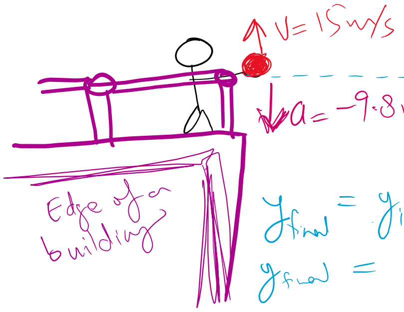
HOMEWORK ASSIGNMENT | Applied Physics, Fall2021 | Due date: October 29^{th}, 2021

1. You throw a ball vertically upward from the roof of a tall building. The ball leaves your hand at a point even with the roof railing with an upward speed of 15.0 m/s; the ball is then in free fall. On its way back down, it just misses the railing. Find (a) the ball's position and velocity 1.00 s and 4.00 s after leaving your hand; (b) the ball's velocity when it is 5.00 m above the railing; (c) the maximum height reached; (d) the ball's acceleration when it is at its maximum height.



(a) $V_{final} = V_{initial} + a\Delta t$

$V_{final} = 15 - 9.8(1s) = 5.2 m/s$ — The ball is still moving upward but with less velocity

$V_{final} = 15 - 9.8(4s) = -24.2 m/s$ — Now the ball is moving down with even greater velocity which shows that it must have passed the y = 0 level

$y_{final} = y_{initial} + V_{initial}\Delta t + 0.5a\Delta t^2$

$y_{final} = 0 + 15(1) - 4.9(1)^2 = 10.1 m$ above the railing

$y_{final} = 0 + 15(4) - 4.9(4)^2 = -18.4 m$ below the railing

(b) $y_{final} = y_{initial} + V_{initial}t + \frac{a}{2}t^2$

$5 = 0 + 15t - 4.9t^2$

Solving this quadratic equation ...

t = 0.38s and t = 2.68s at both of these times the ball reaches height of 5 m, for going up the velocity is $V_{final} = V_{initial} + a(0.38s) = 11.276 m/s$

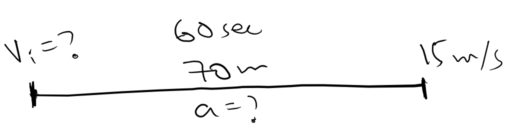
and for going down $V_{final} = V_{initial} + a(2.68) = -11.276 m/s$

(c) $V_{final} = 0 = 15 - 9.8\Delta t \Rightarrow \Delta t = 1.53 sec$

$y_{final} = 0 + 15(1.53) - 4.9(1.53)^2 \Rightarrow y_{final} = 11.48m$ above the railing is the maximum height

(d) The acceleration is constant throughout the motion; −9.8 m/s² due to gravity.

2. An antelope moving with constant acceleration covers the distance between two points 70.0 m apart in 6.00 s. Its speed as it passes the second point is 15.0 m/s. What are (a) its speed at the first point and (b) its acceleration?



for a constant acceleration: $15 = V_{initial} + 6a$

for distance covered: $70 = 0 + V_{initial} + \frac{36a}{2}$

Solving the equations simultaneously we get $V_i = 8.3 m/s$ and $a = 1.12 m/s^2$

3. (a) If a flea can jump straight up to a height of 0.440 m, what is its initial speed as it leaves the ground? (b) How long is it in the air?

