Read 7.1 – 7.3

① $W_{net} = \Delta K$

Net work, including work from springs + gravity

② $W_{NC} = \Delta K + \Delta U$

Only work from non-conservative forces

Potential Energy (work) from springs + gravity

You can use either of these but include work from springs + gravity in only one place. If no springs or change in height, the two are identical

SO FAR Neglected friction

If no friction → Total mechanical Energy conserved

Total Energy is always conserved

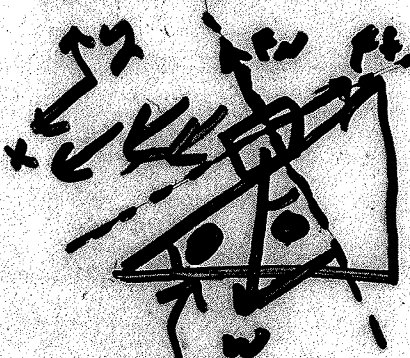
Can lose mechanical energy
Transferred to other types of energy
heat, sound ...

If we have friction

Total mechanical energy decreases
Total Energy remains same

$$W_{NC} = \Delta K + \Delta U$$

ex) A 58 kg skier is coasting down a slope of 25°. A frictional force of 70 N opposes her motion. Near the top her speed is 3.6 m/s. What is her speed at a point 57 m downhill?



$W_{net} = F_{net}\, d \cos\theta$

not the same θ

X: $-F_f + W\sin\theta$ Net Force

Net Force = $-70\,N + (58\,kg)(9.8\,m/s^2)(\sin 25°) = 170\,N$

$W_{net} = (170\,N)(57\,m)\cos 0° = 9700\,J$

$W_{net} = \Delta K = K_f - K_i \qquad K_f = W_{net} + K_i$

$\frac{1}{2} m v_f^2 = K_f = 9700\,J + \frac{1}{2} m v_i^2$

$\frac{1}{2} m v_f^2 = 9700\,J + \frac{1}{2}(58\,kg)(3.6\,m/s)^2$

$\frac{1}{2} m v_f^2 = 10{,}100\,J \quad 10{,}100\,J$

$\boxed{v_f = 19\,m/s}$

EX) A child of mass 50 kg slides down a hill of height 0.46 m. If sled starts from rest and has a speed of 2.6 m/s at the bottom, how much energy* is lost due to friction what is frictional force if hill 20° above horizontal

(* mechanical)

$$W_{nc} = \Delta K + \Delta U$$

$$= \left(\tfrac{1}{2} m v_f^2 - \cancel{\tfrac{1}{2} m v_i^2}^{\,0}\right) + \left(\cancel{U_f}^{\,0} - U_i\right)$$

$v_i = 0$

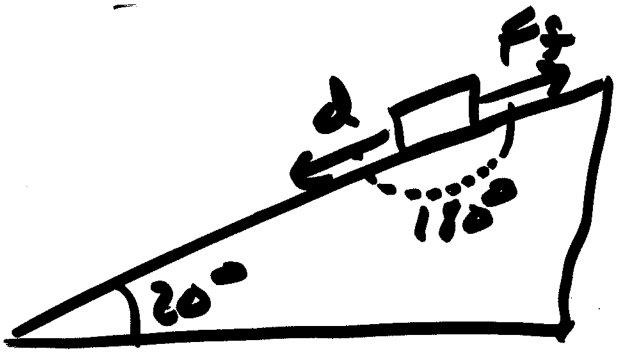
$U_f = 0$

$$W_{nc} = \tfrac{1}{2} m v_f^2 - mgh$$

$$= \tfrac{1}{2}(50\,kg)(2.6\,m/s)^2 - (50\,kg)(9.8\,m/s^2)(.46\,m)$$

$$= \boxed{-56\,J}$$

$w = Fd\cos\theta \qquad \theta = 180^\circ$



$w = Fd\cancel{\cos 180}^{-1} \Rightarrow F = \frac{-w}{d}$

$F = \frac{56\,J}{d}$

$d = \frac{.46\,m}{\sin 20^\circ} = \underline{1.34\,m}$

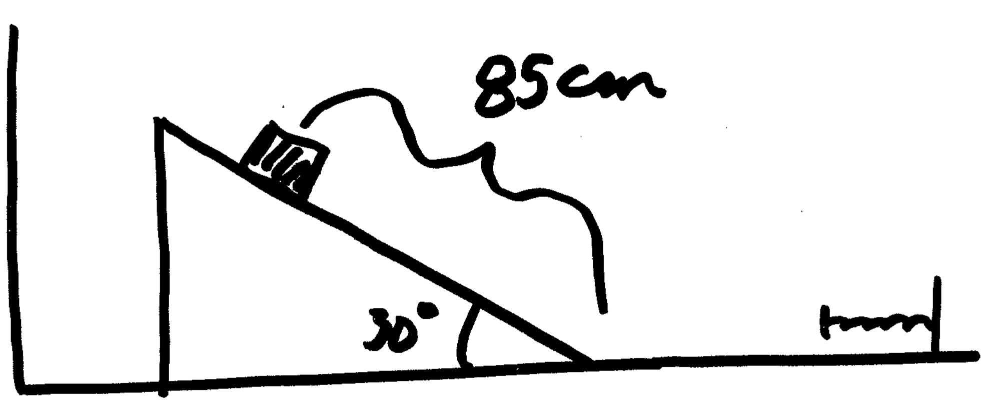
$F = \frac{56\,J}{1.34\,m} = \boxed{42\,N}$

