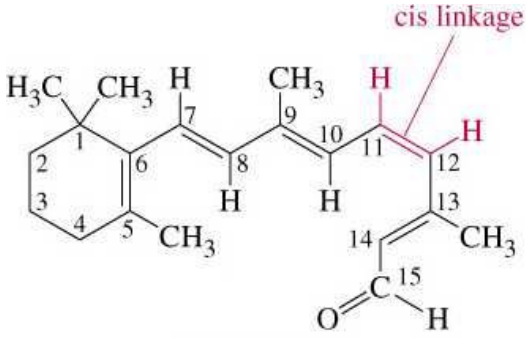
MEDIUM PACKET 1

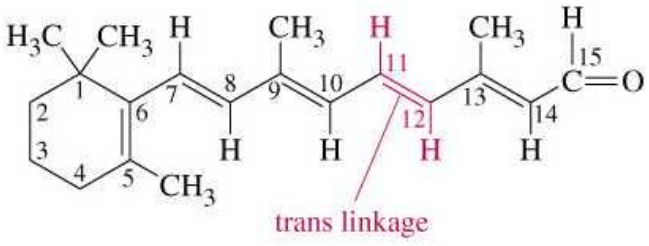
Team ID Number: _____

Thermodynamics

Rhodopsin is an important enzyme for human vision. Using the energy of a single photon, rhodopsin mediates the isomerization of a single molecule of 11-*cis* retinal to 11-*trans* retinal. This biochemical reaction leads to a cascade of reactions that result in the phenomenon known as vision. The two forms are pictured below:



11-*cis*-Retinal



11-*trans*-Retinal

Suppose that the energy for the isomerization reaction is 240.0kJ/mol. *What is the minimum wavelength of light in nanometers for a single molecule of 11-cis retinal to be converted to 11-trans retinal?*

MEDIUM PACKET 1

Team ID Number: _____

Equilibrium

$PbBr_2$ is a sparingly soluble salt in water. Its solubility, K_{sp}, is 8.90×10^{-6} at 25°C. Using this information, *calculate the molar solubility of $PbBr_2$ (in mol/L) in each of the following aqueous solutions at 25*°C. *Then rank the solutions in order of increasing molar solubility of $PbBr_2$.*

a) Pure water
b) 0.20M KBr aqueous solution
c) 0.20M $Pb(NO_3)_2$

MEDIUM PACKET 1

Team ID Number: _____

Chemical Reactions

Potato Joe and Peeti embark on a three day wilderness expedition. Unfortunately they forgot to bring a box of matches and instead took 1.05g of hydrogen peroxide (H_2O_2) They unwisely decide to heat up 2.0L of water by using the heat released from the decomposition of H_2O_2 in the presence of Catalyst X, which causes the decomposition of H_2O_2 to occur rapidly. *A*ssuming that all the heat released from the decomposition reaction is transferred to the water, *how much would the temperature of the water be increased by?*

Given: heat capacity of water = 4.184 $J \cdot C^{-1} \cdot g^{-1}$; density of water = 1.0g/mL; the enthalpy change of the decomposition reaction of H_2O_2 (ΔH = -196.0kJ/mol).

MEDIUM PACKET 2

Team ID Number: _____

Kinetics

Consider the overall reaction shown below:

$$W(aq) + O(aq) + 2C(aq) \rightarrow C_2OW(aq)$$

Five different experiments (Exp 1-5) were performed with different initial concentrations of each reactant. The initial concentrations of reactants and the initial rate in each experiment are recorded in the table shown below. Assume all experiments were done at the same temperature, and the temperature is a constant throughout the reaction. *What is the rate law of this reaction*? In your rate law, write the rate constant, k, as a numerical value.

