Lecture5

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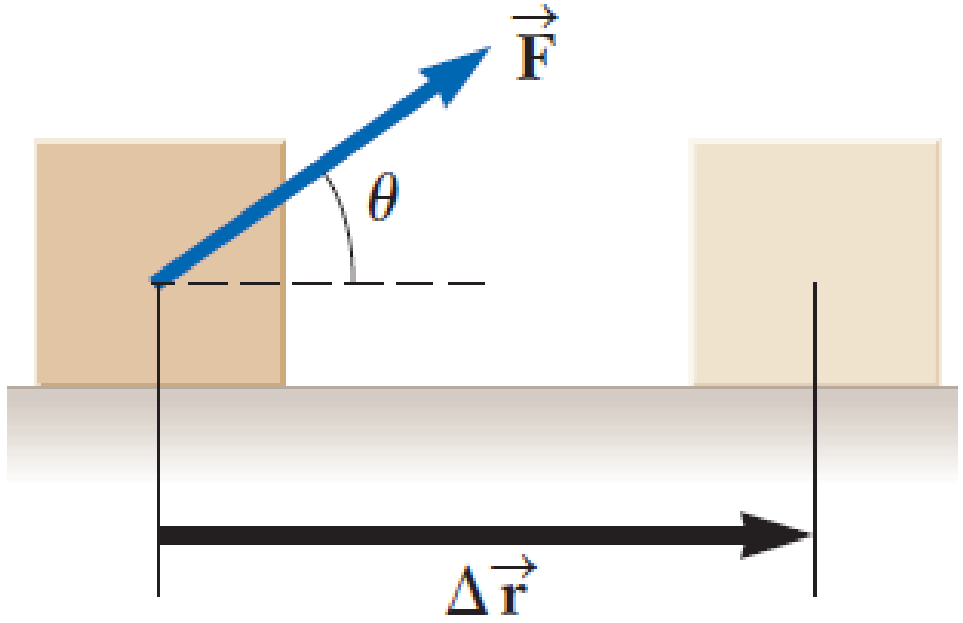
Content

- Chapter5:
  - Force & Work
  - Kinetic Energy
  - Potential Energy
  - Conservation of energy
  - Power

The work done by a constant force

- Work (W) is done on an object when A force moves the object A displacement (Δr)
- W = F. Δr = |F| |Δr| cosθ = |F| |d| cosθ
- W: Work (الشغل)
- F: the force
- Δr: the displacement (d)
- Θ: the angle between F and Δr
- If different forces affecting
- W = (Ft). Δr = |Ft| |Δr| cosθ
- Ft: Total force or resultant force
- Work is a scalar quantity
- The unit is Joule (J) = N . m



The work done by a constant force

- $W = F.\ \Delta r = |F|\ |\Delta r|\ \cos\theta$
- Different cases:

