Unit Review: Kinematics + Dynamics

① 0-4 s constant negative velocity

4-6 s at rest

6-8 s constant negative velocity

8-10 s constant positive velocity

10-12 s at rest

12-13 s constant negative velocity

13-14 s at rest

14-16 s constant positive velocity

② velocity = slope = $\frac{\text{rise}}{\text{run}}$

0-4 s $v = -\frac{30}{4} = \boxed{-7.5 \text{ m/s}}$

4-6 s $v = \boxed{0}$

6-8 s $v = -\frac{20}{2} = \boxed{-10 \text{ m/s}}$

8-10 s $v = \frac{55}{2} = \boxed{27.5 \text{ m/s}}$

10-12 s $v = \boxed{0}$

12-13 s $v = -\frac{15}{1} = \boxed{-15 \text{ m/s}}$

13-14 s $v = \boxed{0}$

② continued

14 - 16 s $v = \frac{30}{2} = \boxed{15 \text{ m/s}}$

③ $v_{avg} = \frac{\Delta \vec{d}}{\Delta t} = \frac{d_f - d_i}{+} = \frac{20 - (-15)}{8}$

$v_{avg} = \frac{35}{8} = \boxed{4.375 \text{ m/s}^2}$

④ 0 - 2 s moving forward, speeding up

2 - 5 s constant velocity forward

5 - 6.25 s moving forward, slowing down

6.25 - 8 s moving backward, speeding up

8 - 10 s constant velocity backward

10 - 12 s moving backward, slowing down

12 - 14 s moving forward, speeding up

14 - 16 s constant velocity forward.

⑤ $a = \text{slope} = \frac{\text{rise}}{\text{run}}$

0 - 2 s $a = \frac{10}{2} = \boxed{5 \text{ m/s}^2}$

2 - 5 s $a = \boxed{0}$

5 - 8 s $a = -\frac{24}{3} = \boxed{-8 \text{ m/s}^2}$

⑤ continued

8 - 10 s $a = \boxed{0}$

10 - 14 s $a = \frac{28}{4} = \boxed{7 \text{ m/s}^2}$

14 - 16 s $a = \boxed{0}$

⑥ d = area

$$= \frac{(2)(10)}{2} + (3)(10) + \frac{(1.25)(10)}{2} - \frac{(1.75)(14)}{2} - (2)(14)$$

$$- \frac{(2)(14)}{2} + \frac{(2)(14)}{2} + (2)(14)$$

$d = \boxed{84 \text{ m}}$

⑦ $a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t} = \frac{0 - 40}{0.012} = \boxed{-3333.\overline{3} \text{ m/s}^2}$

⑧ a) $v_f = v_i + aT$

$0 = 88 + a(11)$

$a = -\frac{88}{11} = \boxed{-8 \text{ m/s}^2}$

b) $d = \left(\frac{v_f + v_i}{2}\right) t$

$= \left(\frac{0 + 88}{2}\right) 11$

$d = \boxed{484 \text{ m}}$

⑨ a) $d = v_i t + \frac{1}{2} a t^2$

$0.8 = (0)t + \frac{1}{2}(6.8 \times 10^4) t^2$

$0.8 = 34000 t^2$

$t = \sqrt{\frac{0.8}{34000}} = \boxed{0.00485 \text{ s}}$

b) $v_f = v_i + at$

$= 0 + (6.8 \times 10^4)(0.00485)$

$v_f = \boxed{329.8 \text{ m/s}}$

⑩ $v_f^2 = v_i^2 + 2ad$

$0 = v_i^2 + 2(-10)(60)$

$0 = v_i^2 - 1200$

$v_i^2 = 1200$

$v_i = 34.6 \text{ m/s}$ or $\boxed{124.7 \text{ Km/h}}$

The car was speeding.

