One mean position and two extreme positions

Distance between mean and extreme is called amplitude

Mean to extreme: P.E↑ and K.E↓

Extreme to mean: PE↓ and KE↑

At mean position:

X=0 F=0, a=0, v=max, K.E=max ,P.E=min

At extreme podition:

X= ± A, F=max, a=max, K.E=0 P.E=max

A particle acted upon by force f=kx^n

If n= even force along –ve x axis always

If n= odd

Force along –ve axis for x>0

Force along =+ve x axis for x<0

0 for x=0

So particle oscillating along mean position is called restoring force

If F=-kx then SHM  
(it is called simple harmonic cause for all other periodic motion [F=-kx] the mathematics is complex)

SHM: linear(spring system) and angular (single pendulum)

Tanθ = slope of F-x =-k

Acceleration= F/m= (-kx)/m= -omega^2x

Omega=sqrt(k/m)

T=2pi sqrt(m/k)

Graph

Tanθ= slope = -omega^2

Acceleration opposite to x

Velocity= ± omega sqrt(A^2 – x^2)

On rearranging we get ellipse equation

Graph

-A to +A(upper half)=+v

+A to –A(lower half)= -v

Energy equation

Total Mechanical energy

T =U\_{0} + omega = U\_{0} (initial P.E)+ ½ m omega^2 A^2(work for displacement)

U(P.E) = U\_{0} + ½ m omega^2 x^2(spring P.E)

K.E= T – U = ½ m omega^2(A^2 – x^2)

Mean position(x=0)

T= U\_{0}+ 1/2m omega^2 A

U= U\_{0} (min) K.E= 1/2m omega^2 A^2 (max)

Extreme( x= ±A)

T= U\_{0} + ½ m omega^2 A

U = U\_{0} + 1/2m omega^2 A^2 (max) K.E= 0 (min)

Graph

A= -omega^2 x

(d^2x)/(dt^2) = - omega ^2 x

X= A sin(omegat ± theta)

Omega = (2 pi )/ T v= (differentiate) omega A cos(omega t ± theta)

a = - omega ^2 A sin(omegat ± theta) = - omega^2 x

theta = phase angle

at t= 0

u= 0 if the body moves from +A and –A

u= ±omega A when at mean postion ( -omegaA if move to –A, +omegaA if moves to +A)

K.E = ½ mv^2 = ½ momega^2A^2cos^2(omegat)

K.E is cos^2 function of omega and U(potential energy) is sin^2 funtion of omega

…………… relation between SHM and uniform circular motion

Time period

T = 2pi sqrt(m/k) → spring block sytem

T= 2pisqrt((|displacement|)/(|acceleration|))

T = 2pisqrt((m + m\_{s}/3)/k) m\_{s} = spring mass and m= mass suspended

T = 2pisqrt(l/g) → pendulum, U shaped tube

Omega= sqrt(C/I) where C= rigidity coefficient (toe= Ctheta) I is the momemt of inertia of body

Omega= sqrt((mgL)/I) L = length of the axis from the centre of mass

In L if radius of gyration exists L\_{eq} = L + k^2/ L

Omega = sqrt(k/I)

Simple pendulum

T=2s → seconds pendulum

Length = 1m

Temperature(T) increase time lost

Temperature decrease time gained

Deltat= (DeltaT)/T \* t

DeltaT = change in temperature

Spring system

Two springs with spring constant k\_{1} , k \_{2}

Series meansthe system all spring experience different force such as two springs connected end to end

Parallel mean system in which two or more springs experience same force of compressesionor relaxation such as pulling two springs together

Series

1/k\_{s} = 1/k\_{1} + 1/k\_{2}

Parallel

K\_{p}= k\_{1}+ k\_{2}

Spring constant k prop 1/l

Case

m\_{1}---------00000--------m\_{2}

T = 2pisqrt(mu/k )

Mu = reduce mass

1/mu= 1/m\_{1}+ 1/m\_{2}

Amplitude of oscillation

A prop 1/m → A\_{1}/A\_{2}= m\_{2}/m\_{1}

Two bodies in phase

Theta\_{1} = theta\_{2} +2npi

Omega\_{1}t = omega\_{2}t +2pi

Vibration per second = omega/(2pi)

Omega\_{1}A\_{1} = omega\_{2}A\_{2}

Time period of pendulum is independent of mass

Velocity= omega

T= 2pisqrt(1/g(1/L +1/R))