Day 7: Continue

24. The first part of the decay of plutonium-240 involves three alpha emissions followed by two beta emissions. What nuclide has been formed at this intermediate stage of the decay series?

(A) Radium-228
(B) Radium-224
(C) Actinium-228
(D) Thorium-232
(E) Thorium-228

25. What ions would you find in solution if potassium perchlorate was dissolved in water?

(A) KCl, O_2
(B) $K+, Cl^-, O_2^-$
(C) KCl, O_2^-
(D) K^+, ClO_4^-
(E) K^+, Cl^-, O_2^-

Day 7

STOP. Correct your answers and note how many correct **points**

Day 7: Answers and Explanations

Answers: Quick Check

1. **A**	2. **E**	3. **D**	4. **C**	5. **D**	6. **E**	7. **A**	8. **E**	9. **E**	10. **C**
11. **A**	12. **B**	13. **E**	14. **B**	15. **B**	16. **B**	17.**C**	18.**D**	19. **D**	20. **D**
21. **D**	22. **C**	23. **B**	24. **E**	25. **D**					

Answers and Explanations

Questions 1 through 3: Rate Law, Order of reactions

1. **A** *Recall:* In first Order reactions, the sum of all exponents of reactants in the rate law equation must add up to 1.

   Note: in Choice A equation: rate = $k[X]^1$ Sum of exponents is **1**

2. **E** *Recall:* A reaction is second order in respect to a specified reactant if the exponent of the reactant is a 2 in the rate law equation.

   Note: In Choice E equation: rate = $k[X]^2[Y]^2$ exponent of Y is **2**.

3. **D** *Recall:* In Third Order reactions, the sum of all exponents of reactants in the rate law equation must add up to 3.

   Note: In Choice D equation: rate = $k[X]^2[B]^1$ Sum of exponents is **3**

Questions 4 through 7: Nuclear particles behavior and properties

4. **C** *Recall:* Gamma has the highest energy of all radiations.

5. **D.** *Note:* This is a fact about another use of X-ray
   When focused on a solid, X-ray produces diffraction pattern that can revealed the crystalline structure of the solid.

6. **E** *Note:* Ozone, O_3, which is found in the upper atmosphere, can be broken down by chlorine (Cl_2). UV light, which is also found in upper atmosphere, catalyzes this reaction.

7. **A** *Recall:* Symbol for an alpha particle is ^4_2He

8. **E** **Formula writing, naming**

Note: Formulas for all other choices are incorrectly named. Correct names for these formulas are given below

CsCl: Cesium chloride CBr_4: Carbon tetrabromide
Fe_2O_3: Iron (III) oxide NO_2: Nitrogen dioxide or

9. **E** **Atomic Structure, Electron configuration, quantum numbers**

Recall that a ground state configuration is correctly written for an atom when the followings are the case:

. The available sublevels for the atom are correctly represented
. The sublevels are filled in order from lowest energy to highest energy (1s 2s 2p 3s 3p 4s 3d 4p 5s 4d.....)
. Each sublevel has the correct number of electrons it should have according to certain rules
. The sum of electrons in the configuration is equal to the atomic number (or number of protons) of the atom

Note: The ground state configuration $1s^2 2s^2 2p^6 3p^5$ given for P (15 electrons) is incorrect because one of the available sublevels (3s) is missing in the configuration

10. **C** **Thermodynamic, Enthalpy change calculation, Heat of formation**

Recognize that ΔH° for this reaction can be calculated using the equation

$$\Delta H^\circ = \sum \Delta Hf^\circ_{products} - \sum \Delta Hf^\circ_{reactants}$$

Step 1: Write a balance equation for the reaction to determine the correct moles of reactants and products.

$$\mathbf{2}C_2H_6(g) + \mathbf{7}O_2(g) \text{ -----> } \mathbf{4}CO_2(g) + \mathbf{6}H_2O(g)$$

