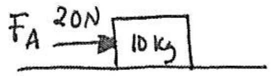
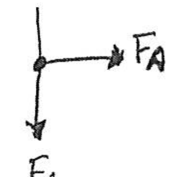
Problem Set #6 Solutions

1\. a. 

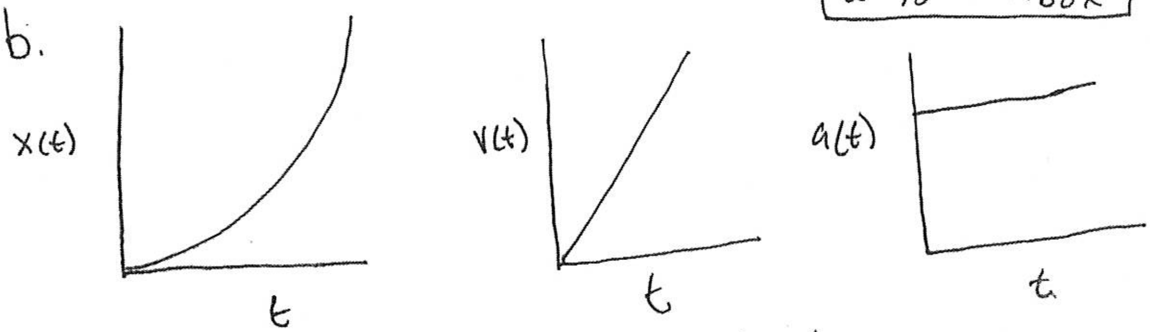

$F_A$ is the only unbalanced force so it will accelerate the box.

$F_A = 20N$
box mass = 10 kg

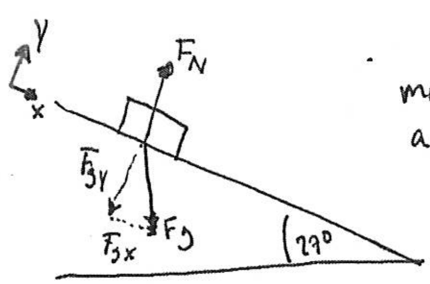
$F = ma \rightarrow F_A = m_{Box}\, a_{Box}$

$\frac{20N}{10\,kg} = \frac{10\,kg \cdot a_{Box}}{10\,kg}$

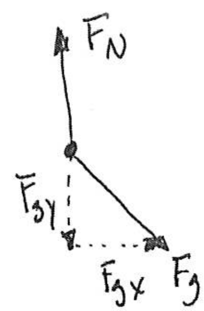
$\boxed{2\,m/s^2 = a_{Box}}$

b. 


The Box is speeding up in the positive direction.

a. 


mass of box = 2 kg
$a_g = g = 9.8\,m/s^2$




b. $F_g = -mg = -2 \cdot 9.8 = -19.6\,kg\,m/s^2$ or $= 19.6\,N$

$F_{gx}$ is the force accelerating the Box down the plane

$\frac{F_{gx}}{F_g} = \sin(27^\circ) \rightarrow F_{gx} = F_g \sin(27^\circ) = +19.6 \sin(27) = 8.9\,N$

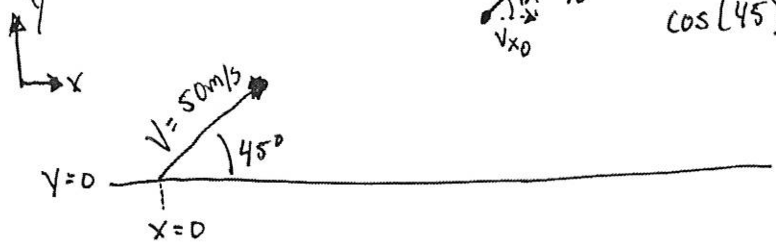
$F_{gx} = m_B \cdot a_B = 8.9N = 2\,kg \cdot a_B$ $\qquad \boxed{a_B = 4.45\,m/s^2}$

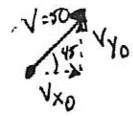
acceleration of box

c\. Force of Plane on Box is equal to the Normal force ($F_N$) which is equal to the y-component of the gravitational Force ($F_{gy}$)

$= -19.6\cos(27^\circ) = \boxed{17.5\,N}$

3.