(11) Speeder: $d = vt$ Cop: $d = v_i t + \frac{1}{2}at^2$

when the cop catches the speeder, the displacements will be equal.

so $vt = v_i t + \frac{1}{2}at^2$

$v(12) = (0)(12) + \frac{1}{2}(4.4)(12)^2$

$12v = 316.8$

$v = 26.4$ m/s or $\boxed{95 \text{ km/h}}$

(12) a) $v_i = 0$

$a = -9.8 \text{ m/s}^2$

$v_f = v_i + at$

$= 0 - 9.8(6)$

$v_f = \boxed{-58.8 \text{ m/s}}$

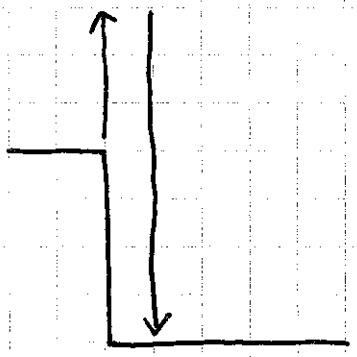
b) $d = v_i t + \frac{1}{2}at^2$

$= (0)(6) + \frac{1}{2}(-9.8)(6)^2$

$d = -176.4$ m

The cliff is $\boxed{176.4 \text{ m}}$ high.

(13)



$v_i = 25$ m/s

$d = -42$ m

$a = -9.8$ m/s^2

$t = ?$

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

$-42 = 25t + \frac{1}{2}(-9.8)t^2$

$4.9t^2 - 25t - 42 = 0$

$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$= \frac{25 \pm \sqrt{25^2 - 4(4.9)(-42)}}{2(4.9)}$

$t = \frac{25 \pm 34.974}{9.8}$

$t = \boxed{5.61 \text{ s}}$ or ~~-1.5 s~~

(14)

$v_f^2 = v_i^2 + 2ad$

$12^2 = 0 + 2a(5)$

$12^2 = 10a$

$a = 14.4$ m/s^2

$\Sigma F = ma$

$= (5.2)(14.4)$

$\Sigma F = \boxed{74.9 \text{ N}}$

(15)

$V_f^2 = V_i^2 + 2ad$

$0 = 4^2 + 2a(0.4)$

$0 = 16 + 0.8a$

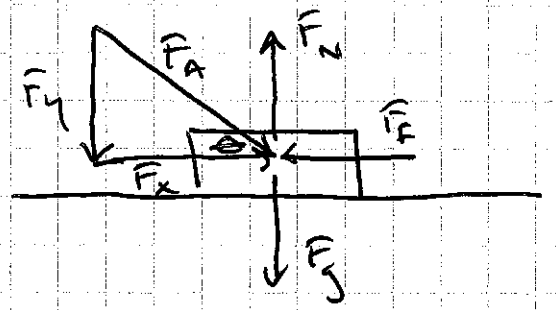
$a = \frac{-16}{0.8} = -20 \text{ m/s}^2$

$\Sigma F = ma$

$-1200 = m(-20)$

$m = \boxed{60 \text{ Kg}}$

(16)



$m = 20 + 30(1.5) = 65 \text{ Kg}$

$F_A = 100 \text{ N}$

$\mu = 0.2$

$\theta = 30°$

$\Sigma F = F_x - F_F$

$ma = F_A \cos\theta - \mu(F_A \sin\theta + mg)$

$65a = 200\cos 30 - 0.2(200\sin 30 + 65(9.8))$

$65a = 173.205 - 0.2(100 + 637)$

$65a = 173.205 - 147.4$

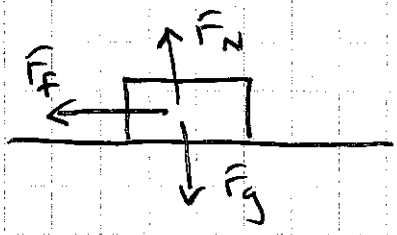
$65a = 25.805$

$a = \boxed{0.397 \text{ m/s}^2}$

$F_N = F_y + F_g$

$F_N = F_A \sin\theta + mg$

(17) Note: There is no applied force. The initial push gets the box moving, and is then removed.



