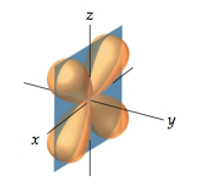
1. A radio station's channel, such as 100.7 FM or 92.3 FM, is actually its frequency in megahertz (MHz {\rm MHz}), where 1MHz=10 6 Hz 1\; {\rm MHz}=10^6\; {\rm Hz}and 1Hz=1s −1 .Calculate the broadcast wavelength of the radio station 94.30 FM.
2. Hospital X-ray generators emit X-rays with wavelength of about 15.0 nanometers (nm \rm nm), where 1nm=10 −9 m 1\;{\rm nm}= 10^{-9}\;{\rm m}. What is the energy of the X-rays?
3. What is the azimuthal quantum number (also called the angular-momentum quantum number), ℓ, for the orbital shown here? Express your answer numerically as an integer.



1. What is the change in energy, ΔE Delta E, in kilojoules per mole of hydrogen atoms for an electron transition from n=3 n=3
      to n=2
2. Here are some data collected on a sample of cesium exposed to various energies of light.

|  |  |  |
| --- | --- | --- |
| **Light energy** (eV {\rm eV}) | **Electron emitted?** | **Electron**KE KE (eV {\rm eV}) |
| 3.87 | no | — |
| 3.88 | no | — |
| 3.89 | yes | 0 |
| 3.90 | yes | 0.01 |
| 3.91 | yes | 0.02 |

What is the threshold frequency ν 0 nu_0of cesium?Note that 1 eV (electron volt)=1.60×10 −19 J. Answer in Hz

1. The energy difference between two energy shells is calculated using the formula

ΔE=E f −E i \Delta E = E_{\rm f} - E_{\rm i}where E f E_{\rm f}~~~~~~is the energy of the final shell, and E i E_{\rm i}is the energy of the initial shell from which the transition occurs. For example, for the transition n=4 n = 4to n=1 n =1, the initial shell is the fourth shell, and the final shell is the first shell. Thus, the change in energy between the fourth and the first shell is denoted as ΔE=E 1 −E 4 \Delta E = E_1 - E_4. The energy corresponding to a shell is calculated using E n =−2.179×10 −18 /(n) 2 J E_{n} = -2.179\times 10^{-18}/(n)^2 ~\rm J

where n nis the shell number. Calculate the energy difference for a transition in the Paschen series for a transition from the higher energy shell n=4 n =4
   .Express your answer to four significant figures and include the appropriate units.

1. A gas at 32 ºC occupies a volume of 250 mL. To what temperature must the gas be changed to occupy a volume of 285 mL?
2. An unknown gas effuses through a porous barrier at a rate that is 0.752 times the rate of Ar (g) under the same conditions. Which of the following is the unknown gas?
3. What is the density (g/L) of propane (C3H8) at STP (1 atm, 273 K)?
4. A system gives off 500 kJ of heat and does 100 kJ of work. What is the change in internal energy?
5. The heat of formation (ΔH°f) of MgCO3 (s) is –1095.8 kJ/mol. The chemical equation associated with this reaction is:
6. Consider:   
     
   2 B5H9 (g) + 12 O2 (g) → 5 B2O3 (g) + 9 H2O (g) ΔH˚reaction= - 8687 kJ.   
     
   What is the enthalpy change when 0.2500 moles of B5H9 are combusted?
7. Which of the following sets of quantum numbers is valid?

|  |  |  |
| --- | --- | --- |
|  |  | n = 1, l = 2, ml = 3, ms = 4 |
|  |  | n = 3, l = 2, ml = -2, ms = 1/2 |
|  |  | n = 1, l = 0, ml = 1, ms = -1/2 |
|  |  | n = 4, l = 4, ml = -1, ms = 1/2 |
|  |  | n = 0, l = 1, ml = 0, ms = -1/2 |

1. Consider the Bohr Model for the hydrogen atom. Which of the following electron transitions releases the MOST energy?

|  |  |  |
| --- | --- | --- |
|  |  | n = 6 to n = 4 |
|  |  | n = 5 to n = 3 |
|  |  | n = 4 to n = 2 |
|  |  | n = 3 to n = 1 |
|  |  | n = 2 to n = 1 |

