Name: KEY

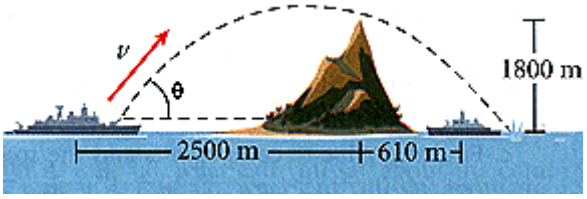
Date:

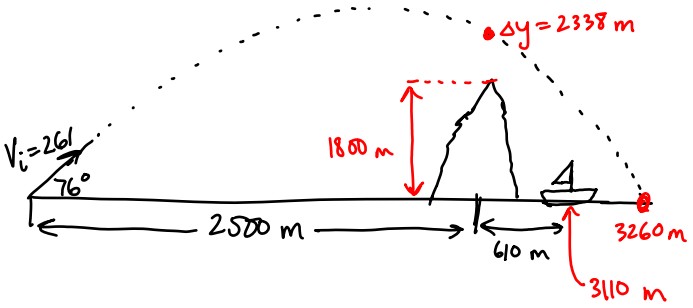
Section C D F

The Masters School
Mr. Alex Rawson
Physics

Projectile Motion III

1. A ship maneuvers to within 2500 m of an island's 1800 m high mountain peak and fires a projectile cannonball at an enemy ship 610 m on the other side of the peak, as illustrated in the figure below. If the ship shoots the projectile with an initial velocity of 261 m/s at an angle of 76° above the horizontal,
   a. How close to the enemy ship does the projectile land?





Enemy ship is 3110 m away

$\Delta x = ?$ $\Delta y = 0$
$V_{ix} = 63.14$ $V_{iy} = 253.25$
$V_{fx} = 63.14$ $V_{fy} =$
$a = 0$ $a = 9.81$
$\Delta t =$ $\Delta t = ?$

$\theta = 76°$
$V_i = 261$

1) Find total time

$\Delta y = V_i \sin\theta \, \Delta t - \frac{1}{2} g \Delta t^2$

$0 = 253.25 \, \Delta t - 4.905 \, \Delta t^2$

$4.905 \, \Delta t = 253.25$

$\Delta t = 51.63$ s

2) Find distance

$\Delta x = V_x \, \Delta t$

$\Delta x = (63.14)(51.63)$

$\Delta x = 3260$ m

$\Delta x_{ship} = 3110$

$\Delta x_{cannonball} = 3260$

150 m too far

   b. By how much does the cannonball clear the peak?

2. at $\Delta x = 2500$, what is Δy?

$\Delta x = 2500$ $\Delta y = ?$
$V_{ix} = 63.14$ $V_{iy} = 253.25$
$V_{fx} = 63.14$ $V_{fy} =$
$a =$ $a =$
$\Delta t =$ $\Delta t = ?$