Step 2: Substitute values from the Table in ΔH equation

$$\Delta H^\circ = \sum \Delta Hf^\circ_{products} - \sum \Delta Hf^\circ_{reactants}$$
$$\Delta H^\circ = [\mathbf{4}(-393) + \mathbf{6}(-251)] - \mathbf{2}(-84)$$
$$\Delta H^\circ = -1572 - 1506 + 168$$
$$\Delta H^\circ = -3078 \text{ kJ for 2 moles of } C_2H_6$$

Step 3: Adjust the calculated KJ for 1 mole of C_2H_6 :
- 2910 KJ / 2 mol = **−1455 kJ/mol**

Day 7: Answers and Explanations

11. **A** **Periodic Trend, atomic structure,**

Recall: Atomic radius decreases from Left to right (Increasing atomic number) due to the increase in nuclear charge (number of protons)

12. **B** **Reaction of acids, property of gases**

Recognize that based on the properties of the gas described in the question, the gas is likely carbon dioxide, CO_2.

Determine: Based on its formula, $NaHCO_3$ (of all the choices listed) is likely to react with an acid to produce CO_2

Note: The net ionic equation for this reaction is:

$$H^+ + HCO^- \text{ -------> } CO_2 + H_2O$$

13. **E** **Rate law, rate constant, rate calculation, writing equation**

Step 1: Write the correct reaction equation based on info given:

$$CH_3CHO(g) \text{ ------> } CH_4(g) + CO(g)$$

Step 2: Write the rate law based on information given and the equation

rate = $k[CH_3CHO]^2$ as stated, rate is 2nd order and depends on $[CH_3CHO]$

Step 3: Determine k (rate-specific constant) at the old concentration

$$k = \frac{\text{rate}}{[CH_3CHO]} = \frac{0.10 \text{ mole} \cdot L^{-1} \cdot \sec^{-1}}{(0.010 \text{ mole } L^{-1})^2}$$

$$k = 1.0 \times 10^3 \text{ L} \cdot \text{mole}^{-1} \sec^{-1}$$

Step 4: Determine rate at the new $[CH_3CHO]$

$$\text{rate} = k[CH_3CHO]^2 = \left(\frac{1.0 \times 10^3 \text{ L}}{\text{mole} \cdot \sec}\right) \times \left(\frac{0.050 \text{ mole}}{\text{L}}\right)^2$$

$$\text{rate} = \frac{2.5 \times 10^1 \text{ mole}}{\text{L.sec}} \quad \text{or} \quad \mathbf{2.5 \text{ mol / (L . sec)}}$$

Day 7: Answers and Explanations

14. **B** **Dipole moments, molecular polarity, molecular structures**

Recall: Dipole moment refers to degree of polarity of a molecule. The more polar the molecule, the higher its dipole moment.

Note: HCl is the most polar (biggest difference in electronegativity values) of the five choices given.

N_2 and Cl_2 are nonpolar. Their dipole moments are zero.

15. **B** **Lewis structures, organic compounds, condensed formula**

Note: Structure B is the only one matches the condensed formula

16. **E** **Gas equilibrium constant calculation, moles in reaction**

Recognize that based on information given, this gas equilibrium problem can be solved using the equation

$$K_p = K_c \times (RT)^{\Delta n}.$$

Step 1: Convert 350°C to Kelvin (Temp in all gas laws must be in Kelvin)

K = °C + 273

K = 350 °C + 273 = 623 K

Step 2: Determine Δn (difference in moles of products to reactants)

2 $NO_2Cl(g)$ <--------> **2** $NO_2(g)$ + **1** $Cl_2(g)$

Δn = **3** moles of products - **2** moles of reactants = **1**

Step 3: Substitute factors into equation and solve for K_p

$K_P = K_c \times (RT)^{\Delta n}$ *($R = 0.0821\ L.atm.mol^{-1}.K^{-1}$)*

$K_p = 8.90 \times (0.0821 \times 623)^1 =$ **455.**

17. **C** **Percent composition by mass**

Recognize that the quickest way to determining the answer to this problem is to divide the mass of H in each formula by the molar mass of the formula, and see which one is equal to 1/5th or 20%.

