Physics Midterm Review

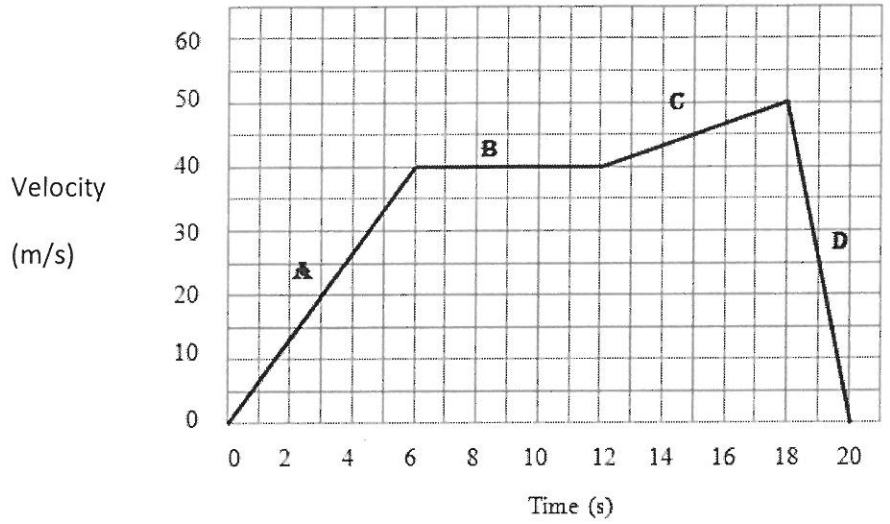
Topics:

- SI units
- Metric prefixes
- Significant figures
- Scientific notation
- Unit conversions
- Dimensional analysis
- Graphing
- Scalar quantities
- Vector quantities
- Displacement, distance
- Velocity, speed
- Acceleration
- X, v, a graphs
- Area under curves of graphs
- Slope of line of graphs
- Average/instantaneous velocity
- Average/instantaneous acceleration
- Forces
- Free-body diagrams
- Centripetal acceleration
- Period
- Radius
- Newton's first law
- Newton's second law
- Newton's third law
- Equal and opposite forces
- Weight vs mass
- Net force
- Static friction
- Kinetic friction
- Coefficient of friction
- Trig functions
- Component vectors
- Resultant vectors
- Directions (E of N, etc)
- Forces on an incline
- Tension
- Projectile
- Trajectory
- Range

Practice Problems

1. Jacques, the speeding Canadian, gets pulled over in the US. His speedometer reads 120 km/hour. How fast is he going in feet/second? 110 ft/s
2. Convert 4.56×10^4 g to kg. 45.6 kg
3. A jet lands on an aircraft carrier at 63 m/s. What is the acceleration if it stops in 2.0 s? $-32\ m/s^2$
4. A car is traveling at 25.0 m/s when the driver sees a dog in the road. It takes the driver 0.90 s to react, then steps on the brakes and slows at 6.5 m/s^2. How far does the car go before it stops? 71 m
5. A ball is thrown vertically upward from the ground with an initial speed of 15.0 m/s. How long does it take the ball to reach its maximum altitude? What is its maximum altitude? Determine the velocity and acceleration of the ball at t = 2.00 s. $t_{y\,max} = 1.53s$ $\Delta y_{max} = 11.5m$ at $t = 2.00s$: $v = -4.60s$ $a = -9.80\ m/s^2$
6. How far does a plane fly in 15 s while its velocity is changing from 145 m/s to 75 m/s at a uniform rate of acceleration? $\Delta x = 2700m$

7. For the graph below:



$a_A = 6.7\ m/s^2$

$a_B = 0\ m/s^2$

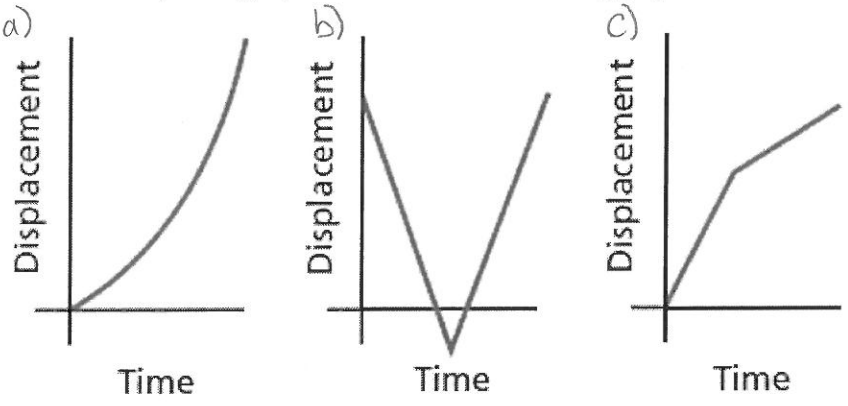
$a_C = 1.7\ m/s^2$

$a_D = -25\ m/s^2$

a. Calculate the acceleration for each section of the graph.

