Name: ______________________ DISC: ____________ Score: _____ / 20

Instructions:

- Do your own work.
- Answer the questions below in the space provided.
- Make sure you show all your work and any equations that you use.
- Please place a box around your answers.
- Remember to give the correct units with all numerical answers

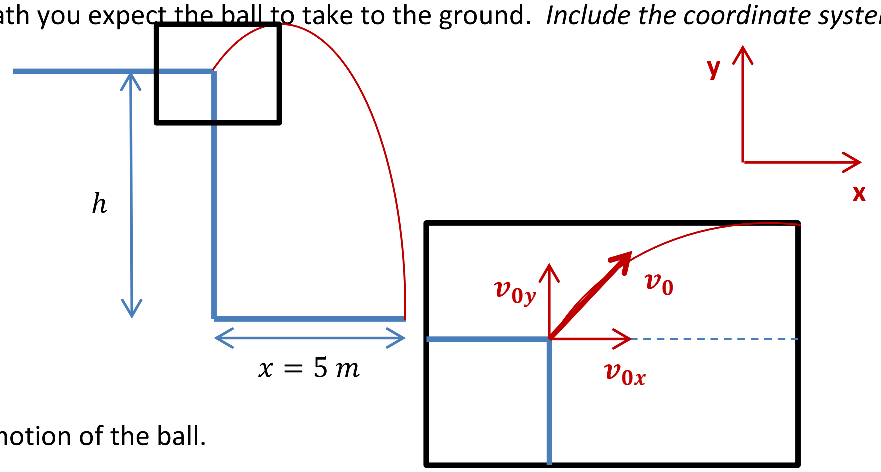
Q1	Q2	Q3	Q4
10	10	5	5

1. You throw a ball off of a cliff with an angle $\theta = +45°$. The ball has an initial speed $v_0 = 2.25\ m/s$ and reaches the ground after travelling $x = 5\ m$. Let the x-direction be horizontal and the y-direction be vertical.

(Lecture 6, pp. 15 & 16)

Picture:

a. Draw a picture of the path you expect the ball to take to the ground. *Include the coordinate system*.



b. Now let's work on the motion of the ball.

Acceleration:
Direction:
v_x
v_y:

i. What is the magnitude of the acceleration of the ball? $\boldsymbol{g = 9.81\ m/s}$

ii. What is the direction of the acceleration? **Negative y-direction**

iii. What is the x-component of the ball's initial velocity (v_{0x})?

$$\boldsymbol{v_{0x} = v_0 \cos 45°}$$

$$\boldsymbol{\left(2.25\frac{m}{s}\right)\frac{\sqrt{2}}{2} = 1.59\ m/s}$$

iv. What is the y-component of the ball's initial velocity (v_{0y})?

$$\boldsymbol{v_{0x} = v_0 \sin 45°}$$

$$\boldsymbol{\left(2.25\frac{m}{s}\right)\frac{\sqrt{2}}{2} = 1.59\ m/s}$$

c. Now we want to find the distance h. Select the equations you could use to calculate h (select all correct equations).

Choice (1 pts):

i. $x(t) = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$

ii. $y(t) = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$

iii. $v_x^2 = v_{0x}^2 + 2\,a_x\,\Delta x$

iv. $v_y^2 = v_{0y}^2 + 2\,a_y \Delta y$

Solution (2 pts):

d. How much time does it take the ball to reach the ground?

We know that $a_x = 0\ m/s^2$ because there are no forces acting in the x-direction.
We also know how far the ball traveled in the x-direction $x = 5\ m$.
Thus:

$$x(t) = x_0 + v_{0x}t + \frac{1}{2}a_x t^2 = v_{0x}t$$

after substitution, and letting $x_0 = 0\ m$. I get to choose this, do you know why?
Now for some algebra:

$$x(t) = v_{0x}t \text{ so } t = x(t)/v_{0x}$$

Now substitute for $x(t)$ and v_{0x}:

$$\frac{5\ m}{1.59\ m/s} = 3.14\ s$$

Solution (2 pts):

e. What is the hight, h, of the cliff?.

Now we can use the second of our chosen equations:

$$y(t) = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$$

to calculate the height of the cliff. We know that:

$$a_y = -9.81\ m/s^2$$
$$y_0 = h,$$
$$t = 3.14\ s$$
$$y(3.14\ s) = 0\ m.$$

Now we can substitute:

$$0\ m = h + 1.59(3.14\ s) + \tfrac{1}{2}\left(-9.81\ m/s^2\right)(3.14\ s)^2.$$

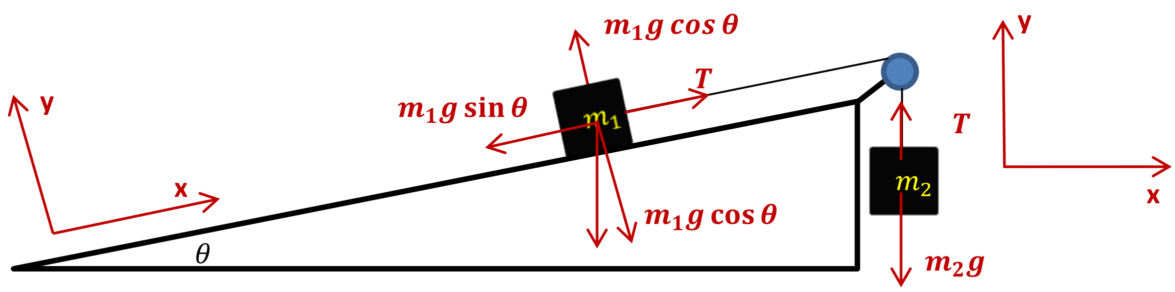
After some arithmetic we get:

$$h = 43.36\ m.$$

2. A block of mass m_1 is in contact with a *frictionless* ramp. The angle between the ramp and the floor is $\theta = 12^o$. The block is connected to a second block of mass m_2 by a massless cord over a frictionless pulley as shown in the diagram. **(Lecture 7, pp. 4)**

   a. Select a coordinate system and complete the free-body diagram. *Include your coordinate system(s) on the diagram.* (Hint: Will it be easier to give each block its own coordinate system?)

Diagram (2pts):



   b. Let's consider the motion of the blocks (Hint: $F_{net} = ma = \sum F$):

      i. Can this system be in equilibrium? **yes**

      ii. Use Newton's laws to describe the forces on m_1.

      $\boldsymbol{m_1 a = T - m_1 g \sin\theta}$ **(Note: I have assumed that the block will move up the plank, that may not be true.)**

      $\boldsymbol{0 = -m_1 g \cos\theta + m_1 g \cos\theta}$

Equilibrium:
F_1:
F_2:

      iii. Use Newton's laws to describe the forces on m_2.

      $\boldsymbol{-m_2 a = T - m_2 g}$ **(Note: But since I have also assumed that the hanging block will fall, the signs will come out right in the end.)**

   c. If the system is in *equilibrium*, what is the ratio m_1/m_2?

Solution (5 pts):

If the system is in equilibrium, then $\boldsymbol{a = 0}$. I can use this fact to set up my system of equations:

$$\boldsymbol{0 = T - m_1 g \sin\theta}$$
$$\boldsymbol{0 = T - m_2 g}$$

I notice that if I subtract the second equation from the first, the tension can be eliminated. This is good, because I do not know anything about the tension yet. You could also use direct substitution. Eliminating $\boldsymbol{T}$ we get:

$\boldsymbol{0 = m_2 g - m_1 g \sin\theta}$ **After some algebra we find that:** $\boldsymbol{\frac{m_1}{m_2} = \frac{1}{\sin\theta}}$**.**