Note: in CH_3 $\dfrac{\text{mass of H}}{\text{mass of } CH_3} = \dfrac{3}{15} = \dfrac{1}{5} = 20\%$ H

18. **D** *Note:* I and II are measurements of the activation energy.

Recall: A catalyst lowers activation energies of a reaction.

Day 7: Answers and Explanations

19 **D** **Partial pressure – mole fraction calculation**

Recognize that based on information given, the equation below can be used to setup and solve the problem for P_{NO2}

$$P_{NO2} = \left(\frac{\text{mole of } NO_2}{\text{Total mole}}\right) \times P_{total}$$

$$P_{NO2} = \left(\frac{4.5\ \text{mol}}{6.0\ \text{mol}}\right) \times 8.0\ \text{atm} = \mathbf{6.0\ atm}$$

20. **D** **Number of dissolved particles – Vapor pressure relationship**

Recognize that based on the diagram and information given, each substance that is placed on top of the mercury creates vapor pressure (VP) that pushes down on the mercury in the manometer.

Note: Since the volume (ml) and molality (m) of the substances in all three manometers are equal, the difference in the push on mercury (as represented by the diagram) is dependent upon the amount of vapor pressure created by each substance.

Lowest mercury level (M) = Greatest push = Highest VP substance

Highest mercury level (K) = Least push = Lowest VP substance

Determine highest VP substance (in M)

M has **water** : because it is pure and produces **no dissolved** particles.

Determine lowest VP substance (in K)

K has **NaCl**: Because it is ionic and produces **2 dissolved particles** (**1**Na+ and **1**Cl-)

L (intermediate VP) has **glucose** because it is molecular, and produces **1 dissolved** particle

Day 7: Answers and Explanations

21. **D** **Oxidation numbers in a formula**

Recall: Total charge in a neutral formula must equal 0

Note the followings about the given formula: $[Cr(NH_3)_6](NO_3)_3$

NH_3 is neutral : Total Charge of 6 NH_3 = 0

NO_3 - ion = -1: Total charge of 3 NO_3^- = -3

Cr must have a total positive charge of **+3** for all charges to equal 0

Note: Since there is just 1 Cr; Oxidation # of Cr = **+3**

22. **C** **Mass–Volume calculation**

Step 1: Determine moles of 150 g $CaCO_3$ consumed

$$\text{moles } CaCO_3 = \frac{\text{mass}}{\text{molar mass}} = \frac{150\text{ g}}{100\text{ g.mol}^{-1}} = \textit{1.50 moles}$$

Step 2: Determine volume of CO_2 through mole proportion in the balanced equation

$$\text{Volume} = 1.5\text{ mol } CaCO_3 \times \frac{1\text{ mol } CO_2}{1\text{ mol } CaCO_3} \times \frac{22.4\text{ L}}{1\text{ mol } CO_2}$$

Volume of CO_2 = **34 L**

Day 7: Answers and Explanations

23. **B** **Change in voltage, Nernst equation, electrochemistry**

Recognize that most of the choices given can be eliminated based on the fact that the information given for these choices will not affect voltage.

Eliminate Choices A, C and E because based on reasoning, mass, color, nor type of salt bridge will not affect voltage.

Eliminate Choice D because both half-cells containing the solutions are in the same area, therefore, the temperature of the solutions should be about the same.