1) Find time at $\Delta x = 2500$ m

$\Delta x = V_x \Delta t$

$\Delta t = 39.59$

2) $\Delta y = V_i \sin\theta \, \Delta t - \frac{1}{2} g \Delta t^2$

$\Delta y = 253.25 \, \Delta t - 4.905 \, \Delta t^2$

$\Delta y = 2338$ m

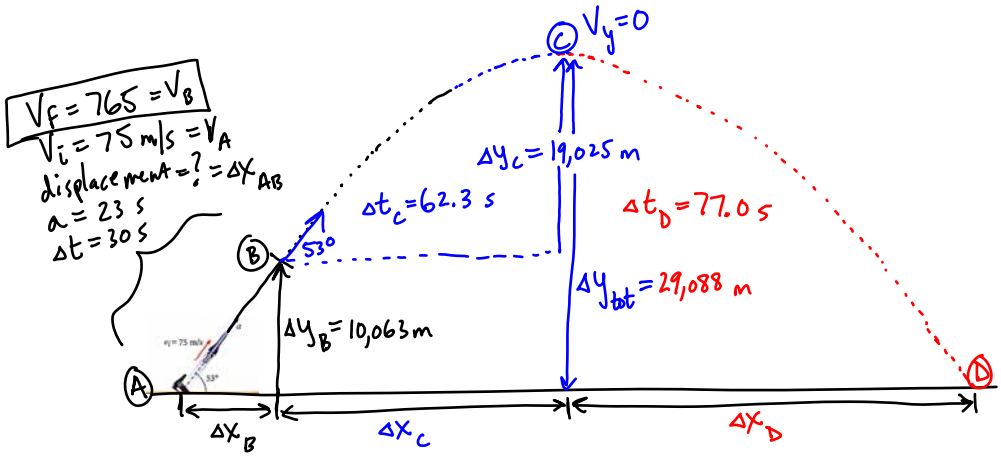
3) $\Delta y_{mountain} = 1800$ m

$\Delta y_{cannonball} = 2338$ m

clears by 538 m

A toy rocket is launched at an angle of 53° above the horizontal with an initial speed of 75 m/s, as shown in the figure below. It accelerates by its own fuel for 30 seconds, and accelerates at 23 m/s^2 in a straight line. At this time its fuel runs out and the rocket proceeds to move as a free body in angled projectile motion.

a. What is the rocket's maximum altitude? (*Hint: Look back to the rocket problems we completed earlier. Your answer should be between 25,000 and 30,000 meters*)



1) Find V_f

$V_f = V_i + a\Delta t$

$V_f = 75 + (23)(30)$

$V_f = 765$ m/s $= V_B$

2) Find Δx_{AB}

$\Delta x = \frac{1}{2}(V_i + V_f)\Delta t$

$\Delta x_{AB} = 12{,}600$ m

3) Find Δy_B

$\Delta y_B = \Delta x_{AB} \sin 53$

$\Delta y_B = 10{,}063$ m

4) Find Δy_C

$V_{fy}^2 = V_i^2 \sin\theta^2 - 2g\Delta y$

$2g\Delta y_C = 765^2 (\sin 53)^2$

$\Delta y_C = 19{,}025$ m

$\Delta y_{tot} = \Delta y_B + \Delta y_C$

$\Delta y_{tot} = 10{,}063 + 19{,}025$

$\Delta y_{tot} = 29{,}088$ m

b. What is the rocket's total time of flight? (*Your answer should be between 2 and 3 minutes*)

Find Δt_C

$V_{fy} = V_i \sin\theta - g\Delta t$

$g\Delta t = V_i \sin\theta$

$\Delta t_C = \frac{765 \sin 53}{9.81} = 62.3$ s

to find Δt_D, first get V_{yf}

$V_{fy}^2 = V_i^2 \sin\theta^2 - 2g\Delta y$

$V_{fy}^2 = -2(9.81)(-29{,}088)$

$V_{fy} = -755.45$ m/s

Find Δt_D

$V_{yf} = V_i \sin\theta - g\Delta t$

$\Delta t_D = \frac{-755.45}{-9.81} = 77.0$ s

$\Delta t_{tot} = \Delta t_B + \Delta t_C + \Delta t_D$

$\Delta t_{tot} = 30 + 62.3 + 77.0 = 169.3$ s

c. What is the rocket's horizontal range? (*Your answer should be between 70,000 and 80,000 meters*)

Find Δx_B

$\Delta x_B = \Delta x_{AB} \cos 53°$

$\Delta x_B = 7583$ m

Find Δx_C

$\Delta x_C = V_x \Delta t_C$

$\Delta x_C = V_i \cos\theta \Delta t_C$

$\Delta x_C = 765 \cos 53 (62.3)$

$\Delta x_C = 28{,}682$ m

Find Δx_D

$\Delta x_D = V_x \Delta t_D$

$\Delta x_D = V_i \cos\theta \Delta t_D$

$\Delta x_D = 765 \cos 53 (77.0)$

$\Delta x_D = 35{,}450$ m

$\Delta x_{tot} = \Delta x_B + \Delta x_C + \Delta x_D$

$\Delta x_{tot} = 7583 + 28{,}682 + 35{,}450 = 71{,}715$ m