$\Sigma F = F_f$

$ma = \mu \cdot mg$

$a = \mu mg$

$a = \mu \cdot g$

$a = (0.3)(9.8) = -2.94 \text{ m/s}^2$

↑ b/c it points left

$v_f^2 = v_i^2 + 2ad$

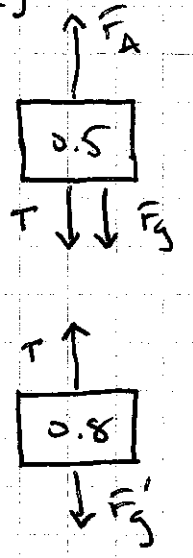
$0 = 3^2 + 2(-2.94)d$

$0 = 9 - 5.88d$

$d = \frac{-9}{-5.88}$

$d = \boxed{1.53 \text{ m}}$

(18) a)



$\Sigma F = F_A - T - F_g + T - F_g'$

$\Sigma F = F_A - F_g - F_g'$

$(m+m')a = F_A - mg - m'g$

$1.3a = 20 - 0.5(9.8) - 0.8(9.8)$

$1.3a = 7.26$

$a = \boxed{5.58 \text{ m/s}^2 [\text{up}]}$

(18) a) continued

0.8 Kg

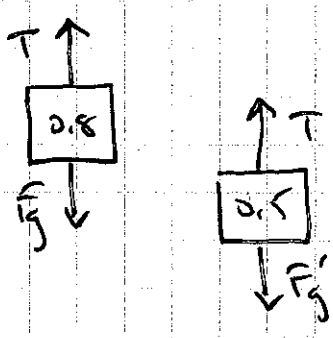
$\Sigma F = T - F_g'$

$m'a = T - m'g$

$(0.8)(5.58) = T - (0.8)(9.8)$

$T = \boxed{12.3\ N}$

b)



$\Sigma F = F_g' - F_g$

$(m+m')a = m'g - mg$

$1.3a = 0.5(9.8) - 0.8(9.8)$

$1.3a = -2.94$

$a = -2.26\ m/s^2$

or

$\boxed{2.26\ m/s^2\ [ccw]}$

0.5 Kg

$\Sigma F = F_g' - T$

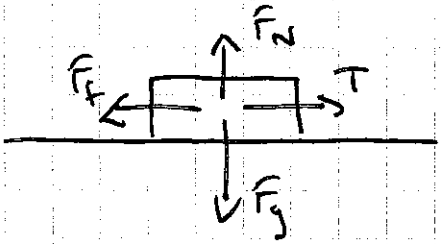
$m'a = m'g - T$

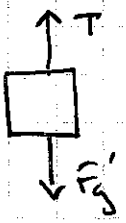
$0.5(-2.26) = (0.5)(9.8) - T$

$T = (0.5)(9.8) + (0.5)(2.26)$

$T = \boxed{6.03\ N}$

(18) c)





$\Sigma F = F_g' - F_f$

$(m+m')a = m'g - \mu \cdot mg$

$(1)a = 0.7(9.8) - (0.12)(0.3)(9.8)$

$a = \boxed{6.51 \text{ m/s}^2 \text{ [cw]}}$

0.7 kg

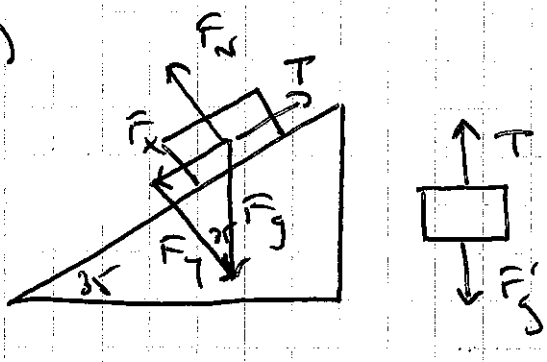
$\Sigma F = F_g' - T$

$0.7(6.51) = (0.7)(9.8) - T$

$T = 0.7(9.8) - 0.7(6.51)$

$T = \boxed{2.3 \text{ N}}$

(18) d)



