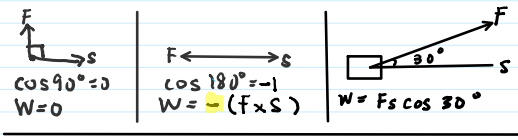
Chapter 4

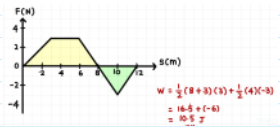
2021年10月16日 12:55

1. Work
   - The product of the magnitude of displacement times the component of the force parallel to the displacement .

$W = Fs\cos\theta$

W = workdone (kgm^2s^{-2} / Nm / J)
F = force
s = displacement of body (m)
θ = angle between F & s





2. Energy
   - system 's ability to do work
   - 3 type of energy

$E = U + K$

① Gravitational potential energy

$U = mgh$

energy stored in body due to position (J) | kg | g = 9.81 ms⁻² | h | m

mass (kg) — U (J) — height (m)

② Elastic potential energy

$U_s = \frac{1}{2}kx^2 \;/\; \frac{1}{2}Fx$

energy store in elastic string / spring due to compressing or stretching | extent / compress distance (m) | restoring force

③ Kinetic energy

$K = \frac{1}{2}mv^2$

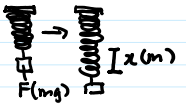
energy in body due to motion | kg | ms^{-1}

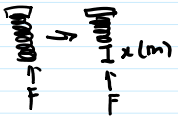
m (kg) — V = ms^{-1}

Hooke's Law

$F \propto x$
$F = kx$

external force to spring

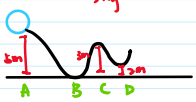




Conservation of energy

$\Sigma E_i = \Sigma E_f$

$U_i + K_i = U_f + K_f$



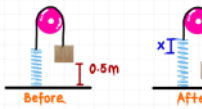
Point A
$E_A = U_A + K_A$
$= mgh$
$= 0.5(9.81)(5)$
$= 24.53\ J$

Point B
$E_B = U_B + K_B$
$E_A = E_B$
$24.53 = \frac{1}{2}mv^2$
$24.53 = \frac{1}{2}(0.5)v^2$
$V_B = 9.85\ ms^{-1}$

Point C
$E_C = U_C + K_C$
$E_A = E_B$

Point D
$E_D = U_D + K_D$
$= E_A = E_B = E_C$

A 5kg block start from rest at the height of 0.5 m from the ground. Determine the speed of the block released at the height of 0.2m from the ground. Spring constant, k = 50 Nm^{-1}



Extension of the spring = 0.5 - 0.2 = 0.3m

$E_i = mgh_1$ $\quad E_2 = \frac{1}{2}kx^2 + \frac{1}{2}mv^2 + mgh_2$

$E_i = E_2$

$mgh_1 = \frac{1}{2}kx^2 + \frac{1}{2}mv^2 + mgh_2$

$5(9.81)(0.5) = \frac{1}{2}(50)(0.3)^2 + \frac{1}{2}(5)v^2 + (5)(9.81)(0.2)$

$24.53 = 2.25 + 2.5v^2 + 9.81$

$2.5v^2 = 12.47$

$v = 2.23\ ms^{-1}$

work-energy theorem > the work done by the net force on a body equals the change in the body's kinetic energy

$W_{net} = \Delta K = K_f - K_i = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

u: initial speed; v: final speed

change in kinetic energy

> According to the work - energy theorem, a moving object has kinetic energy, because work was done to accelerate the object from rest to a speed v

3. Power

rate of workdone (Js⁻¹ / W)

Use if has external forces.

$P_{av} = \frac{\Delta W}{\Delta t} \rightarrow Fs\cos\theta$

$P_{av} = \frac{\Delta E}{\Delta t} \rightarrow K / U$

$P_{ins} = Fv$

F: force; v: speed at particular time