Experiment	$[W]_0$	$[O]_0$	$[C]_0$	**Initial Rate (M/s)**
1	0.60	0.60	0.60	0.0040
2	0.60	0.60	0.30	0.0020
3	1.20	1.20	0.60	0.0160
4	0.60	1.20	0.60	0.0040
5	0.150	0.80	0.60	0.000250

MEDIUM PACKET 2

Team ID Number: _____

Chemical Reactions

Predict the products and balance the equation. Include states of matter and relevant coefficients.

a) $AgNO_3\,(aq) + NaCl\,(aq) \rightarrow ?$
b) $CH_4\,(g) + O_2\,(g) \rightarrow ?$
c) $CO_2\,(g) + 2H_2O\,(l) \rightarrow ?$

MEDIUM PACKET 2

Team ID Number: _____

Thermodynamics

CFCs are a class of compounds consisting of fluorine and chlorine bound to a single carbon atom. These compounds are highly damaging to the ozone layer, which is located in the stratosphere and diminishes the impact of UV radiation on the Earth. CFCs are stable in the atmosphere until they reach the ozone layer, at which point they break down into their corresponding elements, where they interact with ozone and destroy it. The following two reactions are the two steps in ozone depletion:

1) $Cl\cdot + O_3 \rightarrow ClO + O_2$

2) $ClO + O_3 \rightarrow Cl\cdot + 2O_2$

Overall reaction = ???

Note that $Cl\cdot$ represents a chlorine radical.

Using the following table of bond enthalpies, *1) calculate the enthalpy of the overall reaction and 2) determine whether each species is a reactant, intermediate, product, catalyst, inhibitor, or non-reacting.*

Bond	**Heat of dissociation (kJ/mol)**
O - O	180.0
O - Cl	200.0
O = O	498.0
Cl - Cl	243.0

MEDIUM PACKET 3

Team ID Number: _____

Chemical Reactions

Balance the following reactions:

a) $MnO_4^-(aq) + SO_3^{2-}(aq) \rightarrow Mn^{2+}(aq) + SO_4^{2-}(aq)$ (in an acidic environment)
b) $KMnO_4(aq) + FeSO_4(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + MnSO_4(aq) + Fe_2(SO_4)_3(aq) + H_2O(l)$

MEDIUM PACKET 3

Team ID Number: _____

Equilibrium

Given that the K_a of HF is 6.8×10^{-4}, *calculate the fluoride ion concentration of a solution that is composed of 0.20M HF and 0.10M HCl.*

MEDIUM PACKET 3

Team ID Number: _____

Acid/Base

Malachite green is an organic compound that changes color from green to yellow as the pH drops below 1.8. You combine 750.0mL of pure water with a small amount of malachite green in a beaker. Then, you begin adding Solution X, which has an unknown pH, dropwise into the beaker. After adding 520 drops of Solution X (1 drop = 0.05 mL), the solution in the beaker changes color from green to yellow. *What is the pH of the Solution X?*

MEDIUM PACKET 4

Team ID Number: _____

Physical Properties

Raoult's law states that the vapor pressure above a mixture can be found by multiplying the vapor pressure of each pure component by its mole fraction in the mixture. If 20.0 g of a mysterious non-volatile (vapor pressure = 0.0 atm) compound is added to 500.0 g of hexane (assume no volume change), and the vapor pressure decreases from 120.0 mmHg to 112.3 mmHg, *find the molar mass of the compound*.

MEDIUM PACKET 4

Team ID Number: _____

Chemical Reactions

56.7g of propane (C_3H_8) are combusted with 205.7g oxygen under standard conditions (0.0°C and 1.0 atm) in a 2.0L closed, rigid, insulated container. At some point after the reaction is complete, the temperature inside the box is 157°C. *What is the pressure inside the container at this time?*

MEDIUM PACKET 4

Team ID Number: _____

Kinetics

Peeti is working in a chemistry laboratory to obtain the rate of a particular reaction. The following unbalanced reaction is examined.

$$\_\_NH_3\,(g) + \_\_O_2\,(g) \rightarrow \_\_NO\,(g) + \_\_H_2O\,(g)$$

Initially, the concentration of oxygen gas is 10.0M. After two minutes, the concentration of oxygen gas has decreased to 5.7M. *What is the rate of formation of H_2O (g) in terms of M/s?*