$\Sigma F = F_g' - F_x$

$(m+m')a = m'g - mg\sin\theta$

$0.8a = (0.5)(9.8) - (0.3)(9.8)\sin 35°$

$0.8a = 3.214$

$a = \boxed{4.02 \text{ m/s}^2 \text{ [cw]}}$

0.5 Kg

$\Sigma F = F_g' - T$

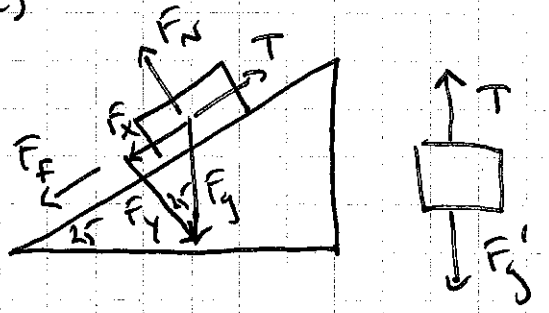
$m'a = m'g - T$

$T = m'g - m'a$

$= (0.5)(9.8) - (0.5)(4.02)$

$T = \boxed{2.89 \text{ N}}$

(18) c)



$F_N = F_y$

$= mg\cos\theta$

$F_f = \mu \cdot F_N$

$= \mu mg\cos\theta$

$\Sigma F = F_g' - F_x - F_f$

$(m+m')a = m'g - mg\sin\theta - \mu mg\cos\theta$

$1.1\,a = 0.8(9.8) - 0.3(9.8)\sin 25 - 0.12(0.3)(9.8)\cos 25$

$1.1a = 6.278$

$a = \boxed{5.71\ m/s^2\ [cw]}$

0.8 Kg

$\Sigma F = F_g' - T$

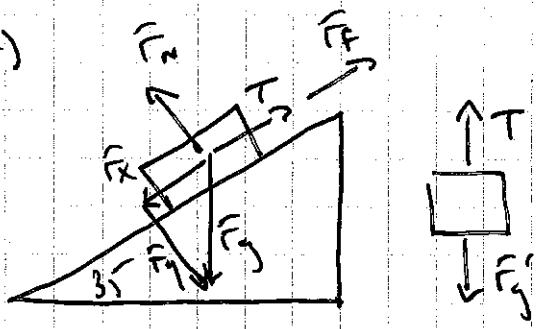
$m'a = m'g - T$

$T = m'g - m'a$

$= (0.8)(9.8) - (0.8)(5.71)$

$T = \boxed{3.27\ N}$

(18) f)



Note: $\vec{F}_x > \vec{F}_g'$

so it will move ccw.

∴ $\vec{F}_f$ points up the incline.

$$\Sigma \vec{F} = \vec{F}_g' + \vec{F}_f - F_x$$

$$(m+m')a = m'g + \mu \cdot mg\cos\theta - mg\sin\theta$$

$$1.1\,a = (0.3)(9.8) + (0.12)(0.8)(9.8)\cos 35° - (0.8)(9.8)\sin 35°$$

$$1.1\,a = -0.786$$

$$a = -0.71 \text{ m/s}^2 \quad \text{or} \quad \boxed{0.71 \text{ m/s}^2 \text{ [ccw]}}$$

