Name: ______________________________ DISC: ____________ Score: _____ / 20

Instructions:

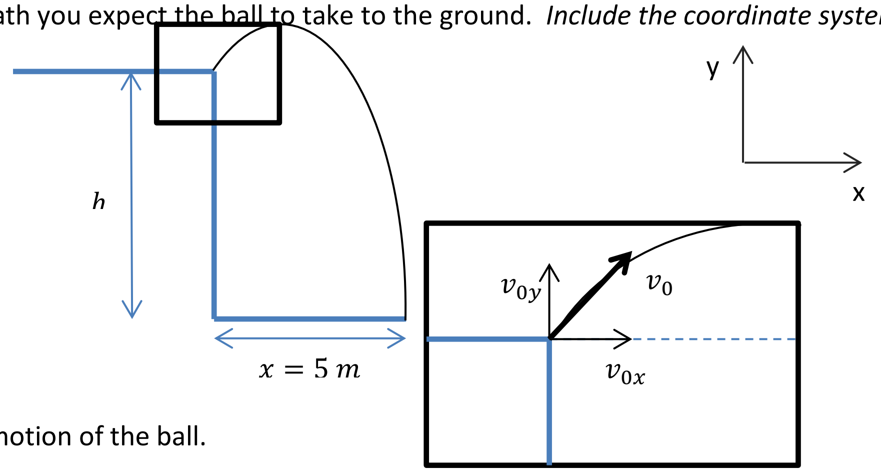
- Do your own work.
- Answer the questions below in the space provided.
- Make sure you show all your work and any equations that you use.
- Please place a box around your answers.
- Remember to give the correct units with all numerical answers

Q1	Q2	Q3	Q4
10	10	5	5

1. You throw a ball from off of a cliff with an angle $\theta = 45°$. The ball has an initial velocity of $2\ m/s$ and reaches the ground after traveling $x = 5\ m$. 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 acceleration of the ball? $g = 9.81\ m/s$

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})? $v_{0x} = v_0 \cos 45° = \frac{\left(2\frac{m}{s}\right)\sqrt{2}}{2} = \sqrt{2}\ m/s$

iv. What is the y-component of the ball's initial velocity (v_{0y})? $v_{0y} = v_0 \sin 45° = \frac{\left(2\frac{m}{s}\right)\sqrt{2}}{2} = \sqrt{2}\ m/s$

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: $x(t) = v_{0x}t$ so $t = x(t)/v_{0x}$. Now substitute for $x(t)$ and v_{0x}:

$$\frac{5\ m}{\sqrt{2}\ m/s} = 3.54\ s$$

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

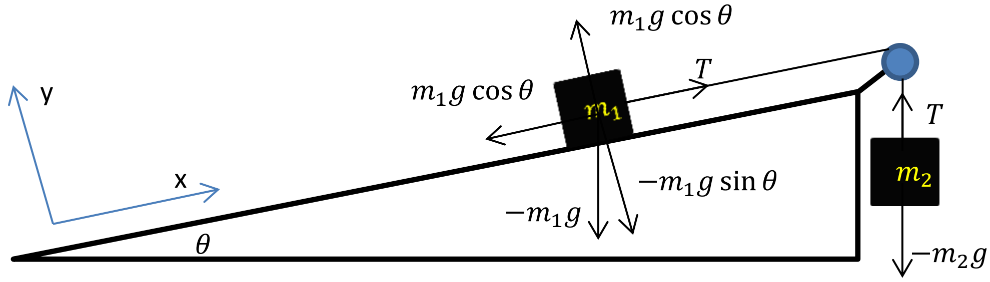
Solution (2 pts):

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 $a_y = -9.81\ m/s^2$, $y_0 = h,\ t = 3.54\ s$, and $y(3.54\ s) = 0\ m$. Now we can substitute: $0\ m = h + \sqrt{2}(3.54\ s) + \frac{1}{2}(-9.81\ m/s^2)(3.54\ s)^2$. After some arithmetic we get: $h = 56.5\ m$.

2. A block of mass m_1 is in contact with a *frictionless* ramp. The angle between the ramp and the floor is $\theta = 15^o$. It 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: $F_{net} = ma = \sum F$):

Equilibrium:
F_1:
F_2:

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.)

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

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 $\frac{m_1}{m_2}$?

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: $\frac{m_1}{m_2} = \frac{1}{\sin\theta}$.