PHYS 111
FIRST HOUR EXAM-- SOLUTIONS

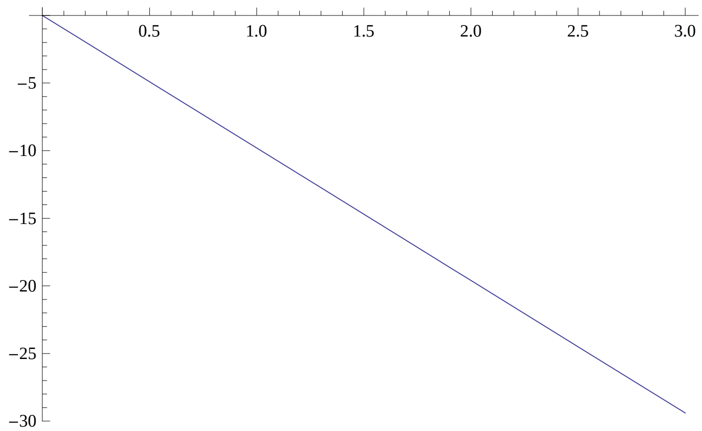
Questions 1 and 2 : All the graphs are represented by straight lines. The first, graph, vertical velocity vs. time, is a straight line with a slope of - g (-9.8 m/s^2). Since the object is thrown horizontally, the initial vertical velocity is zero. Since vertical velocity is determined by:

$$v_y = v_{oy} + at$$

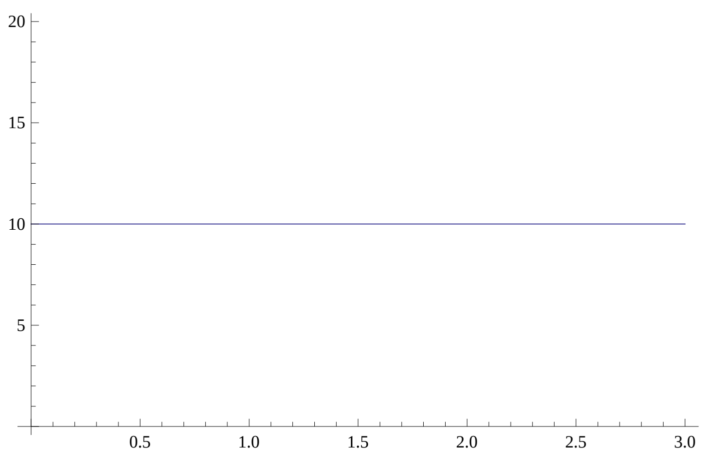
Here, a = -g so that

$$v_y = -gt$$

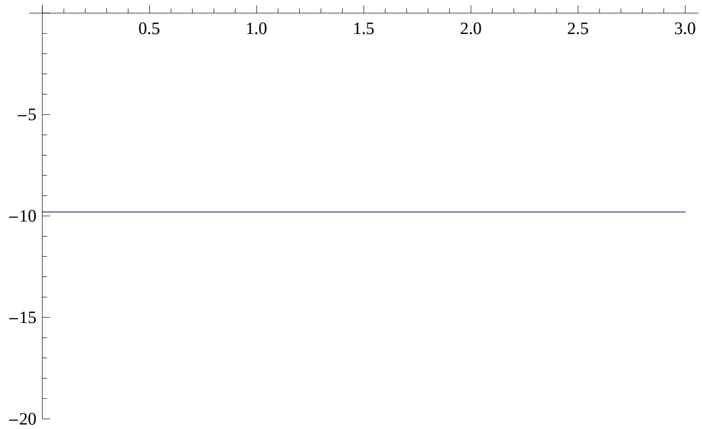
and the graph looks like :



b) The horizontal velocity is constant since there are no horizontal forces acting on the object; therefore there is no acceleration and the slope of this line is zero :

