Quiz 2
Phys 220 - Spring 2014

Names: Solution

Be sure to show work or support your answer for every problem.

1. The text suggests betting your friend they can't catch a \$20 bill. (Warning: air resistance might actually cause you to lose that bet!) On Mars there's no atmosphere so a \$20 bill wouldn't have the air resistance problem it would here on Earth. So "Would it be a safe bet on Mars?"
   a. Determine the reaction time on Earth for catching a ruler which is 6 inches in length. Use -9.8 m/s^2 for the acceleration due to Earth's gravity.
   b. Use the reaction time you found in a. to calculate how far something will drop during that time on Mars. The gravity on Mars is 38% of that on Earth.

6 inch $\left(\frac{2.54\,cm}{in}\right)$ = 15.24 cm

a.) $y_i = 0\,m$
$y_f = -0.1524\,m$
$v_i = 0\,m/s$
$v_f = ?$
$a = -9.8\,m/s^2$
$\Delta t = ?$

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

$-0.152\,m = 0\,m + 0\,m/s\,\Delta t + \frac{1}{2}(-9.8\,m/s^2)\Delta t^2$

$0.0311\,s^2 = \Delta t^2$

$0.18\,s = \Delta t$

$-9.8\,m/s^2\,(.38) = -3.724\,m/s^2$

b.) $y_i = 0\,m$
$y_f = ?$
$v_i = 0\,m/s$
$v_f = ?$
$a = -3.72\,m/s^2$
$\Delta t = 0.176\,s$

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

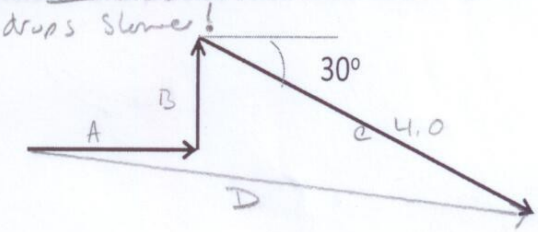
$0\,m = y_f + 0\,m/s(\Delta t) + \frac{1}{2}(-3.72\,m/s^2)(0.176\,s)^2$

$0\,m = y_f + 0.058\,m$

$y_f = -0.058\,m$

So it drops only 5.8 cm on Mars during a normal reaction time.
So No it's a much worse bet, the bill drops slower!

2. A person walks 2.0 blocks East, 1.0 block North and then 4.0 blocks 30° South of East. What is the magnitude of their total displacement?



$\vec{A}$ = 2.0 East, 0 North
$\vec{B}$ = 0 East, 1.0 North
$\vec{C}$ = 3.46 East, -2.0 North

$C_x = 4.0 \cos 30° = 3.46$ blocks
$C_y = 4.0 \sin 30° = -2.0$ blocks

$\vec{D}$ is the total displacement vector

Add $A_{East} + B_{East} + C_{East} = D_{EAST}$
2.0 + 0 + 3.46 = 5.46 blocks

$A_{North} + B_{North} + C_{North} = D_{North}$
0 + 1.0 + -2.0 = -1.0 blocks

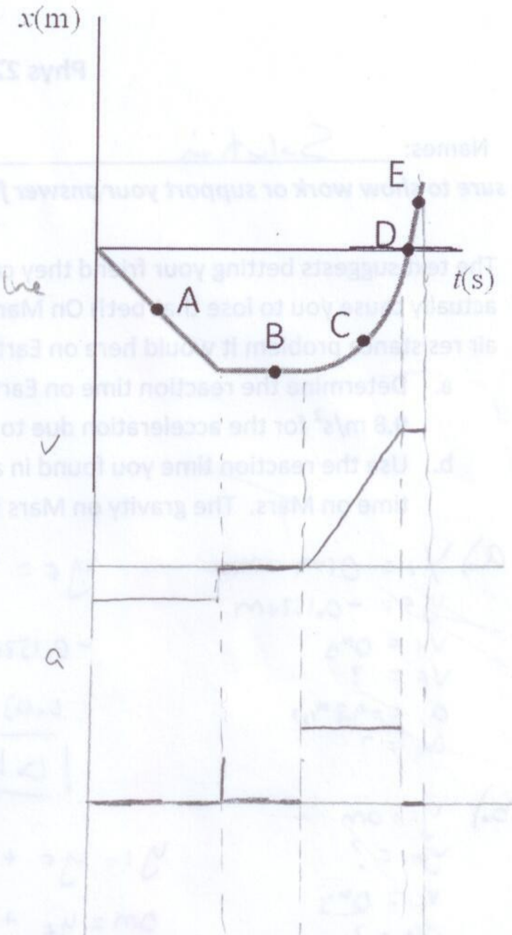
$\vec{D}$ = 5.46 East, -1.0 North or 1.0 South

$D = \sqrt{D_E^2 + D_N^2} = \sqrt{5.46^2 + (-1.0)^2}$
= 5.6 blocks

$\tan\theta = \frac{-1.0}{5.46} = -10.4°$

$\vec{D}$ = 5.6 blocks 10.4° South of East

3. The figure to the right shows a position-versus-time graph. At which lettered point or points is the object
   a. Moving the fastest? D & E
   b. Moving to the left? A
   c. Stationary B
   d. Speeding up? C
   e. Turning around? Somewhere along the B line



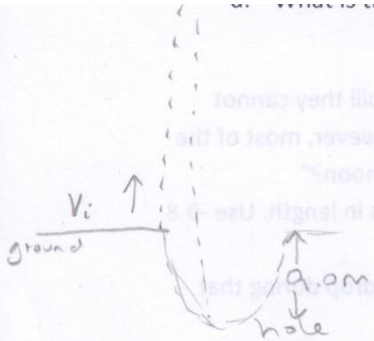
4. Draw the velocity-versus-time and acceleration-versus-time graphs directly below the position-versus-time graph.
   Be sure that the three graphs correspond (use a dotted line to show where points of interest line up.)

5. A ball is thrown straight up from the ground at a rate of 29.4 m/s and falls into a hole 10.0 m below where it starts.
   a. What is its velocity the instant before it hits the bottom of the hole?
   b. How long does it take from release for the ball to pass its original position on the way down?
   c. What is the ball's maximum height?
   d. What is the ball's velocity and acceleration at its maximum height?

$v = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{\Delta t}$ $\quad a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t}$ $\quad$ 2.54 cm = 1 inch $\quad$ 100 cm = 1 m

$x_f = x_i + v_i \Delta t + ½\, a(\Delta t)^2$ $\quad v_f = v_i + at$ $\quad v_f^2 = v_i^2 + 2a(\Delta x)$

d. What is the ball's velocity and acceleration at its maximum height?



$v_i = 0$

$x_f = -9.0m$

$v_i = 29.4 m/s$

$v_f = ?$

$a = -9.8 m/s^2$

$\Delta t = ?$

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

$v_f^2 = (29.4)^2 + 2(-9.8 m/s^2)(-9.0m)$

$v_f = 32. m/s$

b) find the time to the top of the flight and then double that because it has to come back down.

$v_f = v_i + at$

$0 = 29.4 m/s + -9.8 m/s^2 \, t$

$t = 3.0s$

so down also 3.0s

$t = 6.0s$

c. $x_f = x_i + v_i\Delta t + \frac{1}{2}a(\Delta t)^2$

$x_f = 0 + 29.4 m/s(3.0s) + \frac{1}{2}(-9.8 m/s^2)(3.0s)^2$

$= 88.2m - 44.1m$

$= 44.1m$

d. velocity = 0 at the top (turning around)

acceleration $= -9.8 m/s^2$ <u>always</u> when in free fall.