Note: Choice B is left as the correct answer. This can be proven by considering $[Zn^{2+}]$ and $[Cu^{2+}]$ in Nernst equation.

$$E = E^0 - \frac{RT}{nF} \ln Q \qquad \textit{Recall:}\ Q = \frac{[\text{products}]^m}{[\text{reactants}]^n} = \frac{[Zn^{2+}]}{[Cu^{2+}]}$$

According to above equations, voltage depends on [ ]

24. **E** **Nuclear decay series, nuclear particles**

Step 1: Write the symbols of emitted particles in the order given

alpha	alpha	alpha	beta	beta
^4_2He	^4_2He	^4_2He	$^0_{-1}e$	$^0_{-1}e$

Step 2: Write the symbol for plutonium – 240

$$^{240}_{94}Pu$$

Step 3: Subtract the sum of the top (mass) # of emitted particles from 240 : 240 – **12** = 228

Subtract the sum of the bottom (charge) # of emitted particles from 94 : 94 – **4** = 90

Note: 90 is the atomic number. The nuclide is Thorium-228

25. **D** **Composition of a chemical compound, solution, cation and anion**

Note: Potassium perchlorate is an ionic compound with the formula $KClO_4$.

Recall: When an ionic compound is placed in water, it dissolves to produce cation (K+) and anion (ClO_4-)

Day 8: Answers and Scoring Guidelines

(see important scoring guideline information on on page I)

1. **(10 points)**

The reaction $2NO_2(g) + Cl_2(g) \text{ -----> } 2NO_2Cl(g)$ was studied at 20°C and the following data were obtained:

(a) Write the rate law for the reaction.

Note: Based on equation given, rate expression will be as follows:

$\text{rate} = k[NO_2]^n[Cl_2]^m$ **n** = order with respect to $[NO_2]$
m = order with respect to $[Cl_2]$
n and m need to be determined

Determine order ***m*** by setting up rate ratio between experiment 2 and 1 since $[NO_2]$ is constant. Substitute data for both experiments from table into rate expression above.

$$\frac{\text{rate2}}{\text{rate1}} = \frac{k\,(0.100M)^n\,(0.010\ M)^m}{k\,(0.100\ M)^n\,(0.0050\ M)^m} = \frac{2.70 \times 10^{-7}\ \text{mole/(L . sec)}}{1.35 \times 10^{-7}\ \text{mole/(L . sec)}}$$

$$2^m = 2$$

$$m = 1$$

1 point is earned for calculating **m**

Determine order ***n*** by setting up rate ratio between *experiment 3 and 2 since $[Cl_2]$ is constant.* Substitute data for both experiments from table into rate expression above.

$$\frac{\text{rate 3}}{\text{rate2}} = \frac{k\,(0.200\ M)^n\,(0.010\ M)^m}{k\,(0.100M)^n\,(0.010\ M)^m} = \frac{5.40 \times 10^{-7}\ \text{mole/(L . sec)}}{2.70 \times 10^{-7}\ \text{mole/(L . sec)}}$$

$$2^n = 2$$

$$n = 1$$

1 point is earned for calculating **n**

Write rate law by substituting m and n into rate expression:

$\text{rate} = k[NO_2]^1[Cl_2]^1 = \mathbf{k[NO_2][Cl_2]}$

1 point is earned for the correct rate law

(b) What is the overall order for the reaction? Explain.

Recall: Overall order of a reaction is the sum of all the orders.

2 **Overall order of a reaction is the sum of all the orders:** m + n = 1 + 1 = 2	**1 point** is earned for the correct sum with explanation.

(c) Calculate the rate-specific constant, *k*, including the correct units.

Note: Since the rate was determined in part (a), *k* can be determine by substituting data from one of the experiments into the rate law, and solve for k

Rearrange rate law for k rate = $k[NO_2][Cl_2]$ $k = \frac{\text{rate}}{[NO_2][Cl_2]}$	
Substitute data for experiment 1, and solve for k $k = \frac{1.35 \times 10^{-7} \text{ mole/(L . sec)}}{(0.100 \text{ mole/L})(0.005 \text{ mol/L})}$ k = **2.7×10^{-4} L / (mole . sec)**	**1 point** is earned for correctly calculating the k value.
Note: Since temperature is the same for all three experiments, and the reaction is first order with respect to both reactants, data from any of the three experiments can be used to calculate *k*. The value for *k* will be the same	**1 point** is earned for the correct unit

(d) In Experiment 3, what is the initial rate of decrease of $[Cl_2]$?