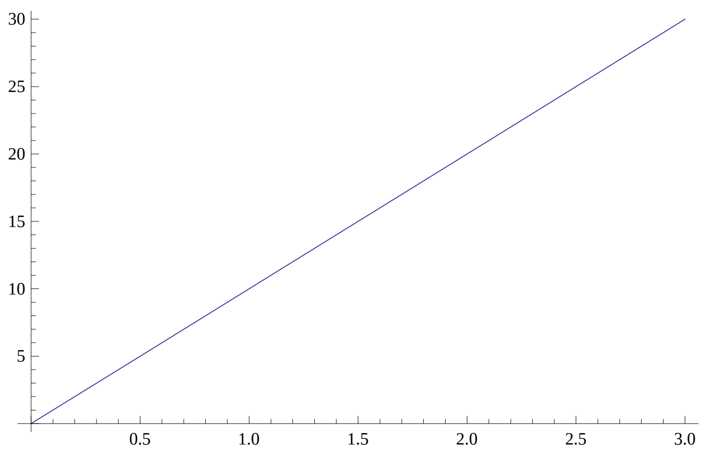


c) The only force acting is gravity, so the only acceleration is in the - y direction;



The slope of this line is 0 m/s^3.

d) Since there are no accelerations in the x direction, the equation of motion is x (t) = v_ot:



The slope is 10 m/s.

3. We choose up to be positive, and set as our initial conditions :

$x_o = 0 = y_o$

$v_{ox} = v_o \cos\theta;\ v_{oy} = v_o \sin\theta$

$a_x = 0;\ a_y = -g$

and our equations of motion become :

$$x(t) = v_o \cos\theta\, t$$

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

b) We find the time of flight by setting y (t) = 0; this will give us the times when the object is on the ground. Making this substitution gives us :

$$0 = v_o \sin\theta\, t - \frac{1}{2} g t^2 = t\left(v_o \sin\theta - \frac{1}{2} g t\right)$$

The expression on the right is zero when t = 0 and when

$$t = \frac{2\, v_0 \sin\theta}{g}$$

The first occurs at launch; the second is the time at impact and is the time of flight.

b) We can find this in a few ways. First, we realize that the time of maximum height is half the time of the total flight, so we find the value of y (t) when t = v_o sin θ/g:

$$y\,(t = v_o \sin\theta / g) = v_o \sin\theta\,(v_o \sin\theta / g) - \frac{1}{2}\, g\,(v_o \sin\theta / g)^2 =$$

$$\frac{v_o^2 \sin^2\theta}{g} - \frac{v_o^2 \sin^2\theta}{2\,g} = \frac{v_o^2 \sin^2\theta}{2\,g}$$

We can also use equation (7) from the list of equations :

$$v_{fy}^2 = v_{oy}^2 + 2\,a\,y$$

The final vertical velocity is 0, the initial vertical velocity is v_o sin θ, the acceleration is -g, so we have:

$$0 = v_o^2 \sin^2\theta + 2\,(-g)\,y_{max}$$

$$y_{max} = \frac{v_o^2 \sin^2\theta}{2\,g}$$

4. The tensions T_1 and T_2 act along the plane, as well as the components of weight down the plane, m_1g sin θ and m_2 g sin θ.

Newton' s second law along the plane for each mass is :

$$\Sigma F_{\text{on } m_1 \text{ along plane}} = T_1 - T_2 - m_1\, g \sin\theta = 0$$

$$\Sigma F_{\text{on } m_2 \text{ along plane}} = T_2 - m_2\, g \sin\theta = 0$$

The second equation gives us :

$$T_2 = m_2\, g \sin\theta$$

Substitute this expression into the first equation and get :

$$T_1 - m_2\, g \sin\theta - m_1\, g \sin\theta = 0 \Rightarrow T_1 = (m_1 + m_2)\, g \sin\theta$$

Look at this result; this shows that the tension in the upper string is equal to the summed weight acting down the plane. This is equivalent to the upper string supporting a combined mass of $(m_1 + m_2)$.