Formula Sheet:

Forces

Units: F: [N] or [kg $\frac{m}{s^2}$] a:[$\frac{m}{s^2}$] m: [kg]

First Law: $Fnet=0$

Second Law: $F_1=m_1 a_1$ $Fnet=F_1+F_2+F_n$

Third Law: $F_{A\,on\,B}=-F_{b\,on\,A}$

Ramps: $F_{¿}=mg\sin\theta$ $F_{perpindicular}=mg\cos\theta$

Unit 2: Work and Heat

Units: W, E, Q : [J], or [Nm] $\Delta T:[K]$ y:[m] v:[m/s]

Δr :[m] c: [J/(kg · K)] P: [J/s or Watt] Δt :s

Isolated: $\Delta U=Ufinal-Uinital=0$

Closed: $\Delta U=Q+W$

Work on a mass: $W=F\Delta r\cos\theta$ *Both F, r are magnitudes. Use angle b/w Force and r

Work: $W=\Delta E_{mechanical}$

Energy: $E_k=\frac{1}{2}mv^2$ $E_{th}=mc\Delta T$ $E_{pot}=mgy$

Work-Energy: $W=E_{kf}-E_{ki}$ *This means the system must receive or release work equal to ΔE_k to change speed

Conservation of Energy: $\Delta Etotal=0$

Gasses

Units: *p* [pa] *V* [m^3] p(density) : kg/m^3 W, E, Δ U: [J]

$T:[K]$ M: (kg/mol) A m^2 ¿] C: [J/(mol · K)]

Constants: r = 8.314 J/mol T[K] = T(Celsius) +273.15

Ideal Gas Law: $pV = nRT$ $\frac{piVi}{Ti} = \frac{piVi}{Ti}$ M= $\frac{\rho}{p} RT$

Kinetic Gas Theory; $pV = \frac{1}{3} Nm \langle v^2 \rangle$

Internal Energy: U = $E_k = \frac{1}{2} m v^2$ = $\frac{3}{2} pV$ = $\frac{3}{2} nRT$ = $\frac{3}{2} Nk \Delta T$

*k = 1.38E-23, U=0, when T=0

RMS: $\sqrt{\langle v \rangle^2}$ = vrms = $\sqrt{\frac{3RT}{M}}$ = $\sqrt{\frac{3kT}{m}}$ M = $\frac{3RT}{vrms^2}$

*vrms is proportional to T

Thermodynamics:

Work: W = -p ΔV

*note: p is constant

Heat: Q = nC ΔT

First Law: $\Delta U = Q + W$

Isochoric: V= const $\frac{pi}{Ti} = \frac{pf}{Tf}$ W = 0 -> $U = Q$ = nC ΔT = $\frac{3}{2}$ nR ΔT

Isothermal: T= const piVi = pfVf $\Delta U = 0$ W = nRTln(Vi/Vf) = nRTln (pF/pi) Q = -W

Isobaric: P = const Vi/Ti = Vf/Tf

W = -p ΔV = -nR ΔT

$Q = \Delta U - W = \frac{5}{2} nR \Delta T$ Q = nC ΔT

Adiabatic: Q = 0 $\Delta U = W = \frac{3}{2}$ nR ΔT

*Note: There is heat transfer, but temperature still changes

$p_i V_i^{5/3}$ = $p_f V_f^{5/3}$ $V_i T_i^{3/2}$ = $V_i T_i^{3/2}$ $p_i^{-2/3} T_i^{5/3}$ = $p_i^{-2/3} T_f^{5/3}$

Transfer of Energy and Matter:

L: [m] Λ: [m] λ: [J/(smk)] D: [m^3 /s] c [mol/ m^3¿

Fourier's Law: $\frac{Q}{t} = ¿$ λA ($\frac{Thigh - Tlow}{L}$¿

λ = Heat conductivity , Q/t = rate of heat transfer, A = cross sectional area

Fick's: $\frac{m}{t} = DA(\frac{\Delta \rho}{L})$ $\frac{n}{t} = \frac{Chigh - Clow}{L}$

Arrhenius: D = D_0 $e^{\frac{-\Delta E}{kT}}$ lnD = ln Do -($\Delta E / kT$¿

Einstein: Λ= $\sqrt{2Dt}$

Mirrors, Lenses

p,f,q,L,R: [m] S_0=25cm = 0.25m

Focal length : f= R/2

Magnification: M = (-q/p)

Snell's: $n_1 sin\alpha = n_2 sin\beta$ v = c/n n cannot be less than 1

Angular Magnification: $\theta / \theta o$ m= so/p

Max. Angular Magnification: m = 1 + so/p

Microscopic Magnification: = mo x me = $\frac{-L \cdot so}{fo \cdot fe}$

Depth: q = -(n2/n1)p

Spherical Interfaces: $\frac{n1}{p} + \frac{n2}{q} = \frac{n2 - n1}{R}$