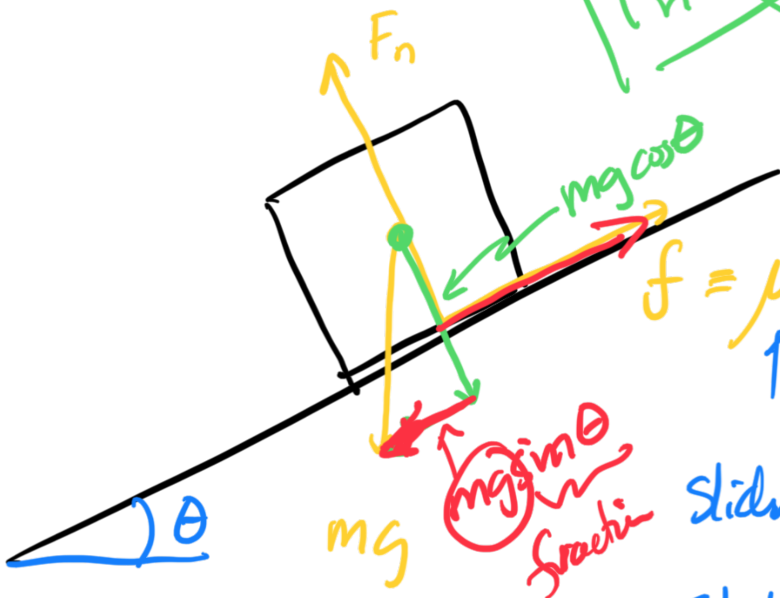
Friction Review

$$\boxed{F_n = \overbrace{mg}^{\text{weight}}\,\underbrace{\cos\theta}_{\text{fraction of weight}}}$$

1.



$f = \mu F_n = F_p$

sliding → μ_K

static → μ_S

→ roughness of surface → μ_K, μ_S

→ F_n → m, angle

2. weight ≡ mg
gravitational force.

3. $F_n = mg\cos\theta$

$= (70)(9.8)\cos\theta$

$F_n = 686\cos\theta$

a) $\theta = 0°$ $\cos(0°) = 1$

(horizontal) $F_n = 686$ N

b) $\theta = 40°$ $\cos(40°) = 0.766$

$F_n = 525.5$ N

4. static case "sitting"

$F_p = f = mg\sin\theta$

$F_p = 686 \sin\theta$

a) $\theta = 0°$ $\sin(0°) = 0$

$F_p = 0$

b) $\theta = 40°$ $\sin(40°) = 0.6428$

$F_p = 686 \cdot 0.6428$

$= 440.95$ N

5. "critical angle" ?

↳ pt. at which the object starts to move.

"which two forces are exactly equal"

F F

$$F_p = F_n$$

$$\cancel{m}\cancel{g}\sin\theta = \cancel{m}\cancel{g}\cos\theta$$

$$\sin\theta = \cos\theta$$

$$\boxed{\theta = 45^\circ}$$

$$\frac{\sin\theta}{\cos\theta} = 1$$

$$\tan\theta = 1$$

$$\theta = \tan^{-1}(1) = 45^\circ$$

6. If the box slides at $\theta = 55^\circ$
what is the coefficient of frictio

$$F_n = mg\cos\theta = 686\cos 55^\circ$$
$$= 393.471$$

equal in static case.

