12

$y_f = \frac{1}{2}at^2 + V_{iy}t + y_i$ (−y_i / −y_i)

$y_f = -4.9t^2 + 10t - 3$

1.

V_i at 30°

20 m/s

$V_{iy} = 20\sin 30 = 10$ m/s

$V_{ix} = 20\cos 30 = 17.3$ m/s

$t = 1.7$ seconds

$x_f = 17.3(1.7) = 29.41$ m

2.

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

$\frac{-10 \pm \sqrt{100-9(-4.9)(-3)}}{-9.8}$

$\frac{-10 \pm \sqrt{100-58.8}}{-9.8}$

$\sqrt{41.2} \to 6.42$

$\frac{-10 \pm 6.42}{-9.8}$

$\frac{-3.58}{-9.8}, \frac{-16.42}{-9.8}$

0.37, 1.68

We chose the time where the ball was travelling downward as opposed to the smaller t value.

$y_f = -4.9(2.625)^2 + 12.86(2.625) + 0 = 0.0066$

0.64 ← $\frac{-9.8t}{15.32} + \frac{25.72}{15.32} = 0$ → 1.68

$-0.64t + 1.68 = 0$

$t = 2.625$ seconds

3.

$x_f = 15.32(2.625) = 40.215$

$\tan(26.57) = \frac{1}{2}$

$\Delta y = \frac{1}{2}\Delta x$

$V_{ix}t =$

20.1075

20 m/s

12.86

40°

15.32

26.57°

40.215

$z = V_i = 20$ m/s

$y_f = z\sin 26.57° = 8.95$

$x_f = z\cos 26.57° = 17.89$

44.96 m

Δy

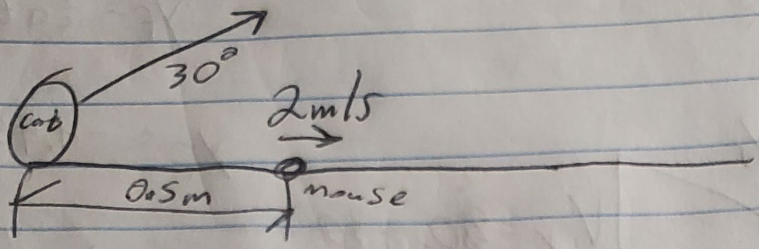
$y_f - y_i = \frac{1}{2}at^2 + V_{iy}t$

$2(-4.9t^2 + 12.86t) = 15.32t$ / 1532t

$\frac{2(-4.9t^2 + 12.86t)}{15.32} \quad \frac{-9.8t + 25.72}{15.32} = 0$

PHYS 407

4.



$x_f = (V_i \cos 30)(-4.9t^2 + V_i/2\, t)$

$\Delta_y = V_{icat} \sin 30 t - 4.9t^2$

$t(V_{icat} \sin 30 - 4.9t)$

$\Delta_x = V_{icat} \cos 30^\circ t$

$t = \frac{V_{icat}}{9.8}$

$\Delta_{mouse} = 0.5 + 2t \rightarrow$

$\rightarrow 0.5 + \frac{2V_{icat}}{9.8}$

$\Delta_x = \frac{0.866 V_{icat}^2}{9.8}$

$0.089 V_{icat}^2 = 0.5 + \frac{V_{icat}}{4.9}$

$\Delta_x = 0.884 V_{icat}^2$

$0.5 + \frac{2V_{icat}}{9.8} = 0.884 V_{icat}^2$

$0.0884 V_{icat}^2 - \frac{1}{4.9} V_{icat} - 0.5 = 0$

$\boxed{V_{icat} = 3.797 \text{ m/s}}$

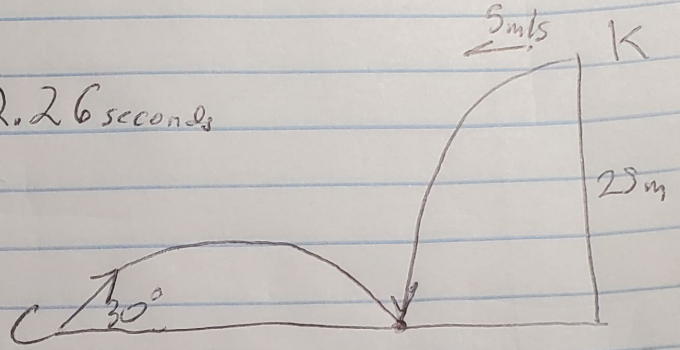
PHYS 407

5.

Kenny:

$0 = -4.9t^2 + 0t + 25$, $t_K = 2.26$ seconds

$5(2.26) = 11.3$ m



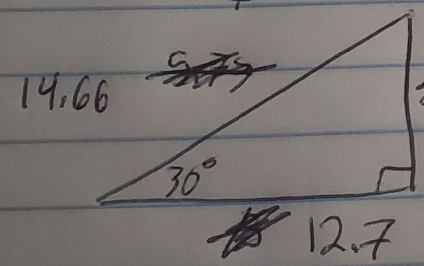
Cartman:

$40 - 11.3$

$X_f = 11.3 = V_i \cos 30° (2.26)$, $V_i = 11.3 / 2.26 / \cos 30°$, $V_i =$

28.7 28.7

~~9.77 m/s~~ 14.66 m/s



$0 = -4.9t^2 + 7.33t + 0$

$t_C = 1.5$ seconds

$t_K - t_C = t_P$ $2.26 - 1.5 = 0.76$ seconds

Cartman waits 0.76 seconds before releasing the slingshot