a) Θ between F and Δr is 90

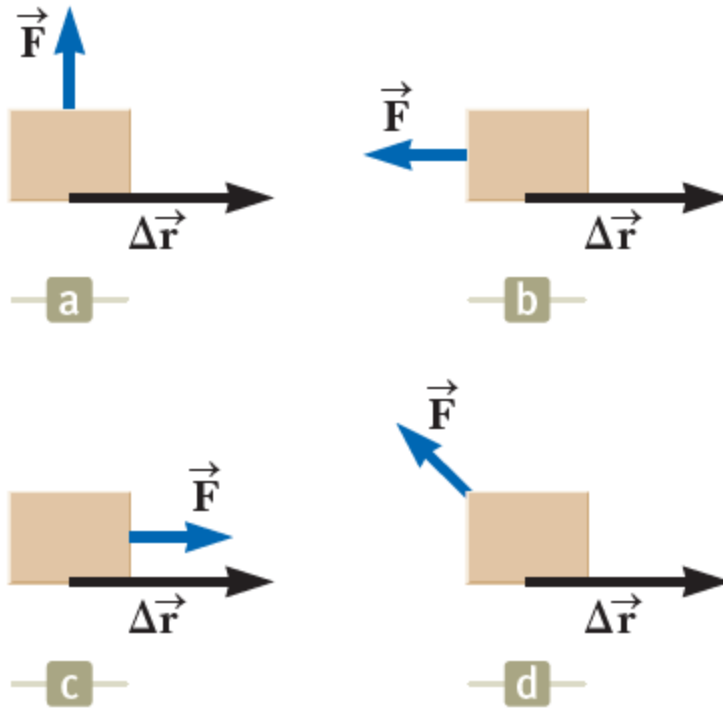
----------> cos90 = 0 and W = 0

b) Θ between F and Δr is 180

----------> cos180 = -1 and W < 0

If Θ between F and Δr is anything else

---> depends on the angle

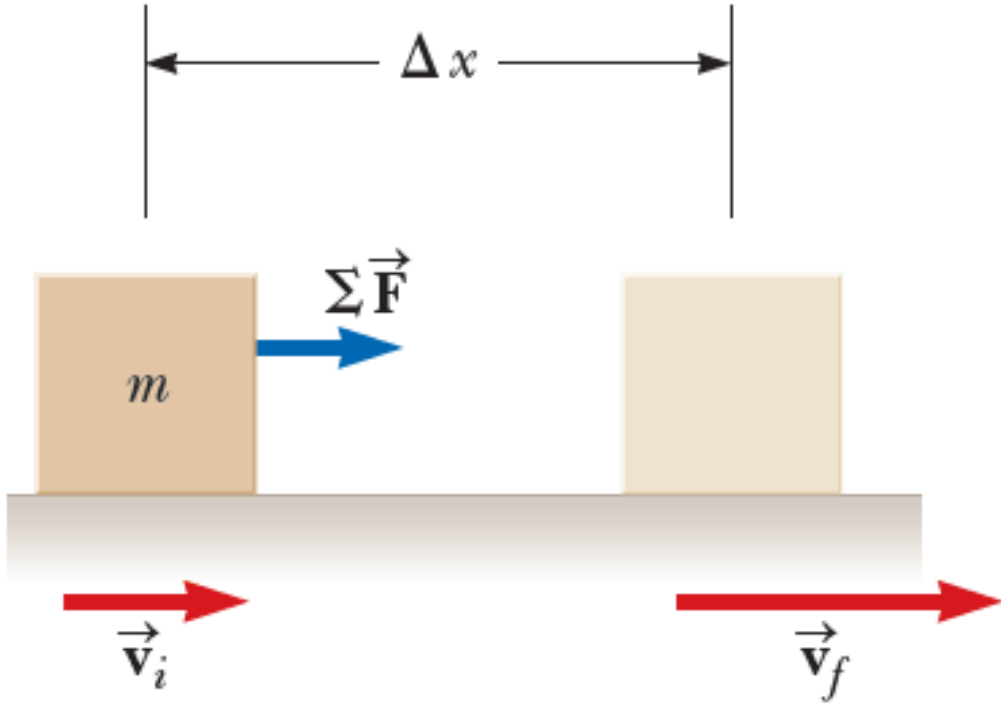


Work – Kinetic Energy theorem

- For an object with mass (m) moving a displacement (Δx) with acceleration (a) and velocities (Vi) and (Vf)
- Kinetic Energy (الطاقة الحركية):

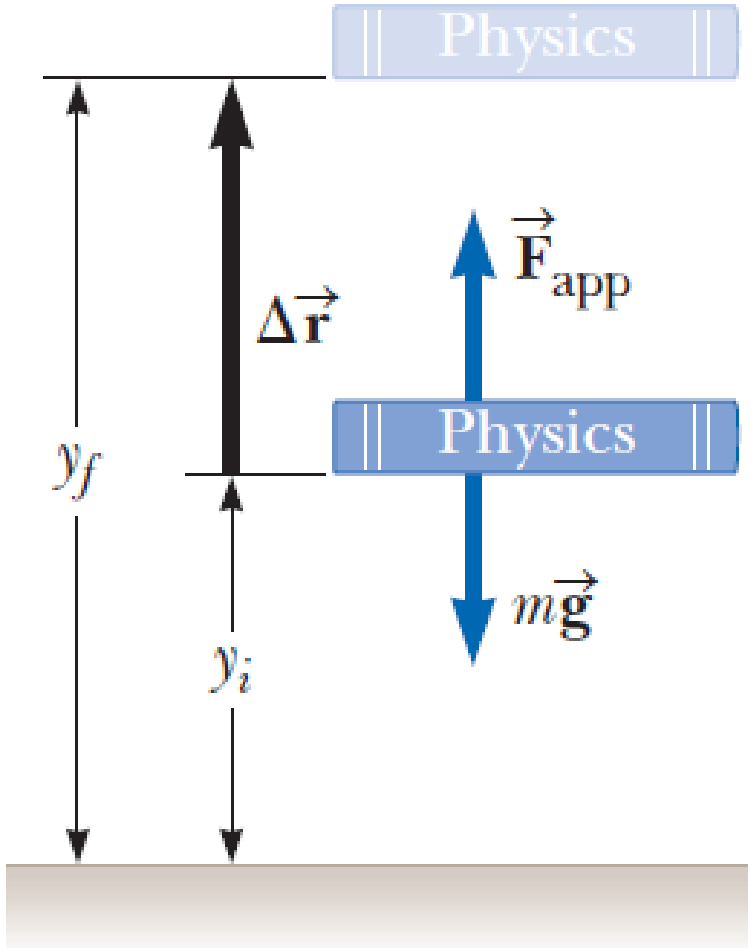
Energy associated with motion

- Kinetic Energy = K.E = 0.5 m V^2.
- There is a relation between K.E and Work:
- "When work is done on a system and the only change in the system is in its speed, the net work done on the system equals the change in kinetic energy of the system"
- **Wext = 0.5 m Vf^2 – 0.5 m Vi^2 = Δ K.E**



