClO_3}{122.545\text{ g } KClO_3} \times \frac{3\text{ mol } O_2}{2\text{ mol } KClO_3} \times \frac{31.998\text{ g } O_2}{1\text{ mol } O_2} = 1.47\text{ g } O_2$$

The empirical formula of a substance is CH_2O. It's molar mass is 180. grams. What is the molecular formula? ↳ MW = 30.026 g

$$\frac{M}{E} \quad \frac{180\text{ g}}{30.026\text{ g}} = 6 \qquad 6(CH_2O) \qquad C_6H_{12}O_6$$

What is the empirical formula of a compound consists if 89.14% Au and 10.80% of O.

$$\frac{89.14\text{ g Au}}{1} \times \frac{1\text{ mol Au}}{196.97\text{ g Au}} = 0.4526\text{ mol Au}$$

$$\frac{10.80\text{ g O}}{1} \times \frac{1\text{ mol O}}{15.999\text{ g O}} = 0.6750\text{ mol O}$$

$$Au\ \frac{0.4526}{0.4526}\ O\ \frac{0.6750}{0.4526}$$

$2(Au_1O_{1.5})$

Rules
0.0 - 0.2 ✓
0.3 - 0.7 X
0.8 - 0.9 ✓

Au_2O_3

Chapter 4 Part 1:

Determine if each compound is a strong, weak , or nonelectrolyte:

$Ca(OH)_2$ strong ↳ Ionic

CH_3CH_2OH Non ↳ covalent

HF Weak ↳ weak acid

HNO_3 Strong ↳ strong acid

Write the net ionic equation for the precipitation reaction. What are the spectator ions?

$$NaCl_{(aq)} + AgNO_{3(aq)} \rightarrow NaNO_{3(aq)} + AgCl_{(s)}$$

Complete: $Na^+_{(aq)} + Cl^-_{(aq)} + Ag^+_{(aq)} + NO_3^-{}_{(aq)} \rightarrow Na^+_{(aq)} + NO_3^-{}_{(aq)} + AgCl_{(s)}$

Net: $Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$

Spectator ions: $Na^+_{(aq)} + NO_3^-{}_{(aq)}$

Chapter 4 Part 2:

Determine what compound is reduced and oxidized.

LEO GER

$\overset{0}{Mg} + 2\,\overset{+}{H}\overset{-}{Cl} \longrightarrow \overset{0}{H_2} + \overset{+2}{Mg}\overset{-}{Cl_2}$

$Mg^0 \rightarrow Mg^{+2}$ lose e^-

$H^+ \rightarrow H^0$ gain e^-

Mg = oxidized

H = reduced

HCl = oxidizing agent

Mg = reducing agent

Determine the oxidation number:

N in N_2O_3: $\overset{+3}{N}\overset{-2}{O}$ → +6 −6 → +3

C in CH_4: $\overset{-4}{C}\overset{+}{H}$ → −4 +4 → −4

C in $C_2O_4^{2-}$: $\overset{+3}{C}\overset{-2}{O}$ → +6 −8 → = −2

Mn in $KMnO_4$: $\overset{+}{K}\overset{+7}{Mn}\overset{-2}{O}$ → + +7 −8 → +8 −8 → +7

What volume of a 18.0 M H_2SO_4 stock solution would you use to prepare 500. mL of a 1.77 M H_2SO_4 solution?

$M_1V_1 = M_2V_2$

$$\frac{(18.0\,M)(V_1)}{18.0\,M} = \frac{(500.\,mL)(1.77\,M)}{18.0\,M}$$

$V_1 = 49.2\,mL$

↗ 0.030 L

If it takes 10.0 mL of 2.0 M HNO_3 to neutralize 30.0 mL of $Ca(OH)_2$, what is the molar concentration of $Ca(OH)_2$?

$2\ HNO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + 2\ H_2O$

$$\frac{2.0\ mol}{L} \times 0.010\ L = 0.02\ mol\ HNO_3 \left| \frac{1\ mol\ Ca(OH)_2}{2\ mol\ HNO_3} \right. = 0.01\ mol\ Ca(OH)_2$$

$$\frac{0.01\ mol}{0.030\ L} = \boxed{0.33\ M\ Ca(OH)_2}$$

$CH_4 + 2\ H_2O \longrightarrow 4\ H_2(g) + CO_2(g)$

How many grams of hydrogen can be produced from the reaction of 80.0 g of CH_4 and 16.3 g of water? What is the limiting reactant?