MEDIUM PACKET 5

Team ID Number: _____

Physical Properties

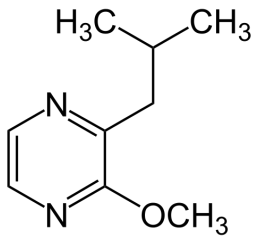
The creature Poliwag uses a special high density water in its attacks to enhance the power of its attacks by sequentially combining oxygen-16 with two isotopes of hydrogen. The mass of 5.0 L of the special high density water is 5.84 kg. There are the same amount of moles per liter in this special water as there is in normal water, and all the special high density water molecules are exactly the same. *What three atoms are each water molecule composed of?* Remember the density of regular water is 1 g/mL and that the isotopes of hydrogen are hydrogen (${}^{1}_{1}\mathrm{H}$), deuterium (${}^{2}_{1}\mathrm{H}$), and tritium (${}^{3}_{1}\mathrm{H}$).

MEDIUM PACKET 5

Team ID Number: _____

Chemical Reactions

Your friend, Peeti, who really likes coffee, claims that he has found a high-throughput method of synthesizing 2-isobutyl-3-methoxypyrazine ($C_9H_{14}N_2O$), one of the compounds that contributes to the flavor of coffee. The compound is shown below.



Peeti says the reaction can be accomplished by using his so called "Peeti Catalyst" as follows:

$$C_4H_9OH + C_5H_6N_2O \rightarrow C_9H_{14}N_2O + H_2O$$

Peeti wants 17.84g of 2-isobutyl-3-methoxypyrazine ($C_9H_{14}N_2O$) for his next cup of coffee. *How many grams of* C_4H_9OH *and* $C_5H_6N_2O$ *will Peeti need for this supposed reaction?* Assume the Peeti Catalyst if 100% effective and the reaction goes to completion.

MEDIUM PACKET 5

Team ID Number: _____

Thermodynamics

Dewgong is a creature whose body produces a special salt whose dissolving process is very endothermic in order to create its ice beams. 1.0 kg of this salt removes 2333.0 kJ of energy from the system. If the amount of ice ejected during the beam is 1.60 kg/second. *How much salt (in g) per second must Dewgong dissolve in order to form the necessary amount of ice?* The surrounding ocean water has a temperature of 17 °C, freezes at -1.94 °C, has a specific heat of 3850 $J \times kg^{-1} \times °C^{-1}$. and a heat of fusion of 334.72 J/g. Assume that the mass of the salt is negligible compared to the water.

MEDIUM PACKET 6

Team ID Number: _____

Equilibrium

Christina makes Solution a by dissolving an excess amount of $Mg(OH)_2$ in 150.0mL of H_2O at 25˚C. Edwin, on the other hand, combines 1.0L of 0.20M $Mg(NO_3)_2$ with 800.0mL of a 0.25M KOH to make Solution B. Given that the K_{sp} of $Mg(OH)_2$ is 5.6×10^{-12} at 25˚C, *in which solution would the greatest amount of $Mg(OH)_2$ (by mass) be dissolved, and by how much?*

MEDIUM PACKET 6

Team ID Number: _____

Electrochemistry

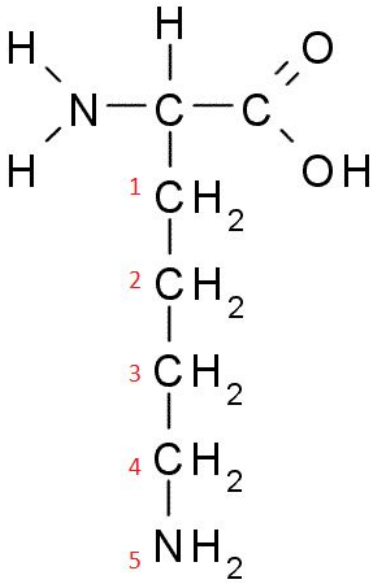
Peeti is trying to put together a galvanic cell with just two different concentrations of Cu^{2+} ions. In one beaker, he has a copper electrode with 0.10M Cu^{2+} ions. In another beaker, he has a platinum electrode with 0.010M Cu^{2+} ions. Next, Peeti hooks the copper electrodes together with a copper wire and adds a salt bridge to both beakers. *What is the cell potential for this galvanic cell?* (Assume the temperature is 25 °C.)