b. Calculate the displacement for the entire time period. $\Delta x = 680m$

8. Sketch a velocity-time graph for each of the following graphs:



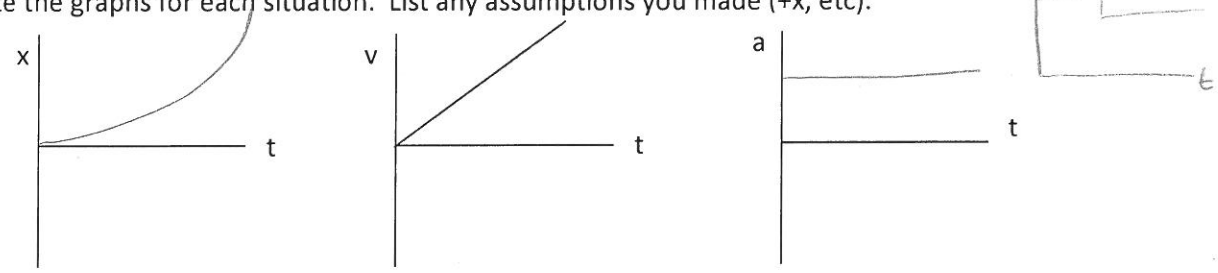
a) v, t

b) v, t

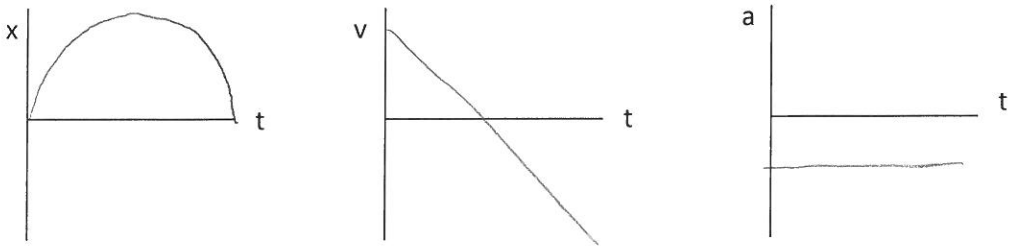
c) v, t

9. Complete the graphs for each situation. List any assumptions you made (+x, etc):

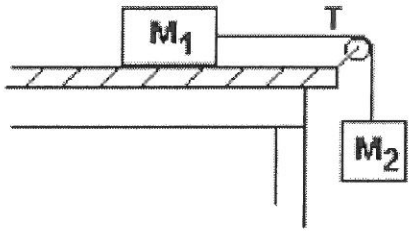
a.



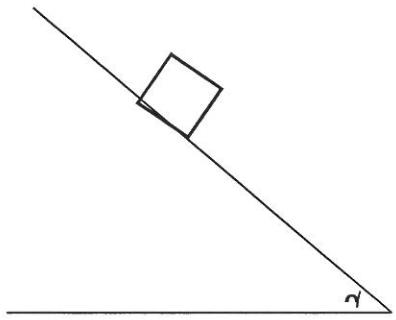
b.