Note: The initial rate of decrease of a reactant is proportional to the initial rate of increase of the products.

Write rate change equation based on the equation given $2NO_2(g) + Cl_2(g) \text{ -----> } 2NO_2Cl(g)$ $\frac{-d[Cl_2]}{dt} = \frac{1}{2}\frac{d[NO_2Cl]}{dt}$ *Note:* - sign indicates that the change of Cl_2 is in opposite direction (decreasing) in respect to the direction of change of NO_2Cl (increasing). *Note:* ½ indicates that moles of Cl_2 is half that of NO_2Cl in the balanced equation. They are at a 1 : 2 ratio.	**1 point** is earned for the correct setup to calculate initial rate of decrease of Cl_2
Substitute rate for experiment 3 and solve for $[Cl_2]$ $-[Cl_2] = \frac{5.40 \times 10^{-7} \text{ mol / (L . sec)}}{2}$ $[Cl_2]$ = **-2.7×10^{-7} mol / (L . sec)**	**1 point** is earned for answer that is consistent with the setup.

(e) Based on the equation given for this reaction:

(i) Propose mechanisms for the reaction that is consistent with the rate law expression you found in part (a).

Note: The sum of the steps of the mechanism must equal the balanced equation.

The sum of the mechanism must be consistent with the experimentally-determined rate law.

Propose mechanisms (steps) and determine the sum of the equations Step 1: $NO_2(g)$ + $Cl_2(g)$ -----> $NO_2Cl(g)$ + ~~$Cl(g)$~~ Step 2: ~~$Cl(g)$~~ + $NO_2(g)$ -----> $NO_2Cl(g)$ Sum: **$2NO_2(g)$ + $Cl_2(g)$ -----> $2NO_2Cl(g)$** *Note:* The sum of the mechanisms is the same as the equation *Note:* The rate law for the rate-determining step is consistent with the experimentally-determined rate law: rate = $k[NO_2][Cl_2]$ for both	**1 point** is earned for the correct mechanisms

(ii) Which is the rate determining step in the proposed mechanism

Step 1 *or* **$NO_2(g)$ + $Cl_2(g)$ -----> $NO_2Cl(g)$ + $Cl(g)$** is the slow rate determining step	**1 point** is earned for mentioning step 1

Day 8: Answers and Scoring Guidelines

2. **(10 points)**

The setup below shows the electrolysis of water that is at 25°C and 1 atm.

The electrolysis process was allowed to proceed for 4.37 minutes while the voltage source supplies a constant 1.213 amperes of current.

a) Write a balance equation for the decomposition of water during the electrolysis process.

$2H_2O(l)$ -----> $O_2(g)$ + $2H_2(g)$	**1 point** is earned for a correct balanced equation

b) Write a balance half-reaction equation for the reaction at the cathode.

Recall: Reduction (gaining of electrons) occurs at the cathode.

The half-reaction must represent reduction.

$2H_2O(l)$ + 2e- -----> $H_2(g)$ + 2OH-(aq)	**1 point** is earned for the correct and balanced half-reaction equation

c) Calculate the amount of electrical charge, in coulombs, that passes through the solution during the time period mentioned.

Recall: 1 ampere = 1 coulomb/sec

1.213 amperes = 1.213 coulomb/sec

Set up using factor-labeling electrical charge = **4.37 min** x $\frac{\textbf{60 sec}}{\textbf{1 min}}$ x $\frac{\textbf{1.213 coul}}{\textbf{sec}}$ **electrical charge = 318 coulombs**	**1 point** is earned for setup **1 point** is earned for the correct answer

d) The half-reaction that occurs at the anode is:

$2H_2O\,(l)$ ----> $O_2\,(g)$ + $4H^+\,(aq)$ + $4e^-$

(i) Calculate the number of moles of $O_2\,(g)$ produced at the anode.