MEDIUM PACKET 6

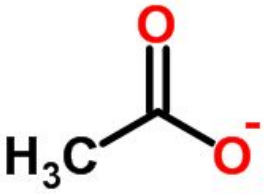
Team ID Number: _____

Acid/Base

In eukaryotic cells, DNA is wrapped around positively charged proteins called histones. Because DNA is negatively charged, it is able to tightly bind to histones because of the favorable interactions between charges. The charge on histones is a result of the amino acid, lysine. Lysine is depicted below:



The carbon chain labelled 1-4 and ending with a nitrogen group labelled 5 is called the R group. Most reactions and interactions of amino acids occur on the R group.
During DNA transcription, histones are often acetylated, which means that an acetate group is added to lysines. The structure of acetate is displayed to the right.



Consider your knowledge of acid-base reactions. Note that DNA is negatively charged.

1) *Circle the number of the atom on which the acetate will react.*
2) *Will this make DNA bind more tightly, less tightly, or have no effect?*

MEDIUM PACKET 7

Team ID Number: _____

Chemical Reactions

Ceric Ammonium Nitrate is an inorganic compound with the molecular formula $(NH_4)_2Ce(NO_3)_6$. When a 2:1 molar ratio of Ceric Ammonium Nitrate and KBr is dissolved in water, a highly reactive bromine ion with a +1 oxidation number is formed. *What is the oxidizing agent and its oxidation state?*

MEDIUM PACKET 7

Team ID Number: _____

Electrochemistry

A team of scientists create a galvanic cell with a large quantity of aluminum and zinc ions with their respective electrodes in two different half cells. They then dissolve 72.5 g of potassium chloride in an aqueous solution to form the salt bridge. Assuming that the reaction runs to completion, with the salt bridge "running out" of ions before the half cells do*, what would be the mass of the metal that is plated onto the electrode?*

$$Zn^{2+} + 2e^- \rightarrow Zn(s) \qquad \xi^\circ = -0.76V$$

$$Al^{3+} + 3e^- \rightarrow Al(s) \qquad \xi^\circ = -1.66V$$

MEDIUM PACKET 7

Team ID Number: _____

Kinetics

Given the following data, what is the activation energy (E_a)?

k	**Temperature (°C)**
5.21×10^{-6}	124
5.47×10^{-1}	332
9.67×10^{-4}	197
5.96×10^{-5}	155
9.45×10^{-3}	238

MEDIUM PACKET 8

Team ID Number: _____

Thermodynamics

For the sake of science, and ignoring IRB restrictions, you want to melt a 5.7 kg Vanillitee (a fictional creature) to 10 ^{o}C. One fourth of the Vanillitee's body is vanilla ice cream and the rest is ice. The normal body temperature of a Vanillitee is -2 ^{o}C. If the melting temperature of ice cream is 0.5 ^{o}C less than ice, *how many kJ of energy will it take to melt the Vanillitee?* Round to the nearest tenth.