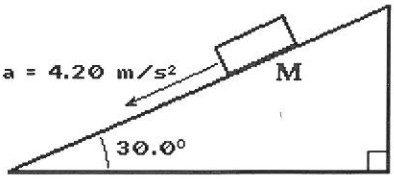


10. On Earth your weight is 550 N. What is your weight on the moon, where g = 0.58 m/s^2? 33 N
11. Marcos is playing tug-of-war with his cat using a stuffed toy. At one instant during the game, Marcos pulls on the toy with a force of 32 N, the cat pulls in the opposite direction with a force of 19.5 N, and the toy experiences an acceleration of 6.25 m/s^2. What is the mass of the toy? 2.0 kg
12. What net force is required to horizontally accelerate a 135 000 kg aircraft from rest to a speed of 35.0 m/s in 11.0 s? 4.30×10^5 N
13. The space shuttle has a mass of 2.0 x106 kg. At lift off, the engines generate an upward thrust force of 1.3x108 N. What is the acceleration of the shuttle when it is launched? 55 m/s^2
14. If the acceleration calculated in the previous problem lasts for 2.4 minutes, what is the shuttle's final velocity if launched from rest? 7900 m/s
15. When empty, a particular helicopter of mass 4250 kg can accelerate straight upward at a maximum acceleration of 1.25 m/s^2. A careless crewman overloads the helicopter so that it is just unable to lift off. What is the mass of the cargo? 540 kg
16. A block with a mass of 25.0 kg is being moved *at constant speed* over a horizontal surface by a force of 80.0 N applied parallel to the surface. Determine the coefficient of kinetic friction .327
17. A golfer takes three strokes to sink his putt on a tricky green. The first putt is 10m due north; the second is 4.0 m southeast; and the third is 3.0 m southwest. What displacement was needed to get the ball in the hole on the first putt? (magnitude and direction) 5.1 m θ = 82° N of E = 8° E of N
18. If M_1 = 7.0 kg and M_2 = 9.0 kg, what is the acceleration of the blocks? The coefficient of kinetic friction between the table and M_1 is 0.35. 4.0 m/s^2



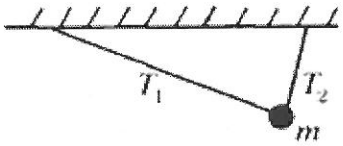
19. A 250.0 kg box is on an incline with an angle of 38.0°. The coefficient of static friction is 0.22 and the coefficient of kinetic friction is 0.15. Determine if the box will slide and the acceleration of the box if it does slide. 4.88 m/s^2





20. In the diagram at the right, a mass slides along an incline which makes an angle of 30.0^0 with respect to the horizontal. A frictional force of 5.00 Newtons acts on the mass as it accelerates at a rate of 4.20 meters/second^2. Determine the mass of the object. 7.14 kg

21. The tension in string 1 is 17.0 N. The angle between string 1 and the horizontal is 34.0°. The tension on string 2 is 45.6 N and its angle is 72.0°. What is the mass of *m*? 5.40 kg



22. Ken, Whitney, and Victor kick a soccer ball. They each kick the ball with the same speed of 10.0 m/s. Victor kicks the ball with an angle of 30°, Whitney kicks at an angle of 45°, and Ken kicks at an angle of 70°. Who kicked the ball the greatest distance? Whitney Who kicked the ball the highest? Ken

23. An arrow is launched with a velocity of 80.0 m/s at an angle of 35° to the horizontal. How far does the arrow travel? 613 m

24. A truck is driven off a cliff that is 67 m high. The truck lands 140 m away from the base of the cliff. What was the truck's velocity when it left the cliff? 38 m/s

25. A 17-g rubber stopper is attached to a 1.93 m string. The stopper is swung in a circle, making one revolution in 7.18 s. Calculate the tension force on the string. .0251 N

26. A runner moving at a speed of 5.5 m/s rounds a bend with a radius of 25 m. What is the acceleration of the runner? 1.2 m/s^2

Physics Midterm Review

① $\frac{120\ km}{hr} \left| \frac{1\ mi}{1.6\ km} \right| \frac{5280\ ft}{1\ mi} \left| \frac{1\ hr}{60\ min} \right| \frac{1\ min}{60\ s} = \boxed{110\ ft/s}$

② $4.56 \times 10^4\ g \left| \frac{1\ kg}{1000\ g} \right. = \boxed{45.6\ kg}$

③ $v_i = 63\ m/s$
$v_f = 0\ m/s$
$t = 2.0\ s$
$a = ?$

$v_f = v_i + at$

$a = \frac{v_f - v_i}{t} = \frac{0\ m/s - 63\ m/s}{2.0\ s}$

$= -31.5 = \boxed{-32\ m/s^2}$

④ $v = 25.0\ m/s$
$t = .90\ s$

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

$\Delta x = v_i t = (25.0\ m/s)(.90\ s) = 22.5\ m = 23\ m$

$v_i = 25.0\ m/s$
$a = -6.5\ m/s^2$
$\Delta x = ?$
$v_f = 0\ m/s$

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

$\Delta x = \frac{v_f^2 - v_i^2}{2a} = \frac{(0\ m/s)^2 - (25.0\ m/s)^2}{2(-6.5\ m/s^2)}$