$\sin(45) = \frac{V_{y0}}{V}$ , $V_{y0} = 50 \sin(45) = 35.35\ m/s$

$\cos(45) = \frac{V_{x0}}{V} \rightarrow V_{x0} = V\cos(45) = 50\cos(45) = 35.35\ m$

| Y | X |
|---|---|
| $Y_0 = 0$ | $X_0 = 0$ |
| $V_{y0} = 35.35\ m/s$ | $V_{x0} = 35.35\ m/s$ |
| $a_y = -9.8\ m/s$ | $a_x = 0$ |
| $V_{ymax} = 0$ | |

a. $Y_{max}$ occurs when $V_{y_0} = 0$

$V_{ymax} = 0 = V_{y0} + a_y t_{max}$

$0 = V_{y0} + a_y t_{max}$

$0 = 35.35\ m/s + (-9.8\ m/s^2) t_{max}$

$\frac{-35.35}{-9.8} = \frac{-9.8\ t_{max}}{-9.8}$

$3.607s = t_{max}$ plug into displacement $\rightarrow$ $y(t) = Y_0 + V_{oy} t + \frac{1}{2} a_y t$

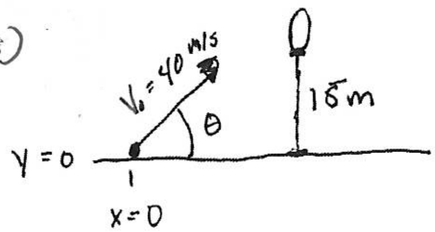
$Y_{max} = Y(t = 3.607) = 0 + 35.35 \cdot 3.607 - \frac{1}{2} 9.8 (3.607$

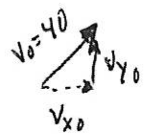
$\boxed{Y_{max} = 63.7m}$

b. Hits ground at two times $t_{max}$

$2 \cdot 3.607 = \boxed{7.214s}$

4. (Honors)




$\frac{V_{y0}}{V_0} = \sin\theta \rightarrow V_{y0} = V_0 \sin\theta = 40 \sin\theta$

$\frac{V_{x0}}{V_0} = \cos\theta \rightarrow V_{x0} = V_0 \cos\theta = 40\cos\theta$

a. if $y_{max}$ or $y_{peak} = 15m$ then using $y(t) = Y_0 + V_{y0} t + \frac{1}{2} a t^2$

$Y_{max} = 15 = 0 + 40 \sin\theta \cdot t_{max} - \frac{1}{2}(9.8) t_{max}^2$

need to $t_{max}$ to solve for $\theta$, we know $V_{ymax} = 0\ m/s$

$V(t) = V_0 + at$ @ $t_{max}$ $\rightarrow$ $0 = 40\sin\theta - 9.8\ t_{max}$

$t_{max} = \frac{40\sin\theta}{9.8}$ plug this in for $t_{max}$

$$Y_{max} = 15 = 40\sin\theta \cdot \frac{40\sin\theta}{9.8} - \frac{1}{2}(9.8) \cdot \left(\frac{40\sin\theta}{9.8}\right)^2$$

$$15 = \frac{1600\sin^2\theta}{9.8} - \frac{1}{2} \cdot \frac{1600\sin^2\theta}{9.8} = \left(\frac{1}{9.8} - \frac{1}{19.6}\right) 1600\sin^2\theta = 0.051 \cdot 1600\sin^2\theta$$

$\boxed{\theta = \sin^{-1}(0.429) = 25.4^\circ}$

b. $t_{max} = \frac{40\sin\theta}{9.8} = \frac{40\sin(25.4)}{9.8}$ $\boxed{1.75s}$

c. $t_{land} = 2 \cdot t_{max} = 3.5s$

$X(t=3.5) = 0 + 40\cos(25.4)\cdot 3.5 + 0 = \boxed{126.5\,m}$

d. find $V_{y\,land}$ $\quad (V_{x\,land} = V_{x0})$

only looking at 2nd half of the motion. From the peak to the ground

$V_{y\,land} = V_{fy} = 0 - 9.8(1.75)$

$= 17.16\,m/s$ ← will find that this is equal to $V_{y0}$ because it is symetrical

$V_{0x} = V_{x\,land} = 40\cos(25.4) = 36.13$

$V_{tot}^2 = V_{y\,land}^2 + V_{x\,land}^2 = (17.16)^2 + (36.13)^2 = 1,600$

$\sqrt{V_{tot}^2} = \sqrt{1600}$

$V_{tot} = 40$ ← Because motion is symetric it should land with the same velocity it was launched with.