Heat of Fusion (H_2O): 334 $J \cdot g^{-1}$
Specific Heat of Liquid H_2O: 4.187 $J \cdot g^{-1} \cdot K^{-1}$
Specific Heat of Ice: 2.108 $J \cdot g^{-1} \cdot K^{-1}$
Heat of Fusion (Vanilla Ice cream): 204 $J \cdot g^{-1}$
Specific Heat of liquid ice cream: 2.74 $J \cdot g^{-1} \cdot K^{-1}$
Specific Heat of solid ice cream: 3.22 $J \cdot g^{-1} \cdot K^{-1}$

MEDIUM PACKET 8

Team ID Number: _____

Equilibrium

What is the maximum concentration of Mg^{2+} ion that can remain dissolved in a solution that contains 0.72 M NH_3 and 0.21 M NH_4Cl given that the K_{sp} for $Mg(OH)_2$ is 1.2×10^{-11} and the K_b for NH_3 is 1.77×10^{-5}?

MEDIUM PACKET 8

Team ID Number: _____

Acid/Base

KHP is a monoprotic acid with a molar mass of 204.22 g/mol, and $K_a=3.9 \times 10^{-6}$. You have a 100.0mL of a 0.50 M solution of KHP, and 1.00g of sodium hydroxide (39.997g/mol) is added, *Find the pH of the resulting solution* (assume the volume of the solution does not change when sodium hydroxide is added).

MEDIUM PACKET 9

Team ID Number: _____

Physical Properties

Because water is so heavy to transport, soda companies produce their product as a syrup, and mix this syrup with water nearby cities where they plan on selling their product. WUCT is planning on making its own soda, which requires mixing 50.0 ml of our own custom syrup (density = 1.25 g/cm^3) with 350.0 mL water (density = 1.0 g/cm^3). This solution is then pressurized to 50.0 atm of carbon dioxide. Assuming the Henry's constant, K_H, is 0.034 $mol \cdot L^{-1} \cdot atm^{-1}$, *what is the percentage of the solution's mass is contributed by carbon dioxide?* (Note: $C_a = K_H \times P$)

MEDIUM PACKET 9

Team ID Number: _____

Electrochemistry

Predict the cell potential for the following reaction when the pressure of the oxygen gas is 2.50 atm, the hydrogen ion concentration is 0.10M, and the bromide ion concentration is 0.25 M.

$$O_2\,(g) + 4H^+\,(aq) + 4Br^-\,(aq) \rightarrow 2H_2O\,(l) + 2Br_2\,(l)$$

Oxidation	$4\ Br^-\ (aq) \rightarrow 2Br_2\ (l) + 4e^-$	$E^o_{ox.} = -1.077V$
Reduction	$O_2\ (g) + 4H^+\ (aq) + 4e^- \rightarrow 2H_2O\ (l)$	$E^o_{red.} = +1.229V$
Overall	$O_2(g) + 4\ H^+(aq) + 4\ Br^-(aq) \rightarrow 2\ H_2O\ (l) + 2\ Br_2\ (l)$	

MEDIUM PACKET 9

Team ID Number: _____

Acid/Base

Determine if the following compounds will be strongly acidic, weakly acidic, neutral, weakly basic, or strongly basic when dissolved in water:

a) HNO_3
b) MgO
c) CH_3COONa
d) $HClO_2$
e) $HClO_4$
f) $MgCl_2$

MEDIUM PACKET 10

Team ID Number: _____

Physical Properties

Xanthan gum is a common emulsifier used in cooking, often in salad dressings and sauces. It is often used as a substitute for gluten in baking. Derived from the bacteria, *Xanthomonas campestris,* xanthan gum is a polysaccharide, meaning that it is made of many monomers. You have derived a sample from a bacterial culture and have determined that a single monomer is composed of 45% carbon, 5.25% hydrogen, and 49.75% oxygen. You have also determined that a dimer (two monomers) has a molar mass of 1.86kg/mol. *What is the molecular formula of a monomer of xanthan gum?*