$= 48\ m$

$\Delta x_{total} = 23\ m + 48\ m = \boxed{71\ m}$

⑤ $v_i = 15.0\ m/s$
$t_{max\,y} = ?$
$\Delta y_{max} = ?$
$a = -9.8\ m/s^2$

$v_f = v_i + at$

$t = \frac{v_f - v_i}{a} = \frac{0\ m/s - 15.0\ m/s}{9.8\ m/s^2}$

$\boxed{t_{max} = 1.53\ s}$

$\Delta y_{max} = v_i t + \frac{1}{2} a t^2$
$= (15.0\ m/s)(1.53\ s)$
$+ \frac{1}{2}(9.8\ m/s^2)(1.53\ s)^2$

$\boxed{\Delta y_{max} = 11.5\ m}$

$t = 2.00\ s$
$v = ?$
$\boxed{a = -9.8\ m/s^2}$

$v_f = v_i + at$
$= 15.0\ m/s + (-9.8\ m/s^2)(2.00\ s)$

$\boxed{V_f = -4.60\ s}$

⑥ $t = 15\,s$
$v_i = 145\,m/s$
$v_f = 75\,m/s$
$\Delta x = ?$

$v_f = v_i + at$

$a = \frac{v_f - v_i}{t} = \frac{75\,m/s - 145\,m/s}{15\,s}$

$a = -4.7\,m/s^2$

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

$= (145\,m/s)(15\,s) + \frac{1}{2}(-4.7\,m/s^2)(15\,s)^2$

$= 2700\,m$

⑦ a) calculate a (slope):

A: slope $= \frac{40\,m/s - 0\,m/s}{6\,s - 0\,s} = \boxed{6.7\,m/s^2}$

B: slope $= \boxed{0\,m/s^2}$

C: slope $= \frac{50\,m/s - 40\,m/s}{18\,s - 12\,s} = \boxed{1.7\,m/s^2}$

D: slope $= \frac{0\,m/s - 50\,m/s}{20\,s - 18\,s} = \boxed{-25\,m/s^2}$

b) calculate Δx (area under curve)