$$80.0\ g\ CH_4 \left| \frac{1\ mol\ CH_4}{16.043\ g\ CH_4} \right. \left| \frac{4\ mol\ H_2}{1\ mol\ CH_4} \right. \left| \frac{2.016\ g\ H_2}{1\ mol\ H_2} \right. = 40.2\ g\ H_2$$

$$16.3\ g\ H_2O \left| \frac{1\ mol\ H_2O}{18.015\ g\ H_2O} \right. \left| \frac{4\ mol\ H_2}{2\ mol\ H_2O} \right. \left| \frac{2.016\ g\ H_2}{1\ mol\ H_2} \right. = \boxed{3.65\ g\ H_2}$$

$\boxed{H_2O = \text{limiting reactant}}$

Chapter 5 Part 1:

Determine if it is an endothermic or exothermic reaction:

Boiling water	Freezing water	Melting chocolate	Combustion
$l \rightarrow g$	$l \rightarrow s$	$s \rightarrow l$	
endo	exo	endo	exo

500 J of heat is added to the system and 200 J of work is done by the system. Calculate the change in internal energy of the system.

$\Delta E = q + w$

$q = +500\ J$

$w = -200\ J$

$= +500\ J + -200\ J$

$= \boxed{300\ J}$

Chapter 5 Part 2:

Given the thermochemical equation:

$N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$ $\Delta H = -91.8$ kJ

How much heat is given off when 1.00 g of H_2 reacts?

$$\frac{1.00\text{ g } H_2}{2.016\text{ g } H_2} \left| \frac{1\text{ mol } H_2}{3\text{ mol } H_2} \right| \frac{-91.8\text{ kJ}}{} = -15.2\text{ kJ}$$

14.0g of metal at 24.0 °C has 250. joules of heat added to it. The metal's specific heat is 0.105 J/g°C. What is its final temperature?

$q = 250$ J
$m = 14.0$ g
$C = 0.105$ J/g°C
$T_1 = 24$°C
$T_2 = ?$

$q = mc\Delta T$

$\frac{q}{mc} = \frac{mc\Delta T}{mc}$

$\Delta T = \frac{q}{mc}$

$= \frac{250\text{ J}}{(14.0\text{ g})(0.105\text{ J/g°C})}$

$= 170$°C

170°C (initial temp) $+ 24$°C (Δ in temp) $= 194$°C

Calculate the ΔH for the reaction $CH_4(g) + NH_3(g) \rightarrow HCN(g) + 3\ H_2(g)$, given:

flip ½ ($N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$) $\Delta H = -91.8$ kJ

flip $C(s) + 2\ H_2(g) \rightarrow CH_4(g)$ $\Delta H = -74.9$ KJ

½ ($H_2(g) + 2\ C(s) + N_2(g) \rightarrow 2\ HCN(g)$) $\Delta H = +270.3$ KJ

$NH_3(g) \rightarrow 0.5\ N_2(g) + 1.5\ H_2(g)$ $\Delta H = +45.9$ kJ

$CH_4(g) \rightarrow C(s) + 2\ H_2(g)$ $\Delta H = +74.9$ kJ

$0.5\ H_2(g) + C(s) + 0.5\ N_2(g) \rightarrow HCN(g)$ $\Delta H = 135.15$ kJ

$NH_3(g) + CH_4(g) \rightarrow HCN(g) + 3\ H_2(g)$ 256.0 kJ

Calculate the enthalpy change of the reaction below:

$CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(l)$

Products − reactants

$\left[(1 \times -393.5) + (2 \times -286)\right] - \left[(1 \times -74.6) + (0)\right]$

$-965.5 - -74.6$

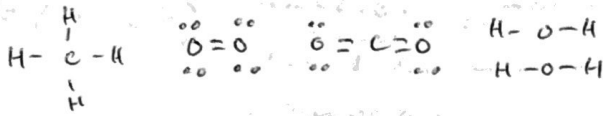
$= \boxed{-891\ kJ}$

Compound	Enthalpy of Formation (kJ/mol)
Hydrogen (H_2)	0
Methane (CH_4)	-74.6
Ethane (C_2H_6)	-84.0
Ethylene (C_2H_4)	52.4
Carbon Dioxide	-393.5
Water (l)	-286
Water (g)	-241.8

Calculate the enthalpy change given the table below:

$CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(l)$

Reactants − products



$\left[(4 \times 413) + (2 \times 495)\right] - \left[(2 \times 745) + (4 \times 467)\right]$

$2642 - 3358$

$= \boxed{-716\ kJ}$

Bond	Energy (kJ/mol)
O=O	495
C=O	745
O-H	467
C-H	413

Chapter 10:

A submarine with a volume of 1.2×10^5 L has an internal pressure of 1.0 atm and an internal temperature of 15° C. If the submarine descends to a depth where the pressure is 150 atm and the temperature is 3.0° C, what will the volume of the gas inside be if the hull of the submarine breaks?