MEDIUM PACKET 10 Team ID Number: _____

Thermodynamics

On Planet Laberstros, solid Scmeckles ($Ż_2Ê_3$) reacts with the gaseous molecule Zoopzoop ($Ỹ_2$) to make solid Shnerps ($Ż$) and liquid Spresynar ($Ỹ_2Ê$)

$$Ż_2Ê_3(s) + 3\ Ỹ_2(g) \rightleftharpoons 2\ Ż\ (s) + 3\ Ỹ_2Ê\ (l)$$

Equilibrium is not achievable under standard conditions. However, in a laboratory, the equilibrium partial pressure of $Ỹ_2$ gas is 63.0atm at 2.0˚C. The $Ỹ_2$ gas behaves as an ideal gas at this temperature and pressure. Given $\Delta G_f°$ ($Ỹ_2Ê$, l) = −237.18kJ/mol at 227.0˚C, *calculate the* $\Delta G_f°$ *(in kJ/mol) of* $Ż_2Ê_3$ *solid at 227.0˚C.*

MEDIUM PACKET 10

Team ID Number: _____

Acid/Base

A solution is created by the addition of sodium hypochlorite (NaClO) to an adequate amount of water to make 2.00L of solution that has a pH of 10.50. Using the information from the equation provided below, *calculate the mass of sodium hypochlorite added*. Assume the reaction occurs at 298K.

$$ClO^- + H_2O \leftrightarrow HClO + OH^- \qquad K_b = 3.3\times10^{-7}$$

MEDIUM PACKET 11 Team ID Number: _____

Physical Properties

Molybdenum is a chemical frequently used in developing solar panels. The following reaction can turn molybdenum oxide into molybdenum, which can then be used for solar panels.

$$2CO\,(g) + MoO_2\,(s) \rightarrow 2CO_2\,(g) + Mo\,(s) \qquad \Delta H = +21.86\ kJ$$

If a poorly illuminated solar cell is hit with 3,600 photons per second per square meter, and 50.0 g of molybdenum is used to create each meter squared of solar panel, *how many seconds will it take to recover the energy spent on making the molybdenum for that solar cell?* Assume all photons have a wavelength of 426 nm. (Hint: This is a really long time!)

MEDIUM PACKET 11

Team ID Number: _____

Acid/Base

Benzoate ion, $C_6H_5COO^-$, is a weak base ($K_b = 1.6\times10^{-10}$). *How many moles of benzoate ions are required to create a 1.5 L solution of sodium benzoate that has a pH of 9.04*?

MEDIUM PACKET 11

Team ID Number: _____

Kinetics

Catalysts are used to increase the rate of a reaction. Shown below are two possible reactions, one catalyzed and one uncatalyzed, for the same reaction of A + B → Z. *How much faster is the catalyzed reaction compared to the uncatalyzed reaction at 298 K?*

Uncatalyzed	
2A + 3B → 2I	E_a = 25.0kJ/mol
I → 2Z + B	E_a = 0.35kJ/mol

Catalyzed	
2A + C → E	E_a = 0.04kJ/mol
E + 2B → F	E_a = 12.5kJ/mol
F → 2Z	E_a = 0.35kJ/mol

MEDIUM PACKET 12 Team ID Number: _____

Physical Properties

Eevee is able to evolve into various forms when influenced by surrounding radiation. Normally this radiation comes from evolution stones. However, you would like to recreate this radiation through the transition of a H atom from n = 3 to n = 2. Assuming Bohr Model, *which unnatural creature from a video game started in the 1990s and has over 12 known iterations to "Catch them all" will your Eevee evolve into? What is the wavelength of the radiation?*

Eeveelution	**Color of Light**	**Wavelength (nm)**
Espeon	violet	380 - 410
Vaporeon	blue	415 - 495
Leafeon	green	495 - 570
Jolteon	yellow	570 - 590
Umbreon	orange	590 - 620
Flareon	yellow	620 - 750

MEDIUM PACKET 12

Team ID Number: _____

Electrochemistry

In the electrolysis of barium chloride, $BaCl_2$, barium ions are plated onto the cathode and chloride gas is produced at the anode. Assume you supply a 0.50A electrical current to the reaction for 30 minutes, *how much barium metal would be produced?*