$$\boxed{F_p = f = mg\sin\theta} = 561.94$$

$$\boxed{f = \mu F_n}$$

$$561.94 = \mu\,(393.47)$$

$$\mu = \frac{561.94}{393.47} = 1.428$$

$$\mu_s^{max} \equiv \text{maximum coefficient of static friction}$$

7. ✓

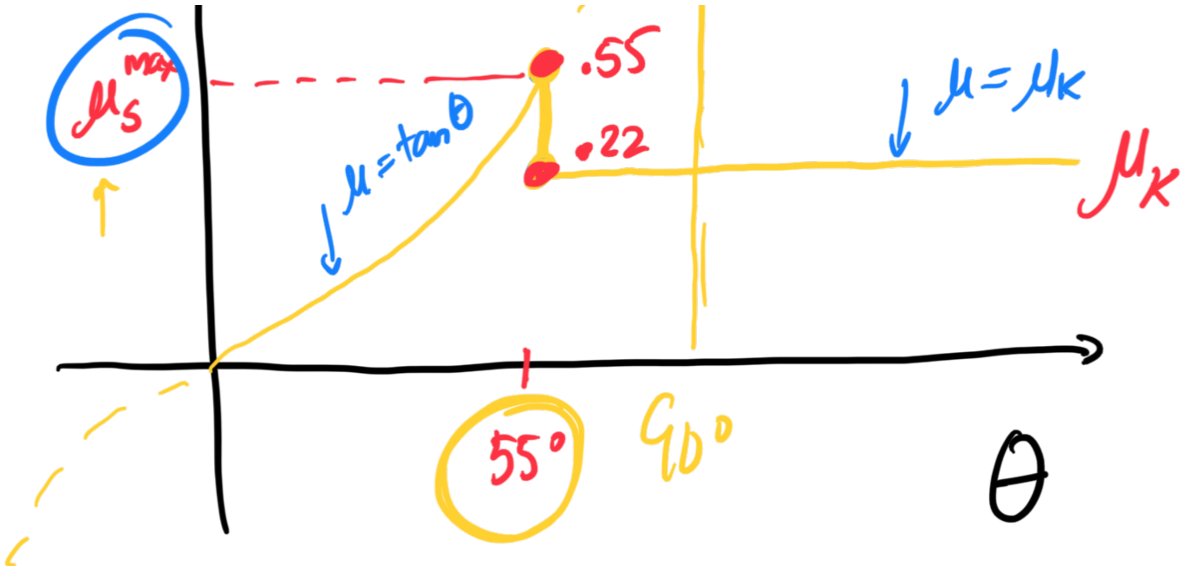
static case.

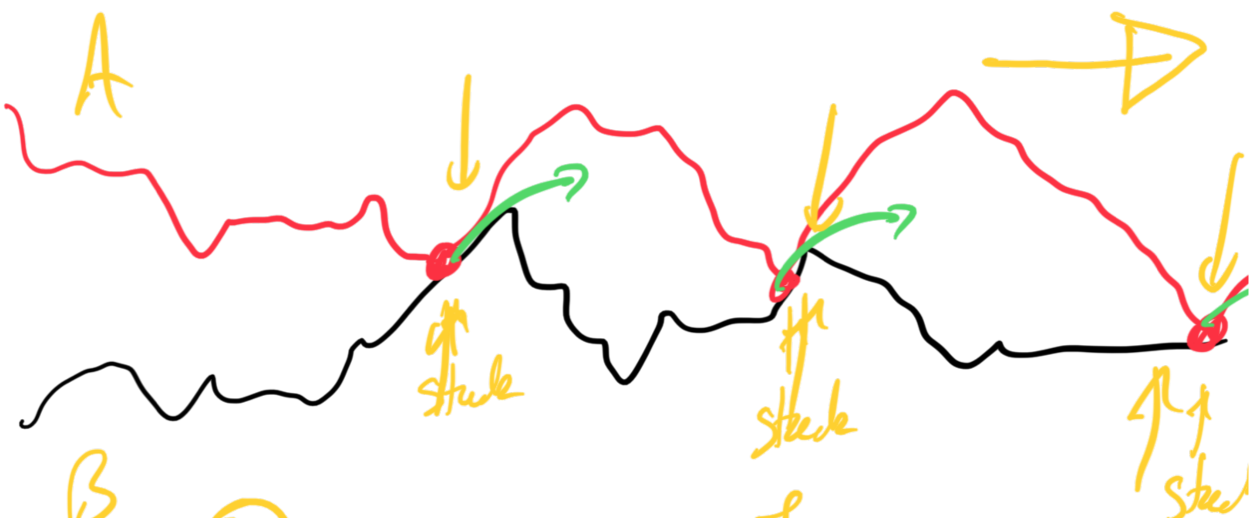
$$f = \mu F_n$$

$$\frac{\cancel{mg}\sin\theta}{\cos\theta} = \mu\left(\frac{\cancel{mg}\cos\theta}{\cancel{\cos\theta}}\right)$$

$$\boxed{\mu = \tan\theta}$$

$\theta_{critical} = \tan^{-1}(\mu_s$





① roughness of surface A, roughness of surface B.