A: $\frac{1}{2}(6\,s)(40\,m/s) = 120\,m$

B: $(6\,s)(40\,m/s) = 240\,m$

C: $\frac{1}{2}(6\,s)(50\,m/s - 40\,m/s) + (6\,s)(40\,m/s)$

$= 270\,m$

D: $\frac{1}{2}(2\,s)(50\,m/s) = 50\,m$

$\Delta x = 120\,m + 240\,m + 270\,m + 50\,m = \boxed{680\,m}$

(10) Earth $F_g = 550\,N$

$g_{moon} = .58\ m/s^2$

$g_{earth} = 9.80\ m/s^2$

Earth: $F_g = m g_{earth}$

$$m = \frac{F_w}{g_{earth}} = \frac{550\,N}{9.80\ m/s^2}$$

$m = 56\ kg$

$F_{g_{moon}} = m g_{moon}$

$= (56\ kg)(.58\ m/s^2)$

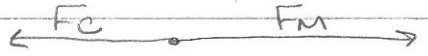
$= \boxed{33\ N}$

(11) $F_M = 32\ N$

$F_c = 19.5\,N$

$a = 6.25\ m/s^2$

$m = ?$



$F_{net} = F_M - F_c$

$ma = F_M - F_c$

$$m = \frac{F_M - F_c}{a} = \frac{32\,N - 19.5\,N}{6.25\ m/s^2}$$

$\boxed{m = 2.0\ kg}$

(12) $F_{net} = ?$

$m = 135\,000\ kg$

$v_i = 0\ m/s$

$v_f = 35.0\ m/s$

$t = 11.0\,s$

$a = ?$

$v_f = v_i + at$

$$a = \frac{v_f - v_i}{t} = \frac{35.0\ m/s - 0\ m/s}{11.0\,s}$$

$a = 3.18\ m/s^2$

$F_{net} = ma$

$= (135\,000\ kg)(3.18\ m/s^2)$

$= \boxed{4.30 \times 10^5\ N}$

(13) $m = 2.0 \times 10^6$ kg
$F_{up} = 1.3 \times 10^8$ N
$a = ?$

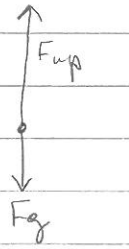
$F_{net} = F_{up} - F_g$
$ma = F_{up} - mg$
$a = \frac{F_{up} - mg}{m} = \frac{1.3 \times 10^8 \text{ N} - (2.0 \times 10^6 \text{ kg})(9.80 \text{ m/s}^2)}{2.0 \times 10^6 \text{ kg}}$
$a = \boxed{55. \text{ m/s}^2}$

(14) $t = 2.4 \text{ min} \left| \frac{60 \text{ s}}{1 \text{ min}} \right. = 144 \text{ s}$
$a = 55. \text{ m/s}^2$
$v_i = 0 \text{ m/s}$
$v_f = ?$

$v_f = v_i + at$
$= 0 \text{ m/s} + (55 \text{ m/s}^2)(144 \text{ s})$
$= \boxed{7920 \text{ m/s}}$

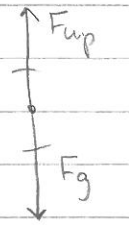
(15) $m_H = 4250$ kg
$a_{net} = 1.25 \text{ m/s}^2$
$m_{cargo} = ?$

Empty:



$F_{net} = F_{up} - F_g$
$F_{up} = F_{net} + F_g$
$= ma + mg$
$= (4250 \text{ kg})(1.25 \text{ m/s}^2 + 9.8 \text{ m/s}^2)$
$= 4.70 \times 10^4 \text{ N}$

overloaded:



$F_{up} = F_g$
$F_{up} = mg$
$m = \frac{F_{up}}{9.80 \text{ m/s}^2}$
$= 4790 \text{ kg}$

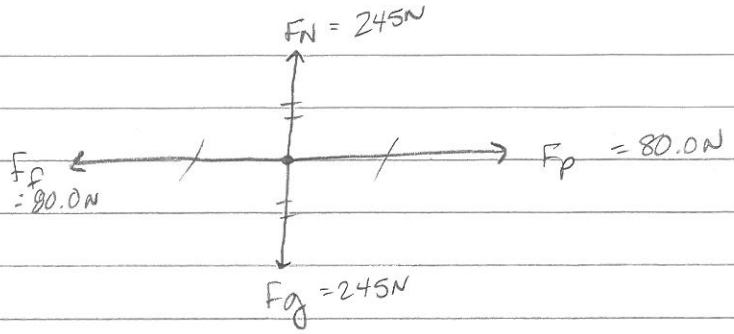
$m_{total} = m_H + m_{cargo}$
$m_{cargo} = m_{tot} - m_H$
$= 4790 \text{ kg} - 4250 \text{ kg}$
$= \boxed{540 \text{ kg}}$

(16) $m = 25.0\ kg$

$a = 0\ m/s^2$

$F_p = 80.0N$

$\mu_K = ?$



$F_N = F_g = mg$

$= (25.0kg)(9.80 m/s^2)$

$F_N = 245N$

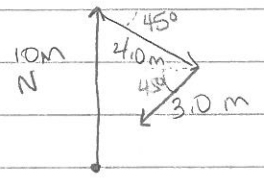
$F_p = F_{f,k}$

$F_p = \mu_K F_N$

$\mu_K = \frac{F_p}{F_N} = \frac{80.0N}{245N}$

$\mu_K = .327$

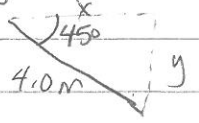
(17)



Stroke 1: $x = 0m$

$y = 10m$

Stroke 2:



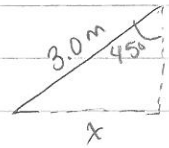
$x = (4.0m)(\cos 45°)$

$= 2.8\ m$

$y = (4.0m)(\sin 45°)$

$= -2.8m$

Stroke 3:



