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

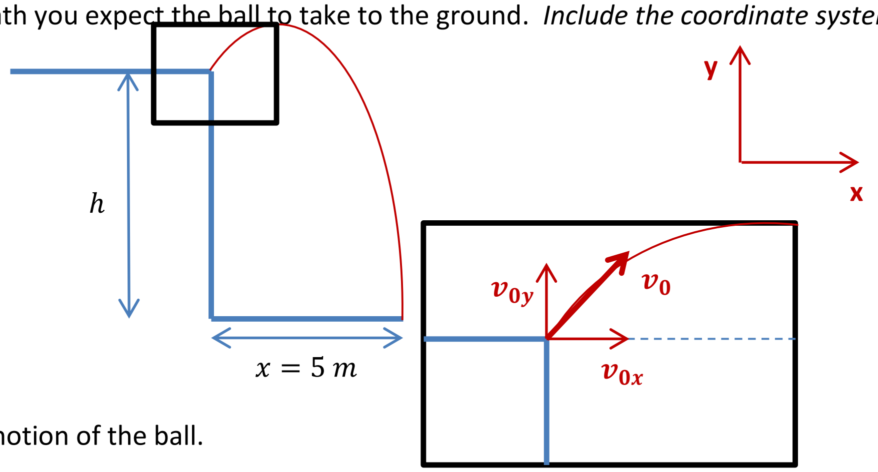
Q1	Q2	Q3	Q4
10	10	5	5

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)

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

Picture:



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

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

Solution (2 pts):

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}:

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

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

Solution (2 pts):

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:

$$h = 43.36\ m.$$

For my group this problem was troublesome. The main points of trouble were:

Part a): 1) missing the coordinate system (-0.5 pts)
2) incorrect angle for the coordinate system they chose (-0.5 pts)

Part b): 1) missing units (-0.5 pts for each missing unit)
2) missing axis for the acceleration (-0.5 pts)

Part c): 1) missing one of the formulae (usually the x-version) (-0.5 pts)

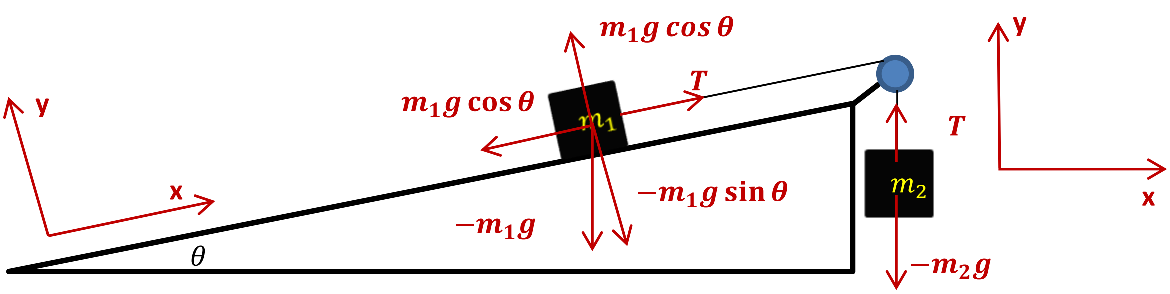
Part d): 1) incorrect initial velocity in the correct formula (-1 pt)
2) using v = at (-2 pts)

Part e): 1) assuming final velocity is zero (-1 pt)
2) incorrectly attempting to use the wrong formula (-2 pts)

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.

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

      $0 = -m_1 g\cos\theta + m_1 g\cos\theta$

Equilibrium:
F_1:
F_2:

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

      $-m_2 a = T - m_2 g$ **(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 $a = 0$. I can use this fact to set up my system of equations:

$$0 = T - m_1 g\sin\theta$$
$$0 = T - m_2 g$$

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 T we get:

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

Again, this problem is somewhat problematic. This is to be expected at this point. This quiz is the first time we have really asked everyone to start putting facts together to solve problems. The most common problems were:

1) **Missing coord. system. (-1 pt)**
2) **Not understanding how to decompose forces and how that can yield an equilibrium state:**
   a. **For part b) students either understood the question or they did not.**
   b. **If any of the force sums were wrong the entire result was wrong**
3) **If the student failed to realize that equilibrium yielded a=0, but did everything else right (-2 pts). Otherwise in my group the students either did this problem correctly, or were completely incorrect.**