Note: 1 mole of e- = 96500 coulombs (see Reference Materials pg 340)

Set up using factor-labeling involving mole ratio mole of $O_2(g)$ = **318 coul** x $\frac{\text{1 mol e-}}{\text{96500 coul}}$ x $\frac{\text{1 mol } O_2}{\text{4 mol e-}}$ **moles of $O_2(g)$ = 8.24 x 10^{-4} moles O_2**	**1 point** is earned for setup **1 point** for correct moles of O_2

(ii) Calculate the volume, in milliliters, of $O_2(g)$ produced during the electrolysis process.

Note: Since temperature (25°C) and pressure (1 atm) are known, use the ideal gas law equation to set up and solve.

$PVo_2 = no_2 RT$ Note: T must be in Kelvin
25°C + 273 = 298 K
n = moles of O_2 (see (i))
R = gas constant

Rearrange ideal gas law equation $Vo_2 = \frac{no_2 RT}{P}$ *Substitute values into equation and solve* $Vo_2 = \frac{(8.24 \times 10^{-4}\ \text{mol})\ (0.0821 \frac{\text{L.atm}}{\text{mol.K}})\ (298\ \text{K})}{1\ \text{atm}}$ **Vo_2 = 0.0202 L = 20 mL**	**1 point** for setup using ideal gas equation **1 point** for the correct volume of O_2

(iii) Explain why the volume of $H_2(g)$ collected is different from the volume of $O_2(g)$ collected during the same time.

Note: The balanced equation for the reaction

$2H_2O(l)$ ----------> $O_2(g)$ + $2H_2(g)$

The volume of $O_2(g)$ produced is less than that of the $H_2(g)$ because, according to the balanced equation, **2 moles of H_2 gas are produced to only 1 mole of O_2 gas**	**1 point** for explanation that includes mole ratio of O_2 to H_2

e) Identify another substance, including its phase, which is also collected in both test tubes along with $O_2(g)$ and $H_2(g)$.

H_2O (g) **Water vapor**	**1 point** for the correct answer

Day 9: Answers and Scoring Guidelines

(see important scoring guideline information on on page i)

1. **(15 points)**

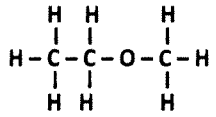
(a) Methanol and acetic acid are mixed and then gently warmed.

Note: This is an esterification reaction

Recall: In esterification, an ester and water are produced by reacting an organic acid with alcohol

(i) Balanced equation CH_3OH + CH_3COOH -----> CH_3COOCH_3 + H_2O *methanol* *acetic acid* *ester* *water*	**1 point** is earned for correct reactants **2 points are** earned for correct products **1 point** is earned for correctly balancing the equation

(ii) Draw the structure of the organic compound formed

	**1 point** is earned for the correct structure of the ester

(b) Solid potassium carbonate is added to 2 *M* sulfuric acid.

(i) Balanced equation K_2CO_3 + 2H+ -------> CO_2 + H_2O + 2K+	**1 point** is earned for correct reactants **2 points are** earned for correct products **1 point** is earned for correctly balancing the equation

(ii) How many molecules of the acid will react with 27.6 grams of the potassium carbonate.

Recall: 1 mole = 6.02×10^{23} molecules

Determine moles of K_2CO_3 in 27.6 g $27.6\ g\ K_2CO_3 \times \frac{1\ mole\ K_2CO_3}{138\ g\ K_2CO_3} = 0.2\ mol\ K_2CO_3$ *Determine moles of the acid based on proportion* $0.2\ mol\ K_2CO_3 \times \frac{2\ mol\ H+}{1\ mol\ K_2CO_3} = 0.4\ mol\ H+$ *Calculate # of molecules in 0.4 moles of H+* molecules = $0.4\ (6.02 \times 10^{23}) = \mathbf{2.4 \times 10^{23}}$	**1 point** is earned for correctly calculating the number of molecules

(c) A pellet of sodium hydroxide is added to a solution of iron (III) sulfate.