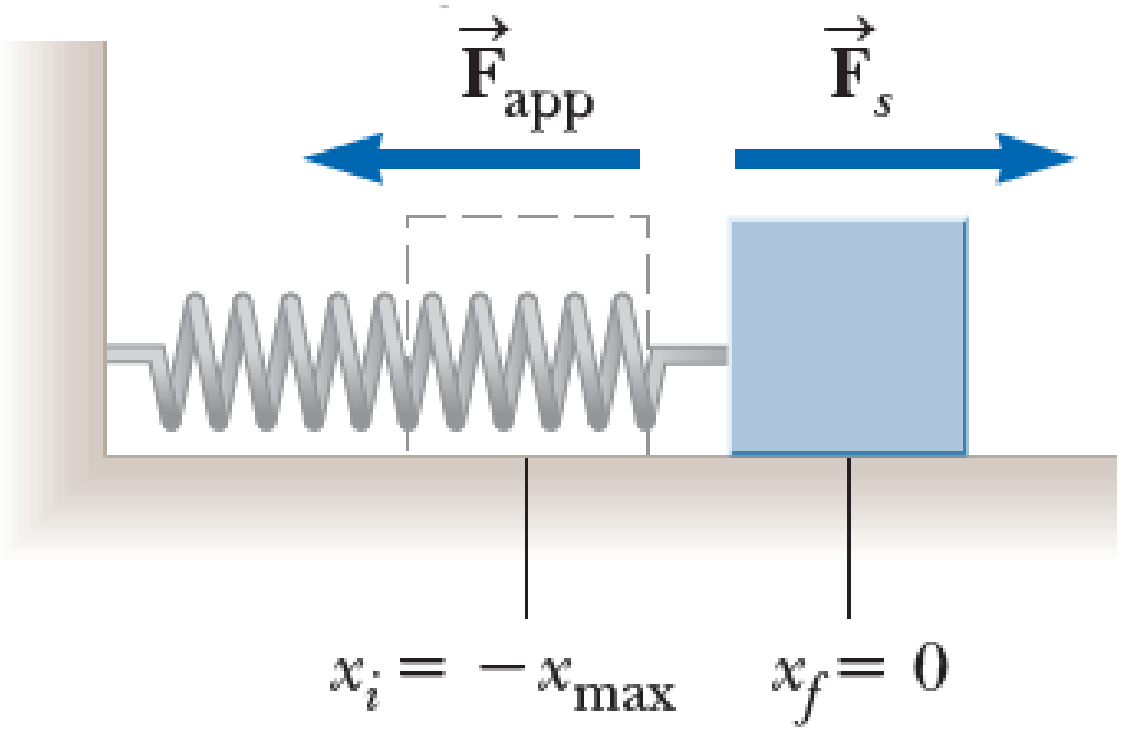
The Potential Energy

- The potential energy (طاقة الوضع) is an energy that is stored in the object or system
- To lift the book upward with no acceleration you need external work (W_{ext})
- If the energy is associated with the gravitational force ---> Gravitational Potential Energy
- $W_{ext} = F \cdot \Delta y = F (yf - yi)$
- $U_g = F \cdot y$
- ---> $W_{ext} = Uf - Ui$ ---> $W_{ext} = \Delta U$
- Always take a reference point and consider it zero



The elastic potential energy

- If the work is done on the spring (زنبرك) by an external force:
- 0.5 k x^2 = U_s.
- K: spring constant
- Wext = ΔU_s.
- Wext = 0.5 k [xf^2 - xi^2]
- The potential energy associated with the spring is called the elastic potential energy



Conservation of energy

- If the system is isolated (no external energy is transferred)
- ---> **ΔK.E + ΔU = 0**
- ---> **K.Ei + P.Ei = K.Ef + P.Ef**
- K.E + P.E is called the Mechanical Energy (M.E)
- ---> **M.Ei = M.Ef**
- ΔK.E : change in Kinetic Energy
- ΔU: change in potential energy

Power

- **Power (P) = W/Δt**
- Average power (Pavg) = W/Δt
- P = W/Δt = (F. Δr)/dt = F (Δr/Δt) = F . v
- **P = F . v**
- F: Force, v: velocity
- Here F is constant with respect to t
- Unit of power is Watt
- 1 Watt = 1 J/s ---> 1 J = 1 Watt . s