$x = (3.0m)(\sin 45°)$

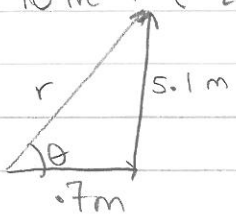
$= -2.1\ m$

$y = (3.0m)(\cos 45°)$

$= -2.1m$

$\Sigma x = 0m + 2.8m + -2.1\ m = .7m$

$\Sigma y = 10m + (-2.8m) + (-2.1\ m) = 5.1\ m$



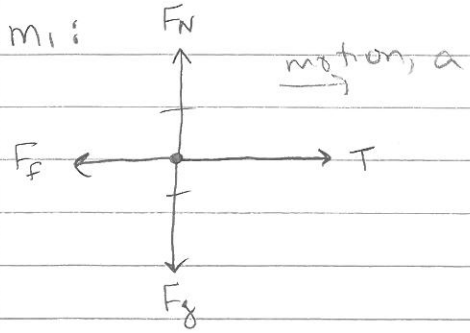
$r = \sqrt{(5.1\ m)^2 + (.7m)^2} = 5.148$

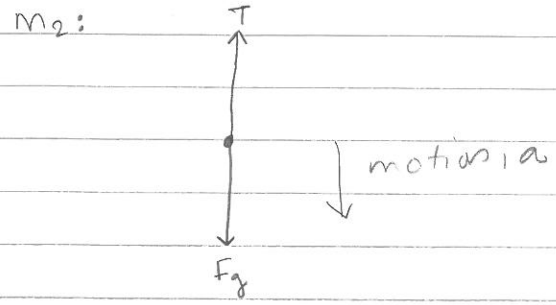
$= \boxed{5.1\ m}$

θ: $\tan\theta = \frac{5.1\ m}{.7m}$

$\theta = \boxed{82°\ N\ of\ E}$

(18)





$m_1 = 7.0\ kg$

$\mu_K = .35$

$m_2 = 9.0\ kg$

$F_{net_1} = T - F_f$

$T = F_{net_1} + F_f$

$T = m_1 a + \mu_K F_N$

$T = m_1 a + \mu_K (m_1 g)$

$F_{net_2} = F_g - T$

$T = F_g - F_{net_2}$

$T = m_2 g - m_2 a$

$m_1 a + \mu_K m_1 g = m_2 g - m_2 a$

$m_1 a + m_2 a = m_2 g - \mu_K m_1 g$

$a(m_1 + m_2) = g(m_2 - \mu_K m_1)$

$$a = \frac{g(m_2 - \mu_K m_1)}{(m_1 + m_2)}$$

$$= \frac{(9.8\ m/s^2)(9.0\ kg - (.35)(7.0\ kg))}{(7.0\ kg + 9.0\ kg)}$$

$$\boxed{a = 4.0\ m/s^2}$$

In case you're interested in T:

using M_2

$T = m_2 g - m_2 a$

$= m_2 (g - a)$

$= (9.0\ kg)(9.8\ m/s^2 - 4.0\ m/s^2$

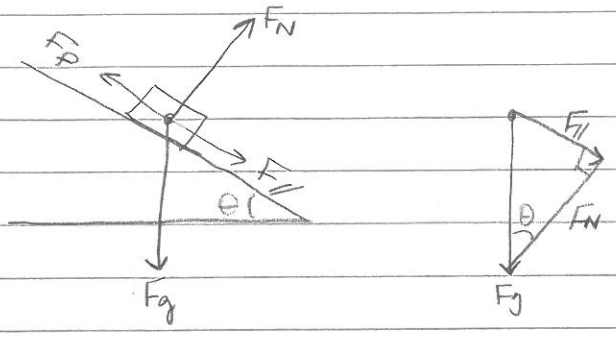
$T = 52\ N$

(19) $m = 250.0\ kg$

$\theta = 38.0°$

$\mu_s = .22$

$\mu_k = .15$



$F_g = mg = (250.0kg)(9.8\ m/s^2)$
$= 2450\ N$

$F_N = mg\cos\theta$
$= (2450\ N)(\cos 38.0°)$
$= 1930\ N$

$F_{//} = mg\sin\theta$
$= (2450\ N)(\sin 38.0°)$
$= 1510\ N$

$F_{f,s} = \mu_s F_N$
$= (.22)(1930N)$
$= 425N$ – yes, the box will slide $F_{//} > F_{f,s}$