$V_1 = 1.2 \times 10^5\ L$

$P_1 = 1.0\ atm$

$T_1 = 15°C \sim 288K$

$P_2 = 150\ atm$

$T_2 = 3.0°C \sim 276\ K$

$V_2 = ?$

$T_2 \cdot \frac{P_1V_1}{T_1 P_1} = \frac{P_2V_2}{T_2 P_2} \cdot T_2$

$\frac{P_1V_1T_2}{T_1 P_2} = \frac{P_2V_2}{P_2}$

$V_2 = \frac{P_1V_1T_2}{T_1 P_2}$

$= \frac{(1.2 \times 10^5\ L)(1.0\ atm)(276K)}{(288K)(150\ atm)}$

$= \boxed{7.7 \times 10^2\ L}$

At what temperature will 5.00g of Cl_2 exert a pressure of 900. Torr at a volume of 750. mL?

$n = 5.00\ g\ Cl_2$

$P = 900.\ torr$

$V = 750\ mL \sim 0.750L$

$T = ?$

$R = 0.08206\ \frac{L \cdot atm}{mol \cdot K}$

$PV = nRT$

$T = \frac{PV}{nR}$

$\frac{5.00\ g\ Cl_2}{70.9\ g\ Cl_2} \left| \frac{1\ mol\ Cl_2}{} \right. = 0.0705\ mol\ Cl_2$

$\frac{900\ torr}{760\ torr} \left| \frac{1\ mol}{} \right. = 1.18\ atm$

$= \frac{(1.18\ atm)(0.750L)}{(0.0705\ mol)(0.08206\ \frac{L \cdot atm}{mol \cdot K})}$

$= \boxed{153K}$

1) Find mol H_2
- $PV=nRT$

2) Convert $H_2 \rightarrow NH_3$
- volume of NH_3

$N_2 + 3\,H_2 \rightarrow 2\,NH_3$

Ammonia is often formed by reacting nitrogen and hydrogen gases. How many liters of ammonia gas can be formed from 24.5 L of hydrogen gas at 93.0 °C and a pressure of 33.9 kPa?

$V = NH_3$?

$V = 24.5\,L$
$T = 93.0\,^\circ C$ } H_2
$P = 33.9\,kPa$ } 366K

$PV=nRT$

$n = \frac{PV}{RT} = \frac{(24.5\,L)(0.335\,atm)}{\left(0.08206\,\frac{L\cdot atm}{mol\cdot K}\right)(366K)} = 0.273\,mol\ H_2$

$\frac{33.9\,kPa}{101.325\,kPa} \left| \frac{1\,atm}{} \right. = 0.335\,atm$

$\frac{0.273\,mol\ H_2}{} \left| \frac{2\,mol\ NH_3}{3\,mol\ H_2} \right| \frac{22.4\,L}{1\,mol\ NH_3}$ @ STP

$= \boxed{4.08\,L\ NH_3}$

A container with two gases, helium and argon, is 30.0% helium. Calculate the partial pressure of helium and argon if the total pressure inside the container is 4.00 atm.

$n_{He} = 30.0\% \rightarrow 0.30\,mol\ He$

$n_{Ar} = 70.0\% \rightarrow 0.70\,mol\ Ar$

$P_{He} = \left(\frac{0.30\,mol}{1\,mol}\right)(4.00\,atm) = \boxed{1.20\,atm\ He}$

$P_{Ar} = \left(\frac{0.70\,mol}{1\,mol}\right)(4.00\,atm) = \boxed{2.80\,atm\ Ar}$

A sample of nitrogen gas (N_2) is contained in a 5.00 L container at a temperature of 300 K and a pressure of 2.00 atm. Calculate the density of the nitrogen gas.

$V = 5.00\,L$
$T = 300\,K$
$P = 2.00\,atm$
$Density = ?$
$mm = 28.014\,g/mol\ N_2$

$Density = \frac{\text{molar mass} \times P}{RT}$

$= \frac{(28.014\,g/mol)(2.00\,atm)}{\left(0.08206\,\frac{L\cdot atm}{mol\cdot K}\right)(300K)}$

$= \boxed{2.28\,g/L}$

Chapter 11:

Rank the following compounds from weakest intermolecular forces to strongest.

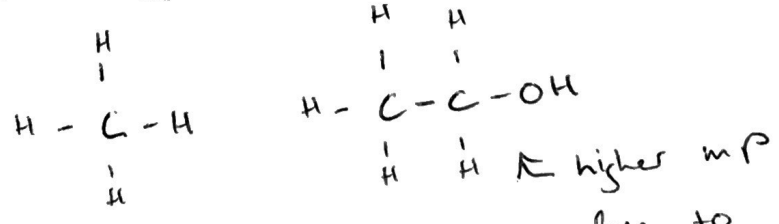
O_2, H_2S, and CH_3OH.