1. The energy of **one mole** of photons having a wavelength of 630 nm is:
2. Use the data below to answer the questions.

|  |  |
| --- | --- |
| Substance | ΔH ∘ f (kJ/mol) \Delta H _{\rm f}^{\circ}~(\rm kJ/mol) |
| C(g) \rm C(g) | 718.4 |
| CF 4 (g) \rm CF_4(g) | − -679.9 |
| CH 4 (g) \rm CH_4(g) | − -74.8 |
| H(g) \rm H(g) | 217.94 |
| HF(g) \rm HF(g) | − -268.61 |

Keep in mind that the enthalpy of formation of an element in its standard state is zero.

Part A

Calculate the enthalpy change, ΔH ∘ \Delta H^\circ, for the "expansion" of methane:CH 4 (g)→C(g)+4H(g) \rm CH_4(g)\rightarrow C(g)+4H(g)

Express your answer to one decimal place and include the appropriate units.

Part **B**

Calculate the enthalpy change, ΔH ∘ \Delta H^\circ, for the reverse of the formation of methane:CH 4 (g)→C(s)+2H 2 (g) \rm CH_4(g)\rightarrow C(s)+2H_2(g)Express your answer to one decimal place and include the appropriate units.

1. The following table lists some enthalpy of formation values for selected substances.

|  |  |
| --- | --- |
| Substance | ΔH f ∘ \Delta {H_{\rm f}}^{\circ}(kJ/mol) (\rm kJ/mol) |
| HCl(g) \rm HCl (g) | −92         -92 |
| Al(OH) 3 (s) \rm Al(OH)_3 (s) | −1277         -1277 |
| H 2 O(l) \rm H_2O (l) | −285.8         -285.8 |
| AlCl 3 (s) \rm AlCl_3 (s) | −705.6         -705.6 |
| H 2 O(g) \rm H_2O (g) | −241.8         -241.8 |

Part A

Determine the enthalpy for this reaction:Al(OH) 3 (s)+3HCl(g)→AlCl 3 (s)+3H 2 O(l) \rm Al(OH)_3 (s) + 3HCl (g) \rightarrow AlCl_3 (s) + 3H_2O (l)

Express your answer in kilojoules per mole to four significant figures.

1. The *standard enthalpy of formation* (ΔH ∘ f ) (\Delta H_{\rm f}^{\circ})is the enthalpy change that occurs when exactly 1 mol \rm molof a compound is formed from its constituent elements under standard conditions. The standard conditions are 1 atm \rm atmpressure, a temperature of 25 ∘ C and all the species present at a concentration of 1 M .A "standard enthalpies of formation table" containing ΔH ∘ f \Delta H_{\rm f}^{\circ}values might look something like this:

|  |  |
| --- | --- |
| Substance | ΔH ∘ f \Delta H_{\rm f}^{\circ} |
| H(g) \rm H{(g)} | 218 kJ/mol \rm kJ/mol |
| H 2 (g) \rm H_2{(g)} | 0 kJ/mol \rm kJ/mol |
| Ba(s) \rm Ba(s) | 0 kJ/mol\rm kJ/mol |
| Ba 2+ (aq) \rm Ba^{2+}(aq) | − -538.4 kJ/mol~\rm kJ/mol |
| C(g) \rm C{(g)} | 71 kJ/mol \rm kJ/mol |
| C(s) \rm C{(s)} | 0 kJ/mol \rm kJ/mol |
| N(g) \rm N{(g)} | 473 kJ/mol \rm kJ/mol |
| O 2 (g) \rm O_2{(g)} | 0 kJ/mol\rm kJ/mol |
| O(g) \rm O{(g)} | 249 kJ/mol \rm kJ/mol |
| S 2 (g) \rm S_2{(g)} | 129 kJ/mol \rm kJ/mol |

Part A

What is the balanced chemical equation for the reaction used to calculate ΔH ∘ f  \Delta H_{\rm f}^{\circ}of BaCO 3 (s) \rm BaCO_3(s)?If fractional coefficients are required, enter them as a fraction (i.e. 1/3). Indicate the physical states using the abbreviation (s\rm s), (l \rm l), or (g \rm g) for solid, liquid, or gas, respectively. Use (aq \rm aq) for aqueous solution.