$V_{final} = 0 = V_i - 9.8t \Rightarrow t = V_i/9.8$

from distance equation

$4 = 0 + V_i t - \frac{9.8}{2}(t)^2$

$4 = V_i\left(\frac{V_i}{9.8}\right) - 4.9\left(\frac{V_i}{9.8}\right)^2$

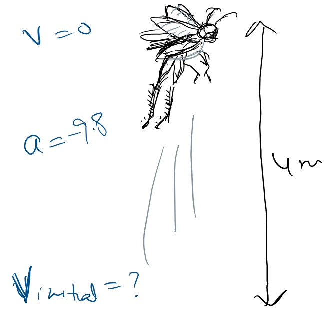
$V_i = 8.77\ m/s$

$t = 8.77/9.8 = 0.89\ sec$

This is the time for the highest point

for total time of the flight

total time $= 2t = 1.79\ sec$



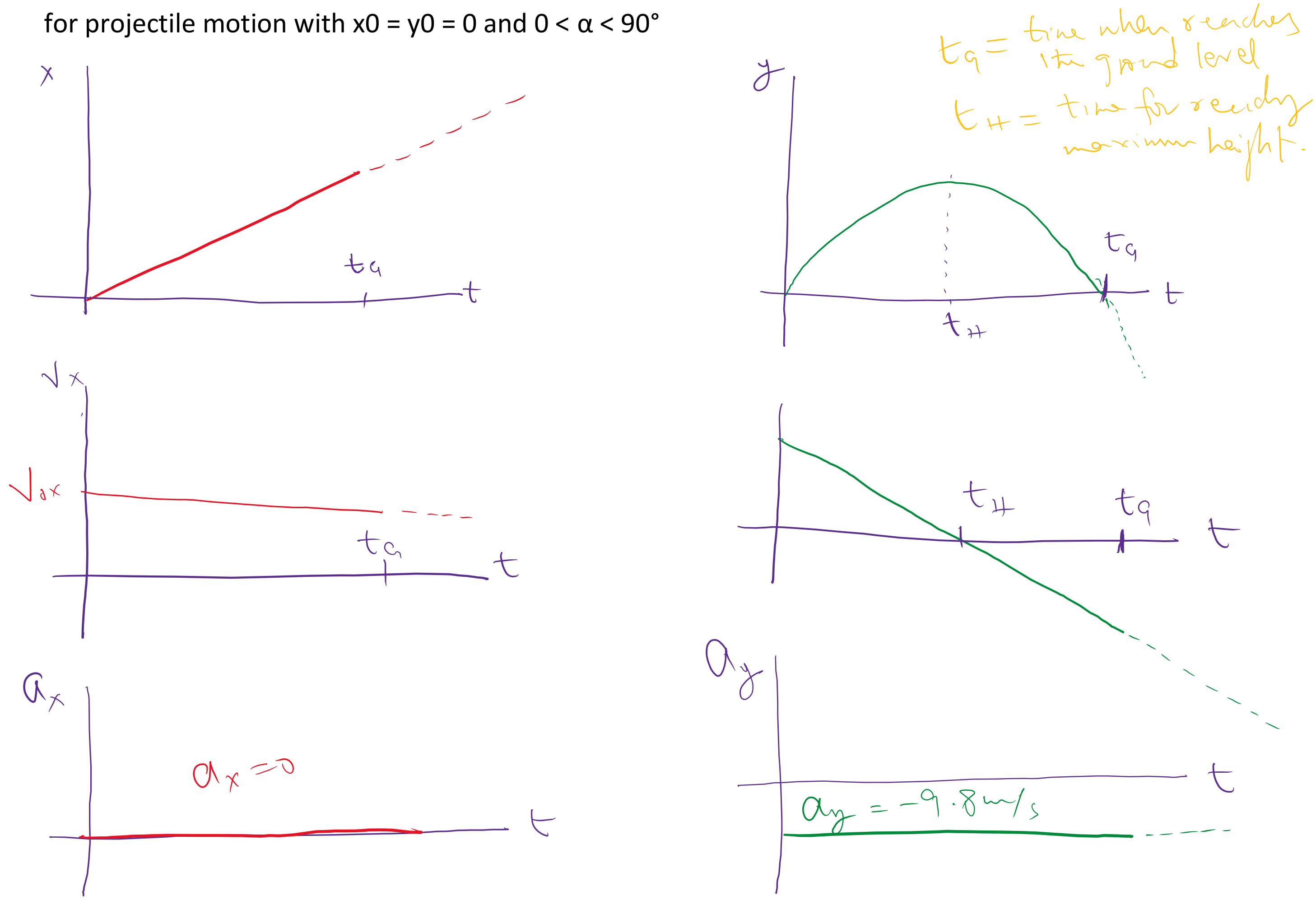
4. A projectile is fired upward at an angle Θ above the horizontal with an initial speed V_o. At its maximum height, what are its velocity vector, its speed, and its acceleration vector?