0.3 Kg

$$\Sigma \vec{F} = \vec{F}_g' - T$$

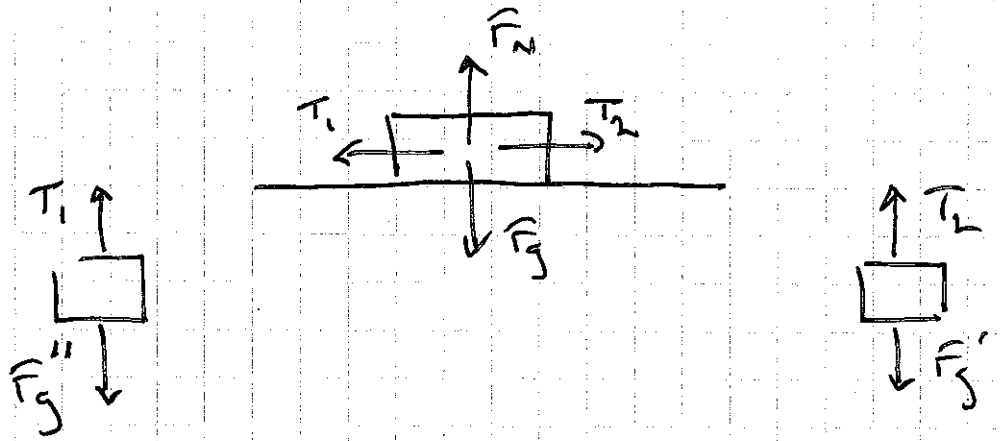
$$m'a = m'g - T$$

$$T = m'g - m'a$$

$$= (0.3)(9.8) - (0.3)(-0.71)$$

$$T = \boxed{3.15 \text{ N}}$$

(19)



$$\Sigma F = F_g' - T_2 + T_2 - T_1 + T_1 - F_g''$$

$$\Sigma F = F_g' - F_g''$$

$$(m + m' + m'')\, a = m'g - m''g$$

$$14\, a = 4(9.4) - (2)(9.8)$$

$$14a = 19.6$$

$$a = \boxed{1.4 \text{ m/s}^2 \ [\text{cw}]}$$

2 Kg

$$\Sigma F = T_1 - F_g''$$

$$m''a = T_1 - m''g$$

$$T_1 = m''a + m''g$$

$$= (2)(1.4) + (2)(9.8)$$

$$T_1 = \boxed{22.4 \text{ N}}$$

4 Kg

$$\Sigma F = F_g' - T_2$$

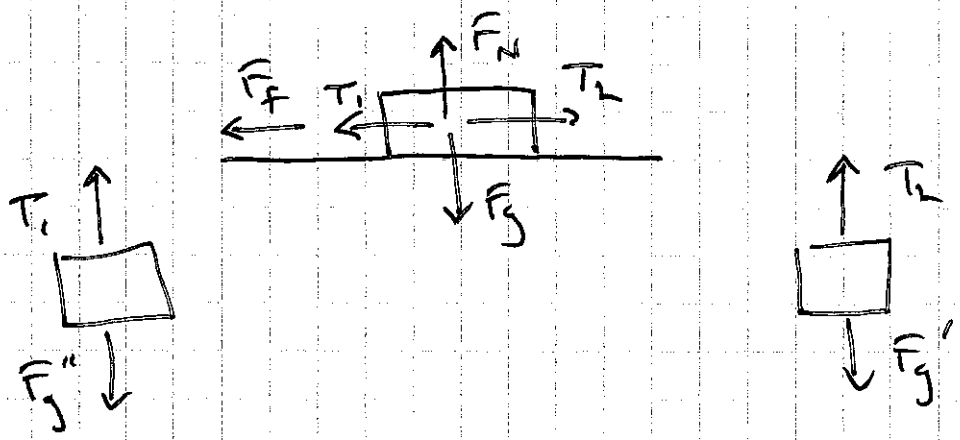
$$m'a = m'g - T_2$$

$$T_2 = m'g - m'a$$

$$= (4)(9.8) - (4)(1.4)$$

$$T_2 = \boxed{33.6 \text{ N}}$$

(20)



$$\Sigma F = F_g' - F_f - F_g''$$

$$(m+m'+m'')a = m'g - \mu mg - m''g$$

$$14a = 4(9.8) - 0.15(8)(9.8) - 2(9.8)$$

$$14a = 7.84$$

$$a = \boxed{0.56 \text{ m/s}^2 \text{ [cw]}}$$

2 Kg

$$\Sigma F = T_1 - F_g''$$

$$m''a = T_1 - m''g$$

$$T_1 = m''a + m''g$$

$$= (2)(0.56) + 2(9.8)$$

$$T_1 = \boxed{20.7 \text{ N}}$$

4 Kg

$$\Sigma F = F_g' - T_2$$

$$m'a = m'g - T_2$$

$$T_2 = m'g - m'a$$

$$= 4(9.8) - 4(0.56)$$

$$T_2 = \boxed{37.0 \text{ N}}$$