(2) Molecular adhesion

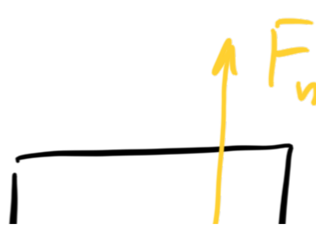
(3) Deformations.

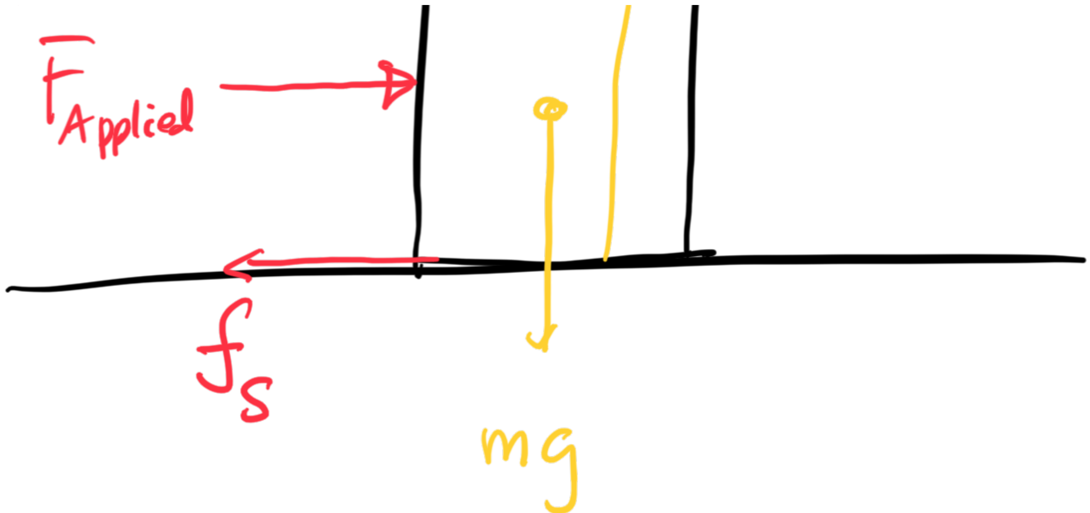
9. $m = 14\,kg$

$\mu_s^{max} = 0.5$

$\mu_K = 0.22$

c)





Static:

