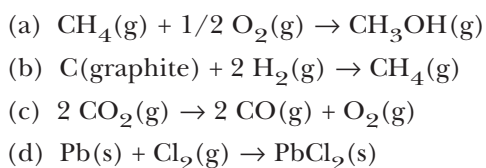


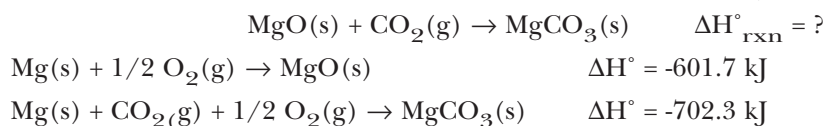
**THERMOCHEMISTRY**

1. (2 points) *Enthalpy of Formation* Which of the following equations represents an equation for the standard molar enthalpy of formation of a compound?



2. (2 points) What is the standard molar enthalpy of formation for  $\text{C}_2\text{H}_6(\text{g})$ ? \_\_\_\_\_ kJ/mol

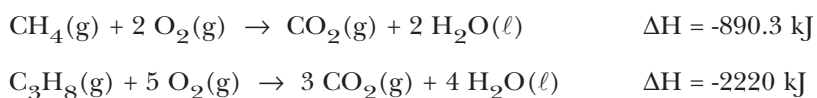
3. (4 points) Using the enthalpy data below, and Hess's Law, calculate the standard molar enthalpy change for the formation of magnesium carbonate from MgO,  $\text{CO}_2$ , and  $\text{O}_2$ .



- (a)  $\Delta H^\circ_{\text{rxn}} = +1304.0 \text{ kJ/mol}$   
(b)  $\Delta H^\circ_{\text{rxn}} = -1304.0 \text{ kJ/mol}$   
(c)  $\Delta H^\circ_{\text{rxn}} = +100.6 \text{ kJ/mol}$   
(d)  $\Delta H^\circ_{\text{rxn}} = -100.6 \text{ kJ/mol}$   
(e) I don't think it is any of these.

My calculations indicate the reaction is (*endothermic*)(*exothermic*) \_\_\_\_\_

4. (5 points) Methane ( $\text{CH}_4$ ) and propane ( $\text{C}_3\text{H}_8$ ) are used as fuels.

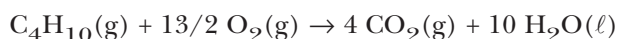


Part 1: If you burn 25 g of methane, what quantity of heat is evolved?

- (a)  $\Delta H^\circ_{\text{rxn}} = -356 \text{ kJ}$   
(b)  $\Delta H^\circ_{\text{rxn}} = -570 \text{ kJ}$   
(c)  $\Delta H^\circ_{\text{rxn}} = -719 \text{ kJ}$   
(d)  $\Delta H^\circ_{\text{rxn}} = -1390 \text{ kJ}$

Part 2: Which fuel provides more heat energy *per gram*, methane or propane? \_\_\_\_\_

5. (3 points) Use the table of standard enthalpies of formation in your textbook to calculate the enthalpy change for the combustion of 1.00 mol of butane,  $C_4H_{10}$ . (Use Table 6.2 or Appendix L to find the required  $\Delta H_f^\circ$  values.)

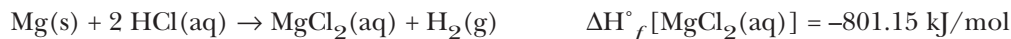


- a)  $\Delta H_{rxn}^\circ = +200.7$  kJ  
b)  $\Delta H_{rxn}^\circ = -888$  kJ  
c)  $\Delta H_{rxn}^\circ = -4306$  kJ  
d)  $\Delta H_{rxn}^\circ = -5320$  kJ  
e) Not a one of them!
6. (3 points) (Study Question 6-69). The combustion of gaseous diborane,  $B_2H_6$ , proceeds according to the equation



and 1941 kJ of heat energy is liberated per mole of  $B_2H_6(g)$  (at constant pressure). Calculate the molar enthalpy of formation of  $B_2H_6(g)$  using this information, the data in Table 6.2, and the fact that  $\Delta H_f^\circ$  for  $B_2O_3(s)$  is -1271.9 kJ/mol.