ex) A 0.50 kg block, starting from rest, slides down a 30° incline with $\mu_k = 0.25$. After sliding 85 cm down the incline, it slides across a frictionless horizontal surface and encounters a spring ($k = 35$ N/m)

a) what is maximum compression of spring

The block then goes back up incline

b) How far along incline does block travel before coming to rest



Find speed at bottom

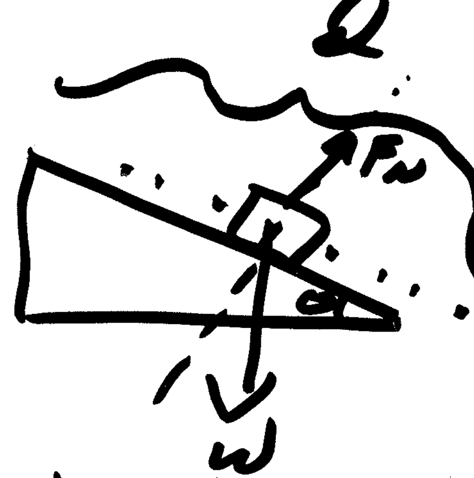
at top $v_i = 0$ $U_i = mgh$

bottom $v_f = ?$ $U_f = 0$

E_i: at top

$\frac{1}{2}m\cancel{v_i^2}^{\,0} + mgh \Rightarrow E_i = mgh$

$$\boxed{mgh - F_f d = \frac{1}{2}mv_f^2} + \cancel{U_f}^{\,0}$$



$F_f = \mu_K F_N$

$F_N - mg\cos\theta = 0$

$F_f = \mu_k mg\cos\theta$

$\Rightarrow v_f = \sqrt{2gh - \frac{2F_f d}{m}}$ $h = d\sin\theta$

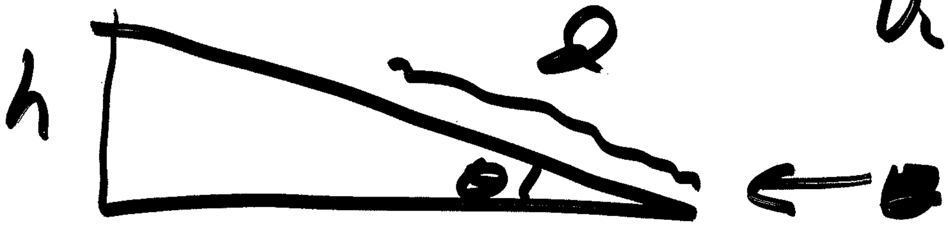
$$v_f = \sqrt{2 \cdot g \cdot d\sin\theta - \frac{2\mu_k \cancel{m}g\cos\theta\, d}{\cancel{m}}}$$

$$= \sqrt{2gd(\sin\theta - \mu\cos\theta)} = 2.17\text{ m/s}$$

$$\cancel{\tfrac{1}{2}}mv^2 = \cancel{\tfrac{1}{2}}kx^2$$

$$x = v\sqrt{\frac{m}{k}} = \boxed{.26\text{ m}}$$

$v_i = 2.17\ m/s$



$$\frac{1}{2}mv^2 - F_f d = mgh \qquad h = d\sin\theta$$

$$\frac{1}{2}mv^2 - F_f d = mgd\sin\theta$$

$$\frac{1}{2}mv^2 = mgd\sin\theta + F_f d$$

$$\frac{1}{2}mv^2 = d(gm\sin\theta + F_f)$$

$$d = \frac{\frac{1}{2}mv^2}{gm\sin\theta + F_f}$$

$$= \frac{\frac{1}{2}\cancel{m}v^2}{g\cancel{m}\sin\theta + \mu_k \cancel{m}g\cos\theta}$$

$$d = \frac{\frac{1}{2}v^2}{g(\sin\theta + \mu_k\cos\theta)}$$

$$\boxed{d = .33\ m}$$

A box slides down an inclined plane with friction and compresses a spring with spring constant K. The box then goes back up the incline to a height h. I then replace the spring with a new spring with spring constant 4K.
How far back up the incline will box go?

- A) same
- B) Twice as high
- C) ½ as high
- D) 4 times as high
- E) unable to determine