Note: This is a double replacement (ion-exchange) reaction
Note: Sodium and sulfate ions are both spectator ions. Therefore, they are not included in the equation.

(i) Balanced equation $\mathbf{3OH^-} + \mathbf{Fe^{3+}} \text{ -----> } \mathbf{Fe(OH)_3}$	**1 point** is earned for correct reactants **2 points are** earned for correct products **1 point** is earned for correctly balancing the equation

(ii) What type of chemical bonding is or are present in a formula unit of iron (III) sulfate.

Ionic and Covalent bonding or **Ionic and polar** bonding	**1 point** is earned for the correct bond types

Day 9: Answers and Scoring Guidelines

2. **(8 points)**

The first three ionization energies (I_1, I_2, and I_3) for magnesium and Argon are given in the following table:

(a) Write the complete electron configurations for magnesium and argon.

Mg $\mathbf{1s^2 2s^2 2p^6 3s^2}$ Ar $\mathbf{1s^2 2s^2 2p^6 3s^2 3p^6}$	**1 point** is earned for the correct configurations for both Mg and Ar.

(b) Draw the Lewis electron-dot diagrams for Mg and Ar.

Recall: Lewis electron-dot diagram shows symbol of atom and dots equal to the number of valance electrons

Mg : **: Ar :**	**1 point** is earned for the correct Lewis electron-dots for both Mg and Ar.

(c) Based on the data table information:

(i) State one similarity found in ionization energies for both atoms.

Recall: Ionization energy is the energy to remove the most loosely bound electron from an atom

Energy to remove the 1^{st} through 3^{rd} electrons increases steadily. **The first ionization energy is the lowest.** **The third ionization energy is the highest.**	**1 point** is earned for any one correct similarity

(ii) Explain why the difference between the 2nd and 3rd ionization energies of Mg is much greater than the difference between the 2nd and 3rd ionization energies of Ar. Include both Mg and Ar.

In magnesium, the 3rd ionization energy is over 5 times as much as the 2nd ionization because: **the 3rd electron to be removed from Mg is located in the second energy level (closer to the nucleus) while the 2nd electron to be removed is located in the third energy level (farther from the nucleus)** In argon, the energy difference is only twice as much because **both the 3rd and 2nd electrons to be removed are located in the same (third) energy level.**	**1 point** is earned for the correct explanation

(d) If chlorine gas is passed into separate containers of heated magnesium and heated argon, explain what compounds (if any) might be formed, and explain your answer in terms of the electron configurations of these two elements.

$MgCl_2$, magnesium chloride	**1 point** is earned for the correct compound
Mg will react with chlorine because **Mg only has two valance electrons, and will readily give them** up to chlorine to form a stable octet valance configuration. Ar will not react (no product will form) with chlorine because **argon already has a complete valance shell configuration and is stable.**	**1 point** is earned for correct explanation that includes Mg and Ar.

Day 9: Answers and Scoring Guidelines

(e) An unknown element, Y, has the following three ionization energies:

Atom	I_1 *(KJ/mol)*	I_2 *(KJ/mol)*	I_3 *(KJ/mol)*
Y	496	4560	6912

On the basis of the ionization energies given, what is the formula and name of the compound produced when chlorine reacts with element Y. Explain your reasoning.

NaCl , sodium chloride	**1 point** is earned for stating NaCl
Element Y is likely sodium for the following reasons: The I_1 of Y is much smaller than the I_1 of Mg indicating that the 1st electron of Y is located farther from the nucleus than the 1st electron of Mg. Y must be an element that is bigger than Mg. **Na** is bigger than Mg. The I_3 of Y is less than twice the I_2 of Y indicating that both the 2nd and 3rd electrons are located in the same energy level. This is the case with most alkali metals. *Note:* If Y was Ca, its I_3 would be much more greater than its I_2 since the 3rd electron would be in an energy level that is closer to the nucleus than that of the 2nd electron.	**1 point** is earned for correct explanation