- (a) +56 kJ/mol  
(b) -56 kJ/mol  
(c) -427 kJ/mol  
(d) +427 kJ/mol  
(e) -1941 kJ/mol  
(f) None of the above?
7. (5 points) In the lab you measured the quantity of heat evolved when 0.20 g of Mg was placed in 100 mL of 1 M HCl a coffee cup calorimeter.



Suppose you drop 0.20 g of calcium metal into 100 mL of 1 M HCl in the same calorimeter.



Will the temperature rise,  $\Delta T$ , be greater for Mg or for Ca? *Explain your answer briefly and support it with calculations.*

**SPECTRA AND RADIATION**1. (3 points) *Spectra and Radiation*

- a) Which color of light in the visible spectrum has the shortest wavelength? \_\_\_\_\_
- b) Which color of light in the visible spectrum has the lowest energy? \_\_\_\_\_
- c) Is the energy of red light higher or lower than that of x-rays in the dentist's office? \_\_\_\_\_

## 2. (5 points) Traffic signals are often now made of LEDs (light-emitting diodes)

- (a) The light from an amber signal has a wavelength of 595 nm, and that from a green signal is 500 nm. Which has the higher frequency? \_\_\_\_\_
- (b) If a red traffic light emits radiation with a wavelength of 680 nm, what is the frequency of the light?
- i)  $6.80 \times 10^{14}$  1/s
  - ii)  $4.40 \times 10^5$  1/s
  - iii)  $4.40 \times 10^{14}$  1/s
  - iv)  $2.27 \times 10^{-15}$  1/s

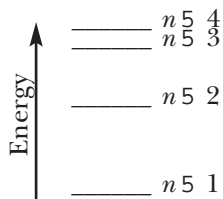
3. (5 points) A cell phone sends signals at about 850 MHz (1 MHz =  $1 \times 10^6$  Hz or cycles per second).

What is the energy of 1.0 mol of photons with a frequency of 850 MHz?

- (a) 0.00040 J
- (b) 0.34 J
- (c) 5.6 J
- (d) 8.5 J
- (e) A whole lot!

A cell phone emits energy that is (*greater than*)/(*less than*) \_\_\_\_\_ the energy of red light.

4. (5 points) Consider only transitions involving the  $n = 1$  through  $n = 4$  electron energy levels for the hydrogen atom (where the line spacing are very approximate).



- (a) How many emission lines are possible, considering only the four quantum levels? \_\_\_\_\_
- (b) Photons of the lowest energy are emitted in a transition from the level with  $n =$  \_\_\_\_\_ to a level with  $n =$  \_\_\_\_\_.
- (c) The emission line having the shortest wavelength corresponds to a transition from the level with  $n =$  \_\_\_\_\_ to the level with  $n =$  \_\_\_\_\_.
5. (3 points) Place the following types of radiation in order of increasing energy per photon:
- yellow light from a sodium lamp
  - x-rays from an instrument in a dentist's office
  - microwaves in a microwave oven
  - your favorite FM music station at 91.7 MHz

\_\_\_\_\_ *Least energetic*

\_\_\_\_\_ *Most energetic*

## QUANTUM NUMBERS

1. (6 points)
- When  $n = 4$ ,  $l = 2$ , and  $m_l = 1$ , to what orbital type does this refer? (Give the orbital label, such as  $1s$ .) \_\_\_\_\_
  - How many orbitals occur in the  $n = 5$  electron shell? \_\_\_\_\_
  - How many subshells occur in the  $n = 5$  electron shell? \_\_\_\_\_
  - Explain briefly why the following is not a possible set of quantum numbers for an electron in an atom:  $n = 2$ ,  $l = 2$ ,  $m_l = 0$
  - Which one or ones of the following orbitals cannot exist according to the quantum theory:  $2s$ ,  $2d$ ,  $3p$ ,  $3f$ ,  $4f$ , and  $5s$ . \_\_\_\_\_
  - A particular orbital has  $n = 4$  and  $l = 2$ . This orbital must be: (a)  $3p$ , (b)  $4p$ , (c)  $5d$ , or (d)  $4d$ .