MEDIUM PACKET 12 Team ID Number: _____

Acid/Base

Aadit is performing an experiment where he places 2.97g of $NaHCO_3$ into a 25.0mL volumetric flask, and then fills to the calibration point with water. Daniel performs an identical experiment to Aadit, but accidently uses 37.0mL of water instead of 25.0mL. Given that the K_a of H_2CO_3 is 4.2×10^{-7}, and the K_a of HCO_3^- is 4.8×10^{-11}, *what will the difference in pH be between Aadit and Daniel's solution?*

MEDIUM PACKET 13 Team ID Number: _____

Physical Properties

One of the many forces that lead to the evolution of Alolan forms of Pokemon is the radioactive carbon (C^{14}) in the surrounding environment. Alolan glucose ($C_6H_{12}O_6$) is composed of 42.86% carbon, 6.41% hydrogen and 50.80% oxygen by weight. *What percent of carbon in Alolan glucose is C^{14}?* Assume the rest of the glucose is C^{12} and all the other atoms have similar ratios of isotopes to the rest of the world.

MEDIUM PACKET 13

Team ID Number: _____

Electrochemistry

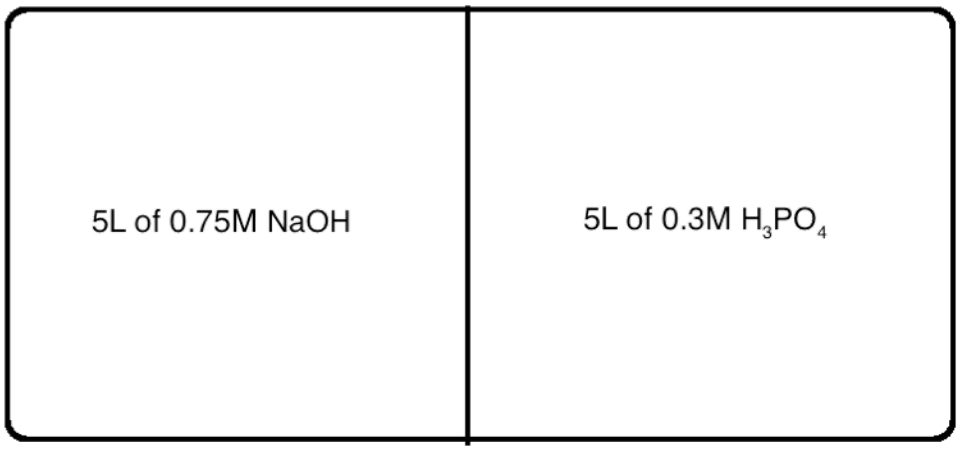
The following reaction, $2Al_2O_3\,(s) + 3C\,(s) \rightarrow 4Al\,(s) + 3CO_2\,(g)$, is carried out in an electrolysis cell. Assume the electrolysis reaction is running with a steady current of 1.20 A for 3 hours. C*alculate the mass (in g) of aluminum metal produced during this period of time.* Show all work to support your answer and circle your final answer. (Note: The oxidation state of Al in Al_2O_3 is +3.)

MEDIUM PACKET 13 Team ID Number: _____

Acid/Base

In the two-sided container below, students placed 5.0 L of 0.75 M NaOH in the left compartment and 5.0 L of 0.3 M H_3PO_4 in the right compartment. The barrier between the two compartments is a permeable membrane, which allows molecules from either side to freely diffuse into the other. *When the system reaches steady-state, which is the point where the two compartments are functionally identical, what is the pH in the container?* Assume that the mixture is created in 25°C.

$$K_{a1} = 7.1\times10^{-3}$$
$$K_{a2} = 6.3\times10^{-8}$$
$$K_{a3} = 4.5\times10^{-13}$$



Two-sided Container With a Permeable Membrane

MEDIUM PACKET 14 Team ID Number: _____

Physical Properties

Raoult's law states that the vapor pressure above a mixture can be found by multiplying the vapor pressure of each pure component by its mole fraction in the mixture. 0.325g of silver chloride ($K_{sp} = 1.77\times10^{-10}$), a non-volatile solute, is added to 600.0mL of water. The vapor pressure of water at room temperature is 0.0313atm. Assume that the density of the solution is 1.0g/mL. *What is the vapor pressure of water after addition of silver chloride?*