$$F_A = f_s$$

$$F_n = mg$$

$$f_s = \mu_s F_n$$

$$f_s = \mu_s mg$$

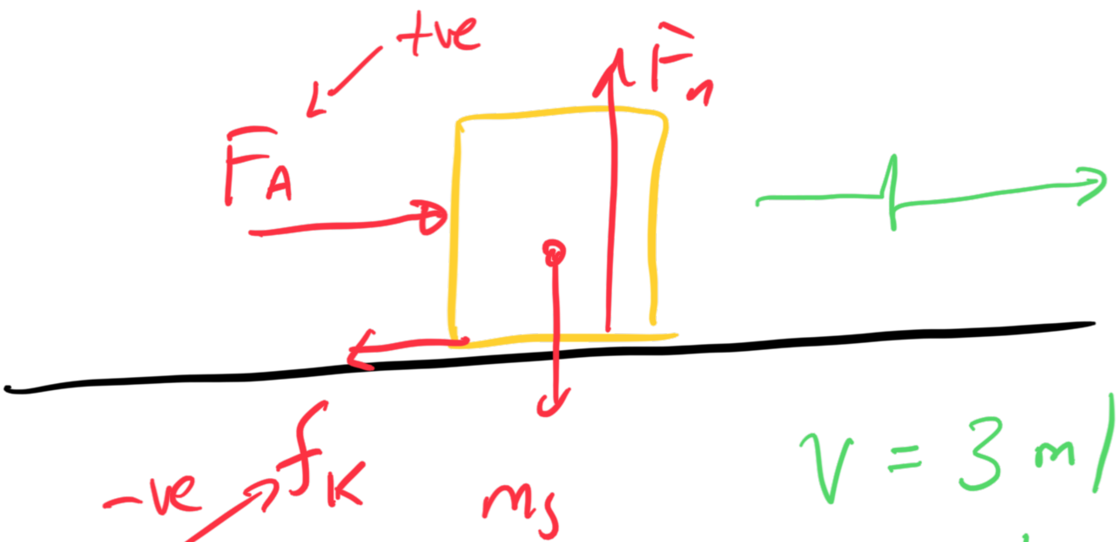
When it starts to move, barely, $\mu_s = \mu_s^{max}$

$$f_s = \mu_s^{max} mg$$

$= (0.5)(14)(9.8)$

$f_s = \boxed{68.6\ N} = F_A$

moving → sliding.



$V = 3\ m/s$

→ constant

$F_{net} = ma$

$\boxed{F_A - f_K = 0} \leftarrow \boxed{\cancel{a = 0}}$

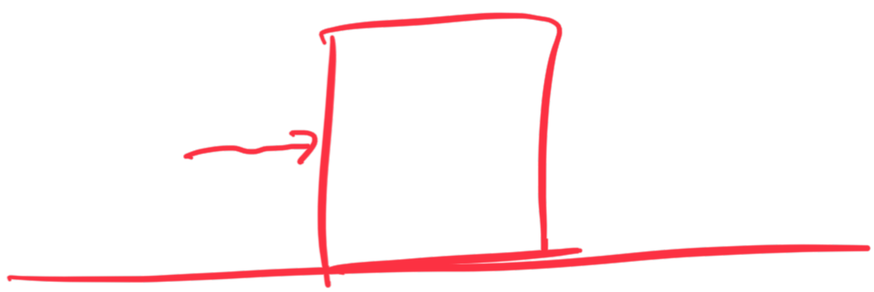
how is the velocity changing?