2. (8 points) *More on atomic structure*

- a) What quantum number is related to the shape of an atomic orbital? \_\_\_\_\_
- b) For a  $3d$  orbital, the value of  $n$  is \_\_\_\_\_ and the value of  $l$  is \_\_\_\_\_.
- c) Indicate what type of orbital is illustrated below.



letter    \_\_\_\_\_                      \_\_\_\_\_                      \_\_\_\_\_

- d) How many *electrons* can be associated with each of the following sets of quantum numbers?

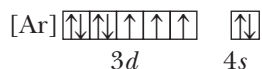
Quantum Number Set	Number of Electrons
$n = 4$ and $l = 1$	_____
$n = 3, l = 2, m_l = -1$	_____

## ELECTRON CONFIGURATIONS

4. (7 points) *Electron Configurations*

- a) What element has the electron configuration  $[\text{Ar}] 3d^8 4s^2$ ? \_\_\_\_\_
- b) What element has a  $2+$  ion with the configuration  $[\text{Ar}] 3d^6$ ? \_\_\_\_\_ Is the ion paramagnetic or diamagnetic? \_\_\_\_\_
- c) How many unpaired electrons are there in a  $\text{Mn}^{2+}$  ion? \_\_\_\_\_
- d) Is a mercury(II) ion,  $\text{Hg}^{2+}$ , paramagnetic or diamagnetic? \_\_\_\_\_
- e) What  $2+$  ions in the first series of transition elements (Sc through Zn) have two unpaired electrons? \_\_\_\_\_
- f) With what element is the  $n = 4$  shell of electrons completed? \_\_\_\_\_

## 5. (3 points) The configuration for an element is given here.



- (a) What is the identity of the element with this configuration? \_\_\_\_\_
- (b) Is a sample of the element paramagnetic or diamagnetic? \_\_\_\_\_
- (c) How many unpaired electrons does a  $3+$  ion of this element have? \_\_\_\_\_

2. (8 points) Using the spectroscopic or spdf notation [e.g.,  $1s^22s^2$ ], write electron configurations for each of the following:

S (*do NOT use the noble gas notation for this case*)

Iron (*do NOT use the noble gas notation for this case*)

Uranium (*please DO use the noble gas notation for this case*)

$V^{2+}$  (*your choice*)

3. (6 points) Using the orbital box notation, write electron configurations for the following atoms or ions. *Please use the noble gas notation in all three!*

Cl

$Ni^{2+}$

$Se^{2-}$

## PERIODIC TRENDS

1. (12 points) *Periodic Trends*

- a) Of the elements O, S, and F, which has the largest atomic radius? \_\_\_\_\_
- b) Which is larger, I or I<sup>-</sup>? \_\_\_\_\_
- c) What element in the alkaline earth metal group has the largest radius? \_\_\_\_\_
- d) What element in the second period has the largest affinity for an electron? \_\_\_\_\_
- e) What element in Group 3A has the largest ionization energy? \_\_\_\_\_
- f) Place the following elements in order of increasing ionization energy: F, Al, C

\_\_\_\_\_ lowest IE

\_\_\_\_\_ highest IE

- g) Which ion is larger, Rb<sup>2+</sup> or Br<sup>-</sup>? \_\_\_\_\_
- h) Which of the following ions is (are) unlikely to exist: Ti<sup>5+</sup>, F<sup>3-</sup>, Al<sup>3+</sup>, Sr<sup>2+</sup>, Pt<sup>4+</sup>?  
\_\_\_\_\_
- i) Of the elements Na, O, F, Cl, which has the largest atomic radius \_\_\_\_\_ and which has the largest ionization energy? \_\_\_\_\_

## 2. (5 points) Answer the questions below about the elements A and B, which have the electron configurations shown.



- (a) Is element A a metal, nonmetal, or metalloid? \_\_\_\_\_
- (b) Which element has the greater ionization energy? \_\_\_\_\_
- (c) Which element has the smaller affinity for an electron? \_\_\_\_\_
- (d) Which element has the larger atomic radius? \_\_\_\_\_
- (e) Which is more likely to form an anion? \_\_\_\_\_