MEDIUM PACKET 14 Team ID Number: _____

Thermodynamics

The neutral hydroxyl radical (OH□) plays an important role in cleaning up the atmosphere. It is highly reactive molecule and tends to combine with hydrogen atoms from other gaseous compounds, causing them to break up. The hydroxyl radical is generated when sunlight hits gaseous water, breaking one of the O-H bonds in water. One reaction that can occur with the hydroxyl radical involves turning methane to the methyl radical, as shown in the equation below.

$$OH\bullet\,(g) + CH_4\,(g) \rightarrow\ CH_3\bullet\,(g) + H_2O$$

Estimate the the energy required (in kJ/mol) to create a methyl radical starting from from methane and gaseous water. Use the following information:

Bond Enthalpy		**Standard Enthalpy of Formation**	
O-H	460 kJ/mol	H_2O	-286 kJ/mol
C-H	413 kJ/mol	CH_4	-74.8 kJ/mol

MEDIUM PACKET 14 Team ID Number: _____

Electrochemistry

In order to generate the electricity they use in battles, Pikachu are essentially living galvanic cells. In a Pikachu, there is a solid zinc electrode in a puddle of $ZnSO_4$ solution in one cheek, and a solid silver electrode in a puddle of Ag_2SO_4 solution in the other. The body of the Pikachu acts as a wire and salt bridge for the system.

A certain Pikachu has 4.33 M $ZnSO_4$ solution in one cheek and 1.79 M Ag_2SO_4 in the other. Given that the body temperature of the Pikachu is 37.8 ^oC *what is the electric potential of the Pikachu?* Give answers to the nearest thousandth.

MEDIUM PACKET 15

Team ID Number: _____

Physical Properties

Alkali metal hydrides are unusual compounds because hydrogen holds more of the electron density. Alkali metal hydrides are also very reactive, often reacting with air or water. Although lithium hydride typically does not dissociate into ions, it is helpful to model the molecule as ionic to facilitate understanding of its reactivity. *Model LiH as individual ions (i.e. a lithium ion and a hydrogen ion) by adding electrons and the relevant charge(s) to the Lewis structure given.* Recall that the Pauling electronegativity of hydrogen is 2.20 and that of lithium is 0.98. *Then, use your model to determine if LiH is more likely to act as an oxidizing or reducing agent.*

Li H

MEDIUM PACKET 15

Team ID Number: _____

Chemical Reactions

Sulfuric acid has many industrial applications from phosphate fertilizer production to metal processing. Consider the *unbalanced* synthesis of sulfuric acid:

$$\_\_\_S\,(s) + \_\_\_O_2\,(g) + \_\_\_H_2O\,(l) \rightarrow \_\_\_H_2SO_4\,(aq)$$

A factory has 5.0 kg of sulfur, 600.0 L of O_2 at 10.0 atm and 280 K, and excess water. The yield of the reaction is 80%. If the factory makes $300.00 for every metric ton (1000.0 kg), *how much money will the factory make?*

MEDIUM PACKET 15 Team ID Number: _____

Electrochemistry

Researchers on Planet Laberstros have been trying to communicate with the scientific community on the continental Earth concerning the way they generate electrical currents using batteries. Unfortunately, their periodic table uses different symbols than we use on Earth, and the cell diagram transmitted to earth is as follows:

$$฿_{(s)} | ฿^{3+}_{(aq)} || \cancel{A}^{2+}_{(aq)} | \cancel{A}_{(s)}$$

Through other sources, we know the element ฿ has 13 protons. Furthermore, we know the $\Delta G°$ on Earth is -1157.82kJ for 2 moles of ฿. *What is the identity of the element* $\cancel{A}$ *and* ฿ *using periodic tables on Earth?*