At maximum height ; $V_{horizontal} = V_0 \cos\theta$ $\quad V_{vertical} = 0$

Speed will only depend on the horizontal component ; $S = |V_0 \cos\theta|$

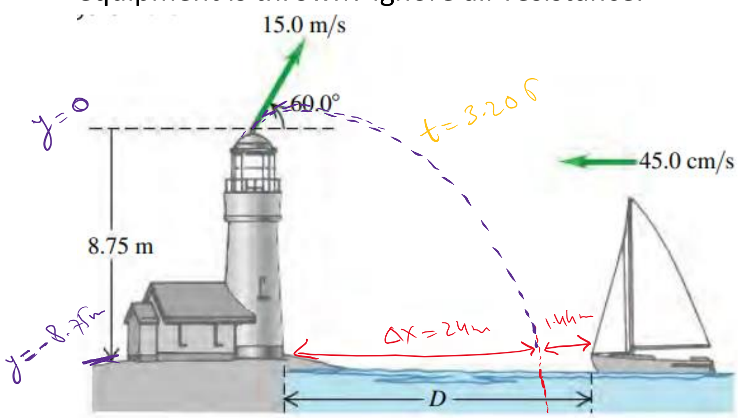
$\vec{a} = -9.8\hat{j}$

5. Sketch the six graphs of the x- and y-components of position, velocity, and acceleration versus time for projectile motion with x0 = y0 = 0 and 0 < α < 90°



6. An important piece of landing equipment must be thrown to a ship, which is moving at 45.0 cm/s, before the ship can dock. This equipment is thrown at 15.0 m/s at 60.0° above the horizontal from

the top of a tower at the edge of the water, 8.75 m above the ship's deck. For this equipment to land at the front of the ship, at what distance D from the dock should the ship be when the equipment is thrown? Ignore air resistance.



From the Vertical position relation

$y_{final} = -8.75m = 0 + V_{iy} t + \frac{g}{2} t^2$

$-8.75 = (15 \cdot \sin 60)t - 4.9t^2$

$t = \begin{cases} -0.55 \text{ sec} \\ 3.205 \text{ sec} \end{cases}$ ✓

we use the forward time since this is when the package reaches the ship. This is the time of projectile.

$X_{final} = X_{initial} + V_0 \cos\theta\, t$

$\Delta X = (15 \cdot \cos 60)(3.205)$

$\Delta X = 24$ m

Should be the distance of the ship when the package lands. But the ship is moving at 0.45 m/s.

$D = \Delta X + (0.45 \text{ m/s})(3.205 \text{ s}) = 24\text{ m} + 1.44\text{ m}$

$D = 25.44$ m

7. When you fly in an airplane at night in smooth air, you have no sensation of motion, even though the plane may be moving at 800 km/h (500 mi/h). Why?

Because the relative velocities of the passenger and the plane is zero.

8. Why is the earth only approximately an inertial reference frame?

For the small and short enough experiments, the earth appears to be an inertial frame but for experiments with long enough observational time or distances (such as days or miles) the earth appears to be a non-inertial frame.

9. Can a body be in equilibrium when only one force acts on it? Explain.

Single force will always execute some finite acceleration on the body, hence, the body with only single force being applied on it cannot be in equilibrium.

10. A spaceship far from all other objects uses its thrusters to attain a speed of 1x104 m/s. The crew then shuts off the power. According to Newton's first law, what will happen to the motion of the spaceship from then on?

With boosters shut off, the acceleration becomes zero therefore the crew and the ship are now travelling at the speed of $1\text{x}10^4$m/s.