Express your answer as a chemical equation.

1. For the reaction 2A+B⇌2C+2D, how much heat is absorbed when 3.10mol molof A \rm Areacts?

Express your answer to three significant figures and include the appropriate units.

1. Ozone, O 3 \rm O_3, is destroyed when ClO\rm ClOlevels are high. ClO \rm ClOis likely formed from the decomposition of chlorofluorocarbons (CFCs) in sunlight.

Standard enthalpies of formation for selected substances are given in the table below.

|  |  |
| --- | --- |
| Substance | ΔH ∘ f \Delta H^{\circ}_{\rm f} (kJ/mol \rm kJ/mol) |
| ClO(g) \rm ClO(g) | 101.0 |
| ClO 2 (g) \rm ClO_2(g) | 102.0 |
| O(g) \rm O(g) | 247.5 |
| O 2 (g) \rm O_2(g) | 0 |
| O 3 (g) \rm O_3(g) | 142.3 |

Part A

Calculate the standard enthalpy change of the reaction ClO(g)+O 3 (g)→ClO 2 (g)+O 2 (g) \rm ClO(g)+O_3(g)\rightarrow ClO_2(g)+O_2(g)Express your answer in kilojoules using four significant figures.

1. What is the enthalpy for reaction 1 reversed? reaction 1 reversed: N 2 O 4 →N 2 + 2O 2

Express your answer numerically in kilojoules per mole.

1. When 0.501g gof biphenyl (C 12 H 10 ) {\rm{(C}}_{12} {\rm{H}}_{10} )undergoes combustion in a bomb calorimeter, the temperature rises from 25.2 ∘ C ^\circ Cto 29.4 ∘ C ^\circ C.Find ΔE rxn \Delta {\kern 1pt} E_{{\rm{rxn}}}for the combustion of biphenyl in kJ/mol \rm {kJ}/{mol}biphenyl. The heat capacity of the bomb calorimeter, determined in a separate experiment, is 5.86 kJ/ ∘ C
2. Instant cold packs, often used to ice athletic injuries on the field, contain ammonium nitrate and water separated by a thin plastic divider. When the divider is broken, the ammonium nitrate dissolves according to the following endothermic reaction: NH 4 NO 3 (s)→NH 4 + (aq)+NO 3 − (aq) {\rm{NH}}_4 {\rm{NO}}_3 (s)\; \rightarrow \;{\rm{NH}}_4{} ^ + (aq)\; + \;{\rm{NO}}_3{}^ - (aq)In order to measure the enthalpy change for this reaction, 1.25 g {\rm g}of NH 4 NO 3 {\rm{NH}}_4 {\rm{NO}}_3is dissolved in enough water to make 25.0 mL {\rm mL}of solution. The initial temperature is 25.8 ∘ C ^\circ {\rm C}and the final temperature (after the solid dissolves) is 21.9 ∘ C ^\circ {\rm C}.Calculate the change in enthalpy for the reaction. (Use 1.0g/mL 1.0\;{\rm{g}}/{{\rm{mL}}}as the density of the solution and 4.18J/g⋅ ∘ C 4.18\;{\rm{J}}/{{\rm{g}} \cdot {\rm{^\circ C}}}as the specific heat capacity.)
3. The change in internal energy for the combustion of 1.0 mol {\rm mol}of octane at a pressure of 1.0 atm \rm atmis 5084.2kJ kJ.If the change in enthalpy is 5074.4kJ kJ, how much work is done during the combustion?answer in kJ
4. It takes 47.0J Jto raise the temperature of an 11.3g gpiece of unknown metal from 13.0 ∘ C \rm ^\circ Cto 24.1 ∘ C ^\circ{C}. What is the specific heat for the metal?
5. The molar heat capacity of silver is 25.35 J/mol⋅ ∘ C How much energy would it take to raise the temperature of 11.3g gof silver by 19.0 ∘ C? Express your answer with the appropriate units.
6. What is the specific heat of silver?