$F_{f,k} = \mu_k F_N$
$= (.15)(1930\ N)$
$= 290.N$

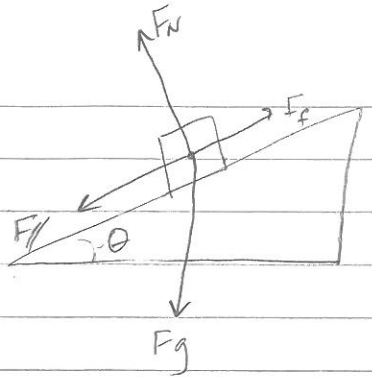
$F_{net} = F_{//} - F_{f,k}$

$ma = F_{//} - f_{f,k}$

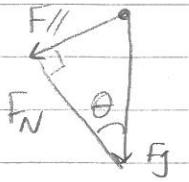
$a = \dfrac{F_{//} - F_{f,k}}{m} = \dfrac{1510\ N - 290.\ N}{250.0\ kg}$

$\boxed{a = 4.88\ m/s^2}$

(20)



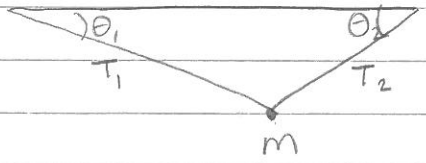
$a = 4.20\ m/s^2$
$F_f = 5.00\ N$
$m = ?$
$\theta = 30.0°$



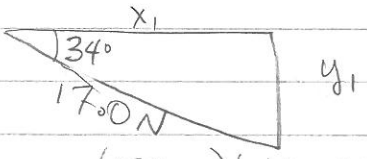
$F_g = mg$
$F_N = mg\cos\theta$
$F_{//} = mg\sin\theta$

$F_{Net} = F_{//} - F_f$
$ma = mg\sin\theta - F_f$
$ma - mg\sin\theta = -F_f$
$m(a - g\sin\theta) = -F_f$
$m = \dfrac{-F_f}{a - g\sin\theta}$
$= \dfrac{-(5.00\ N)}{4.20\ m/s^2 - (9.80\ m/s^2)(\sin 30.0°)}$
$= \boxed{7.14\ kg}$

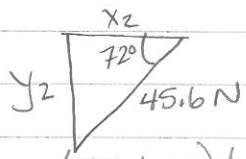
(21)



$T_1 = 17.0N$
$\theta_1 = 34.0°$
$T_2 = 45.6N$
$\theta_2 = 72.0N$
$m = ?$



$y_1 = (17.0\ N)(\sin 34°)$
$= 9.51\ N$

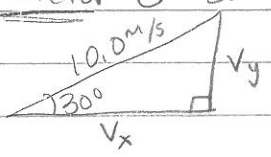


$y_2 = (45.6\ N)(\sin 72.0°)$
$= 43.4N$

$T_y = F_g$
$T_{y1} + T_{y2} = mg$
$m = \dfrac{T_{y1} + T_{y2}}{g}$
$= \dfrac{9.51\ N + 43.4N}{9.80\ m/s^2}$
$m = \boxed{5.40\ kg}$

(22) $v_i = 10.0\ m/s$

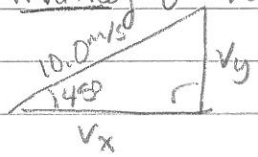
Victor $\theta = 30°$



$v_x = (10.0\ m/s)(\cos 30°)$
$= 8.66\ m/s$

$v_y = (10.0\ m/s)(\sin 30°)$
$= 5.00\ m/s$

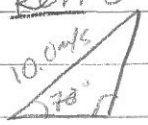
Whitney $\theta = 45°$



$v_x = (10.0\ m/s)(\cos 45)$
$= 7.07\ m/s$

$v_y = (10.0\ m/s)(\sin 45)$
$= 7.07\ m/s$

Ken $\theta = 70°$



$v_x = (10.0\ m/s)(\cos 70°)$
$= 3.42\ m/s$

$v_y = (10.0\ m/s)(\sin 70°)$
$= 9.40\ m/s$

t to max Δy:

$v_{f,y} = v_{i,y} + a_y t$

$t = \frac{v_{f,y} - v_{i,y}}{a_y}$ $\quad v_{f,y} = 0\ m/s$ at max Δy

$a_y = -9.8\ m/s^2$

$t_v = \frac{-v_{i,y}}{a_y} = \frac{-5.00\ m/s}{-9.8\ m/s^2}$

$t_v = .510\ s$

$t_w = \frac{-v_{i,y}}{a_y} = \frac{-7.07\ m/s}{-9.8\ m/s^2}$

$t_w = .721\ s$

$t_k = \frac{-v_{i,y}}{a_y} = \frac{-9.40\ m/s}{-9.8\ m/s^2}$

$t_k = .959\ s$

Δy_{max}:

