1. Convert the temperatures indicated to complete the following table

|  |  |  |
| --- | --- | --- |
| oF | oC | K |
| 77 | 25 | 298.15 |
| 98.6 | 37 | 310.15 |
| 212 | 100 | 373.15 |
| -40 | -40 | 233.15 |
| 32 | 0 | 273.15 |

1. Make a graph representing the potential energy of a harmonic oscillator as a function of displacement from equilibrium. On the same graph, include a function describing the kinetic energy as a function of displacement from equilibrium as well as the total energy of the system.
2. Calculate the work required to move a 3.2 kg mass 10.0 m against a resistive force of 9.80 N.

Work is given by the negative product of force and displacement.

So,

1. Calculate the work needed for a 22.4 L sample of gas to expand to 44.8 L against a constant external pressure of 0.500 atm.

The work of expansion of a gas against a constant external pressure is

So

But what is an *atm L*? This can be converted to J using the ratio of the gaslaw constant expressed in appropriate units:

Alternatively, one can convert to MKS units by recognizing that

So

1. If the internal and external pressure of an expanding gas are equal at all points along the entire expansion pathway, the expansion is called “reversible.” Calculate the work of a reversible expansion for 1.00 mol of an ideal gas expanding from 22.4 L at 273 K to a final volume of 44.8 L.

The work of a reversible expansion (expressed in differential form) is given by

So, to get *w*, one must integrate!

But pressure is very much dependent on volume for an ideal gas.

So

For an isothermal, reversible expansion. (If the gas was not ideal, a difference equation of state might be used to substitute for *p* in terms of *V*, *n*, *R*, and *T*.) After integration, the expression becomes

Substituting the values from the problem,

1. The reaction of combustion of the gasoline (assuming it is composed of n-octane only) is given by the following chemical equation:

From the following table, calculate the total amount of energy available to drive a 1500 kg car by burning 40.0 L of gasoline, assuming 25% efficiency of converting the chemical energy in the fuel into mechanical (kinetic) energy of the car. The density of n-octane is 703 kg/m³.

|  |  |  |
| --- | --- | --- |
| **Compound** | **DHf (kJ/mol)** | **MW (g/mol)** |
| C8H18(l) | -208.27 | 114.2285 |
| O2(g) | 0 | 31.9988 |
| CO2(g) | -393.475 | 44.0095 |
| H2O(l) | -285.828 | 18.01528 |

First, let’s calculate the enthalpy of combustion for octane from the data provided.

This means that for every 2 mol of C8H18(l) combusted, 11023.676 kJ of energy will be released. Now, we just need to figure out how many mol of C8H18(l) there are in 40.0 L.

So, the total energy available, assuming 25% efficiency is given by