miniquiz 6 (2200955)

Due: Mon Feb 6 2012 01:01 PM EST

Question 1 2 3

Comment: when $\vec{F}_{net} = -mg\hat{j}$ then $\vec{a} = -g\hat{j}$ and we have for $\xrightarrow{V_0}$ θ

$$X(t) = X_0 + (V_0 \cos\theta)t$$

$$y(t) = y_0 + (V_0 \sin\theta)t - \frac{1}{2}gt^2$$

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1. Question Details

Tipler6 4.P.006. [1694628]

A truck moves away from you at constant velocity (as observed by you while standing in the middle of the road). Which of the following is true?

- ○ No forces act on the truck.
- ○ A constant net force acts on the truck in the direction of its velocity.
- ○ ▨ The net force acting on the truck is zero.
- ○ The net force acting on the truck is its weight.

$\vec{V}(t) = \vec{V}_0 \leftarrow$ constant

$\Rightarrow \frac{d\vec{V}}{dt} = \vec{a} = \vec{0}$

thus $\vec{F}_{net} = m\vec{a} = \boxed{0.}$

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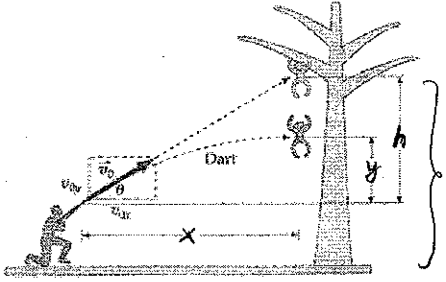
2. Question Details

Tipler6 3.P.075. [956640]

In the figure below, what is the minimum initial speed of the dart if it is to hit the monkey before the monkey hits the ground, which is 10.2 m below the initial position of the monkey, if *x* is 40 m and *h* = 9 m? (Ignore any effects due to air resistance.)

☐ 28.4 m/s



$\underbrace{10.2m}_{y_0}$

Intuitive Leap: the minimum velocity is the one for which the Monkey gets hit just a small bit above ground.

Time for monkey drop: find from $0 = y_0 - \frac{1}{2}gt^2$ (☆) thus $t = \sqrt{\frac{2y_0}{g}}$. On the other hand, the position of the dart is given by $X = (V_0 \cos\theta)t$. Hence, $t = \frac{X}{V_0 \cos\theta} = \sqrt{\frac{2y_0}{g}}$. We need another eq^n since V_0 & θ are unknown. Consider the eq^n for the vert. position of the dart: (☆)

$$0 = y_0 - h + (V_0 \sin\theta)t - \frac{1}{2}gt^2 \Rightarrow h = (V_0 \sin\theta)t$$

Hence, $t = \frac{h}{V_0 \sin\theta} = \frac{X}{V_0 \cos\theta} \Rightarrow \tan\theta = \frac{h}{X}$ $\therefore \theta = \tan^{-1}(\frac{h}{X})$ $\boxed{\theta = 12.68°}$

$$V_0 = \left(\frac{h}{\sin\theta}\right)\left(\frac{1}{t}\right) = h\sqrt{\frac{g}{2y_0}}\left[\frac{1}{\sin(12.68°)}\right] = (9m)\sqrt{\frac{9.8 m/s^2}{2(10.2m)}}\left(\frac{1}{\sin(12.68°)}\right)$$

$$= \boxed{28.42 m/s}$$

The speed of an arrow fired from a compound bow is about 42.1 m/s.

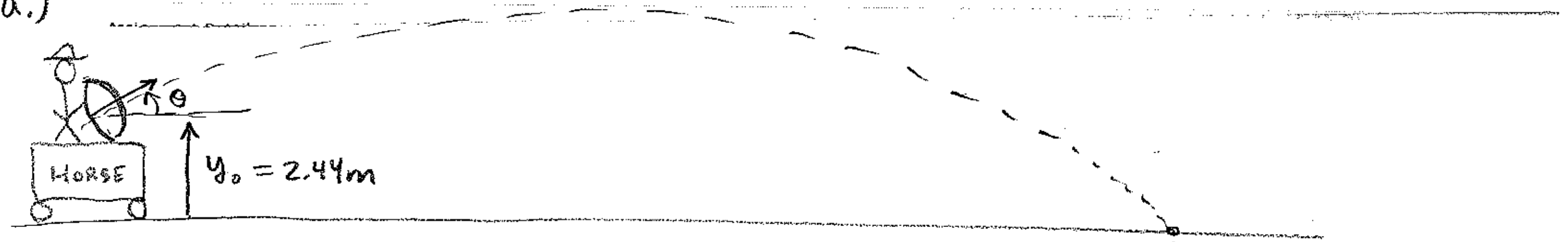
(a) A Tartar archer sits astride his horse and launches an arrow into the air, elevating the bow at an angle of 10.5° above the horizontal. If the arrow is 2.44 m above the ground at launch, what is the arrow's horizontal range? Assume that the ground is level, and ignore any effects due to air resistance.

76 m

(b) Now assume that his horse is at full gallop, moving in the same direction that the archer will fire the arrow. Also assume that the archer elevates the bow at the same elevation angle as in Part (a) and fires. If the horse's speed is 11.3 m/s, what is the arrow's horizontal range now?

96.7 m

(a.)



$$x(t) = (V_0 \cos\theta)t$$

$$y(t) = y_0 + (V_0 \sin\theta)t - \tfrac{1}{2}gt^2 \overset{\swarrow}{=} 0$$ condition for hitting ground

$$2.44 + (42.1)\sin(10.5°)t - 4.9t^2 = 0$$

$$\Rightarrow -4.9t^2 + 7.672t + 2.44 = 0 \quad \begin{cases} t = 1.837s \leftarrow \text{time of interest.} \\ t = -0.2711s \end{cases}$$

$$x(1.837s) = \left(42.1\,\tfrac{m}{s}\right)\cos(10.5°)(1.837s) = \boxed{76.04\,m}$$

(b.) The initial velocity of arrow relative to ground's fixed frame of reference is

$$\vec{V}_1 = \vec{V}_0 + \left(11.3\,\tfrac{m}{s}\right)\hat{i} \quad \begin{cases} V_{1x} = V_0 \cos\theta + 11.3\,\tfrac{m}{s} \\ V_{1y} = V_0 \sin\theta \end{cases}$$

Thus,

$$x(t) = V_{1x}t$$

$$y(t) = y_0 + (V_0 \sin\theta)t - \tfrac{1}{2}gt^2 \overset{\swarrow}{=} 0$$ same as part (a.) $\rightarrow$ $\underline{t = 1.837s}$

$$x(t) = \left[\left(42.1\,\tfrac{m}{s}\right)\cos(10.5°) + 11.3\,\tfrac{m}{s}\right](1.837s)$$

$$= \left(52.695\,\tfrac{m}{s}\right)(1.837s)$$

$$= \boxed{96.8m}$$