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

$\Delta y_v = (5.00\ m/s)(.510\ s) + \frac{1}{2}(-9.80\ m/s^2)(.510\ s)^2$

$\Delta y_v = 1.28\ m$

$\Delta y_w = (7.07\ m/s)(.721\ s) + \frac{1}{2}(-9.80\ m/s^2)(.721\ s)^2$

$\Delta y_w = 2.55\ m$

$\Delta y_k = (9.40\ m/s)(.959\ s) + \frac{1}{2}(-9.80\ m/s^2)(.959\ s)^2$

$\Delta y_k = 4.51\ m$

Δx: $\Delta x = v_{ix} t$

$\Delta x_v = (8.66\ m/s)(.510\ s \cdot 2)$

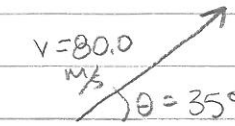
$\Delta x_v = 8.83\ m$

$\Delta x_w = (7.07\ m/s)(.721\ s \cdot 2)$

$\Delta x_w = 10.2\ m$

$\Delta x_k = (3.42\ m/s)(.959\ s \cdot 2)$

$\Delta x_k = 6.56\ m$

(23) 

$v = 80.0\ m/s$

$\theta = 35°$

$\Delta x = ?$

$a_y = -9.80\ m/s^2$

$v_x = v\cos\theta$
$= (80.0\ m/s)(\cos 35°)$
$= 65.5\ m/s$

$v_y = v\sin\theta$
$= (80.0\ m/s)(\sin 35°)$
$= 45.9\ m/s$

time to peak:

$v_{f,y} = v_{iy} + a_y t$

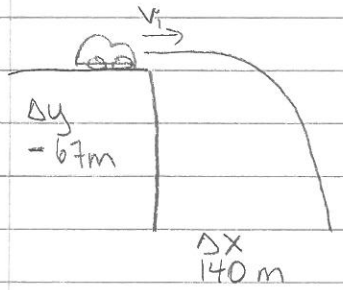
$t = \frac{v_{fy} - v_{iy}}{a} = \frac{0\ m/s - 45.9\ m/s}{-9.80\ m/s^2}$

$t_{peak} = 4.68\ s$

$t_{flight} = 2 \cdot t_{peak} = 2(4.68\ s) = 9.36\ s$

$\Delta x = v_x t = (65.5\ m/s)(9.36\ s)$

$\boxed{\Delta x = 613\ m}$

(24) 

$v_{yi} = 0\ m/s$

$v_i = v_{xi}$

$\Delta y = v_{yi}t + \frac{1}{2}a_y t^2$

$\Delta y = \frac{1}{2}a_y t^2$

$t = \sqrt{\frac{2\Delta y}{a_y}}$

$= \sqrt{\frac{2(-67\ m)}{-9.80\ m/s^2}}$

$= 3.7\ s$

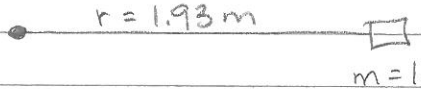
$\Delta x = v_x t$

$v_x = \frac{\Delta x}{t}$

$= \frac{140\ m}{3.7\ s}$

$\boxed{v_x = 38\ m/s}$

(25)



$T = 7.18\,s$

$m = 17\,g$
$r = 1.93\,m$
$T = 7.18\,s$
$F_T = ?$

$$\frac{17\,g}{1000\,g}\left|\frac{1\,kg}{}\right. = .017\,kg$$

$$a_c = \frac{4\pi^2 r}{T^2} = \frac{4\pi^2(1.93\,m)}{(7.18\,s)^2}$$

$$a_c = 1.48\ m/s^2$$

Tension force:

$$F_T = ma_c = (.017\ kg)(1.48\ m/s^2)$$

$$\boxed{F_T = .0251\ N}$$

(26) $v = 5.5\ m/s$
$r = 25\,m$
$a_c = ?$

$$a_c = \frac{v^2}{r} = \frac{(5.5\ m/s)^2}{25\,m}$$

$$\boxed{a_c = 1.2\ m/s^2}$$