$O_2 < H_2S < CH_3OH$

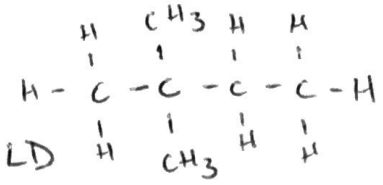
LD D-D HB

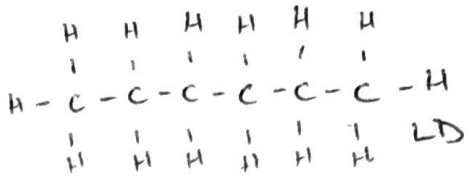
Which of the following will have the highest melting point?

CH_4 or C_2H_5OH



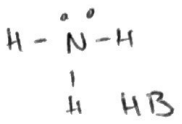
LD HB ← higher mp due to HB

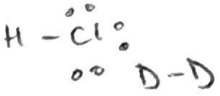




Rank the following in order of increasing boiling point:

Ne, $CH_3C(CH_3)_2CH_2CH_3$, C_6H_{14}, NH_3, HCl

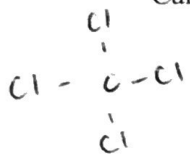


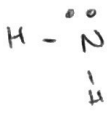


Ne < $CH_3C(CH_3)_2CH_2CH_3$ < C_6H_{14} < HCl < NH_3

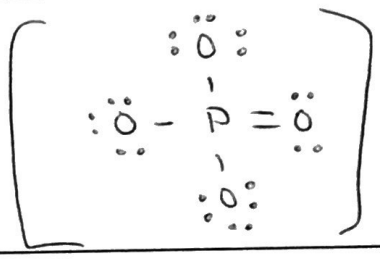
Which compound below is most likely to dissolve best in water?

Carbon tetrachloride or ammonia





NH_3 will dissolve better in water b/c "like dissolves like"

Chapter 8, 9	Phosphate PO_4^{3-} 32e⁻
Lewis Dot Structure Has resonance	
Formal Charge = val e⁻ - nonbonding e⁻ - ½ (bonding e⁻)	-O: 6 - 6 - ½ (2) = -1 =O: 6 - 4 - ½ (4) = ∅ P: 5 - 0 - ½ (10) = ∅
# e- domains	4
e- domain geometry	Tetrahedral
Molecular geometry	Tetrahedral
Bond Angle	109.5°C
Hybridization	sp^3
Polar or Nonpolar Molecule	Nonpolar
Polar or Nonpolar bonds	Polar bonds (3.5 - 2 = 1.5 ← electronegativity difference)
Sigma and pi bonds	σ = 4 π = 1

Chapter 6:

A light has a wavelength of 500. nm. What is the frequency of the light wave?

$\lambda = 500.\ nm$

$c = 3.00 \times 10^{8}\ m/s$

$c = \lambda\nu$

$\nu = \frac{c}{\lambda}$

$\frac{c}{\lambda} = \frac{\lambda\nu}{\lambda}$

$500.\ nm \times \frac{1\ m}{10^{9}\ nm} = 5 \times 10^{-7}\ m$

$= \frac{3.00 \times 10^{8}\ m/s}{5.00 \times 10^{-7}\ m} = \boxed{6.00 \times 10^{14}\ s^{-1}}$

A photon of light has a wavelength of 400. nm. Calculate the energy of the photon.

$\lambda = 400.\ nm$

$h = 6.626 \times 10^{-34}\ J \cdot s$

$c = 3.00 \times 10^{8}\ m/s$

$E = \frac{hc}{\lambda}$ ← $E = h\nu$ + $c = \lambda\nu$

$400.\ nm \times \frac{1\ m}{10^{9}\ nm} = 4.00 \times 10^{-7}\ m$

$= \frac{(6.626 \times 10^{-34}\ J \cdot s)(3.00 \times 10^{8}\ m/s)}{4.00 \times 10^{-7}\ m}$

$= \boxed{4.97 \times 10^{-19}\ J}$

Determine the electron configuration of the following elements:

Cr: condensed $[Ar]\,4s^1 3d^5$

Cl^-: $1s^2\,2s^2\,2p^6\,3s^2\,3p^6$

Mg^+: $1s^2\,2s^2\,2p^6\,3s^1$

Determine the condensed electron configuration for the following element:

Se $[Ar]\,4s^2\,3d^{10}\,4p^4$