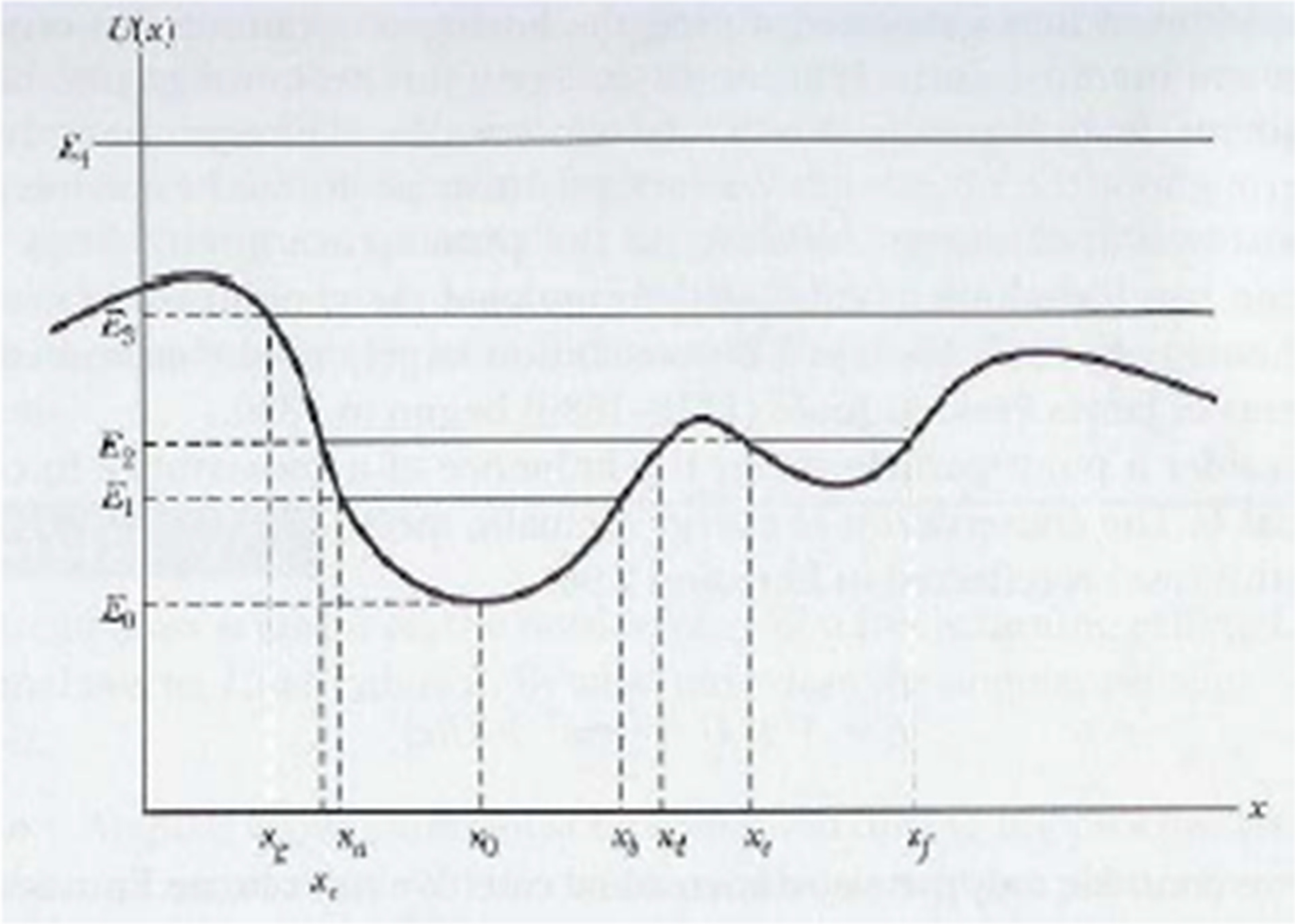
Lecture 13

Newtonian Mechanics

- the concepts of **Work & Energy**.
- **Conservation of Energy: Force Language** to **Energy Language (Newton's Law)**.

from the book Thornton (page 84)



Summary of (SHM : ideal case)

- Oscillations→ perturbation from equilibrium.
- Simplest approximation of restoring force F=-kx
- (Hookes Law within elastic limit)
- So if we make "x" n times larger , F will be n times larger.
- Spring constant k=del F/del x.
- Equation of motion of SHM→ **$d^2x/dt^2+w^2x=0$;** where $w^2=k/m$
- General Solution → $x=A\cos(wt-\phi)$
- Total energy is proportional to square of the amplitude. $E=.5\ kA^2$
- Time period does not depend on amplitude.
- Phase Space behavior.

Summary

<u>Equation of Motion of Single Particle</u>

- Position $r(t)$
- Velocity $v(t)=dr(t)/dt$
- Acceleration $a(t)=dv(t)/dt=d^2r(t)/dt^2$
- Momentum $p(t)=mv(t)$

Newton's second Law (Inertial Frame) → the equation of motion that is position of the particle as a function of time.

$F(r,v,t)=dp(t)/dt$

Problem type 1

Object sliding on a surface.

With friction and without friction.

Forces :

- Force due to gravity and its components.
- Different Frictions.

Apply Second law and integration!!

Problem type 2

Massless pulley with masses suspended at each end.

Forces :

- Force due to gravity.
- Tension Forces.

Problem type 3

Velocity dependent force. Retarding forces.
Proportional to v or higher powers of v.

- Particle undergoing vertical motion in the presence of gravity. Phenomena of terminal velocity.
- Projectile motion with drag. (example 2.6 and 2.7)

Problem 2.8, 2.9, 2.11, 2.12, 2.34 (Classical dynamics: Thornton and Marion)
Time to reach a certain distance in a particular direction? 2.14, 2.36

Problem:

A particle of mass “m” has speed $v=a/x$, where x is its displacement. Find the force $F(x)$ responsible.

Problem:

A boat with initial speed v0 is launched in water. The boat is slowed in water by force $F=-ae^{bv}$. Find the time for the boat to stop.

Conservation of Linear Momentum
Concept of Phase Space
Work and Energy

Total energy=K.E + P.E

We can express Force as gradient of potential.