HW 1: Internal Energy

1) $\overset{m}{O} \xrightarrow{v_i} \boxed{M}$ $m = 0.1\,kg$ $M = 1\,kg$ $v_i = 4\,m/s$ Inelastic collision

a) Translational energy after collision?

$p_0 = mv_i = 0.4\,kg\,m/s$ $v_f = \frac{0.4}{1.1} = 0.\overline{36}\,m/s$

$p_f = p_0 = (M+m)v_f = 0.4$ $E_f = \frac{1}{2}mv^2 = \boxed{0.07\overline{2}\,J}$

b) How much of the KE was converted into internal energy?

$KE_i - KE_f = \frac{1}{2}(0.1)(4^2) - 0.07\overline{2} \approx \boxed{0.7\overline{2}\,J}$

2) sand

0.6 m

$m_{sand} = 0.5\,kg$

a) Increase in thermal energy each turn?

$mgh = (0.5\,kg)(9.81\,m/s^2)(0.6\,m) = 2.943\,J$

internal energy $\boxed{U = 2.943\,J}$

b) After 100 turns, change in heat of sand = 0.6 K. $= U$ since no deformation

$\underbrace{\text{specific heat}}_{}$ of the sand?

heat needed to raise temp of 1 gram 1°C

$Q = mc\Delta T \rightarrow c = \frac{Q}{m \cdot \Delta T}$

$C_v (K \cdot kg) = J$ $C_v (0.6\,K \cdot 0.5\,kg) = 100(2.943\,J)$

$\boxed{C_v = 981\,\frac{J}{K \cdot kg}}$

Lecture 2: Heat and Temperature

10/11/23

Heat Conductivity:

$\boxed{T_2}$ — A, q — $\boxed{T_1}$, d

Heat flux: $q = -k\frac{T_2 - T_1}{d}$ (q: W/m^2; k: intrinsic, $\frac{W}{K \cdot m}$)

k: Thermal conductivity

Total heat flow over time period Δt: $Q = qA\Delta t$

Heat Capacity: Larger means more heat energy needed to raise temp

$C = \frac{dQ}{dt} = \frac{1}{dT/dQ}$

Heat Capacity:

$C = \frac{dQ}{dT}$ ← Def

$dU = dQ - pdV$

$C = \frac{dU}{dT} + p\frac{dV}{dT}$

$C_V = \frac{dU}{dT}$

Total heat capacity: C_V J/K

Specific heat: c_v $J/kg \cdot K$

Molar heat cap: $c_{v,mol}$ $J/mol\,K$

$C_V = c_v \cdot m$

$C_V = c_{v,mol} \cdot n$

$n = \frac{N}{N_A}$ ← # Atoms, $N_A = 6.022 \times 10^{23}$

$Q = \int_{T_i}^{T_f} C\,dT$

const V

$\Delta U = \int_{T_i}^{T_f} C_V\,dT$