$F_A = f_K$

$$= \mu_K F_n = \mu_K m g$$

$$= (0.22)(14)(9.8)$$

$$= \underline{30.2 \text{ N}}$$



10. $$F_A - f_K = ma$$

F_A: 60 N

f_K: $\mu_K mg = 30.2$ N

$$60 - 30.2 = 14a$$

$$29.8 = 14a$$

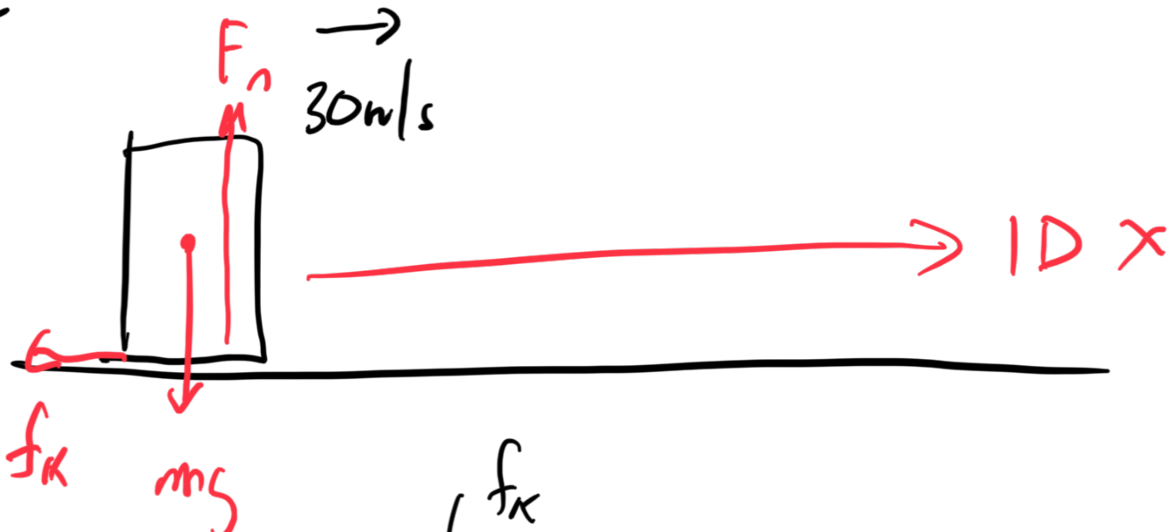
$$a = 29.8/14 = 2.13 \, m/s^2$$

b) 240 N

$$240 - 30.2 = 14a$$

$$a = 14.99 \, m/s^2$$

11.



f_k

$$-\mu_k g = a$$

a)

① $a = -\mu_k g = -2.156$ m/s

↑ slowing down.

② $V_i = 30$ m/s ~ 60 mph

③ $V_f = 0$ m/s (stop)

→ $\Delta x = ?$

Kinematics

Motion in 1D with constant acceleration.

① $V_f = V_i + at$

② $\Delta x = v_i t + \frac{1}{2} a t^2$

③ $\Delta x = v_f t - \frac{1}{2} a t^2$

④ $\Delta x = \left(\frac{v_f + v_i}{2}\right) t$

(5) $\boxed{v_f^2 = v_i^2 + 2a\Delta x}$

5 unknowns : v_i, v_f, a, t, Δx

(1) You will be given / identify (3)

(2) Solve for the other two.

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$\Delta x = \frac{v_f^2 - v_i^2}{2a}$$

$$= \frac{0^2 - 30^2}{2(-2.156)}$$

$$= \frac{-900}{-4.312}$$

$$\Delta x = 208.7 \text{ m}$$

How long does it take?

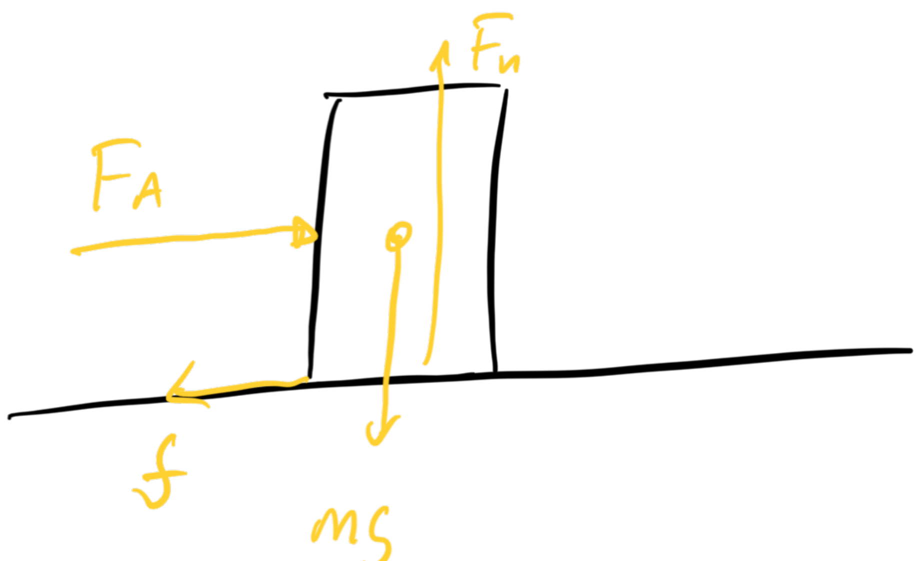
$$t = ?$$

$$v_f = v_i + at$$

$$t = \frac{v_f - v_i}{a} = \frac{0 - 30}{-2.156}$$

$$= 13.9\ s$$

12.



$F_n = mg$ ← double the mass, double F_n

$f = \mu F_n = \mu mg$ double f.

13.