I understand that the University of Florida expects its students to be honest in all their academic work. I agree to adhere to this commitment to academic honesty and understand that my failure to comply with this commitment may result in disciplinary action up to and including expulsion from the University.

Name: _____________________________________________________

UF ID: _____________________________________________________
Ignore air friction in all problems.

Please give complete responses to all questions including units and theoretical justification for responses.

You must show ALL of your work to receive full credit!

Useful values and formulas:

\[ G = 6.7 \times 10^{-11} \text{ N m}^2 / \text{kg}^2 \]

\[ M_{\text{Earth}} = 5.98 \times 10^{24} \text{ kg} \]

\[ R_{\text{Earth}} = 6378 \text{ km} \]

1 km = 0.62 miles

1 kg = 2.2 lbs
1. (9 pts) What are the standard (SI) units used for distance, time, and mass?

Distance = meters (m)

Time = seconds (s)

Mass = kilograms (kg)

2. (9 pts) Draw the path of an object in uniform circular motion. Indicate the directions of the velocity, acceleration, and force vectors at one point of your choice along that path.
3. (10 pts) What is Newton’s first law? Write down the law, and give a real life example. Be very specific.

Law of Inertia: Every object in uniform motion (at rest or moving) tends to remain in that state of motion unless an external force is applied to it.

Ex: demo was the air track, or a book on a table, or an object going around a hula hoop that is cut in half

4. (10 pts) Identify at least 2 action-reaction pair in the following image:

Starting at the left and moving right:
Tarzan’s feet on ground and ground on feet
Tarzan pulls L end of rope 1 left, L end of rope 1 pulls Tarzan right
R end of rope 1 pulls monkey left, monkey pulls R end of rope 1 to the right
Monkey pulls L end of rope 2 left, L end of rope 2 pulls monkey right
R end of rope 2 pulls tree left, tree pulls R end of rope 2 right
5. (3 pts) A cheetah is trying to run down a baby elephant for dinner. The cheetah’s top speed is 70 mph. How fast is that in m/s?

70 miles/hr * (1 km / 0.62 miles) * (1000 m / 1 km) * (1 hr / 60 min) * (1 min / 60 s) = 31.36 m/s

(3 pts) How far will the cheetah run in 30 seconds?

31.36 m/s * 30 s = 940.86 m
6. (15 pts) Two students are standing on a ledge 10 m above the ground. One student throws the first ball, ball 1, upward at 13.7 m/s. At the same time the other student drops the second ball, ball 2. The first ball just misses the ledge on the way back down.

What is the time the dropped ball spends in the air?

Use: \( y = y_0 + (v_{0y} \cdot t) + \left(\frac{1}{2} \cdot a \cdot t^2\right) \)

For the ball that is dropped \( v_{0y} = 0 \) and \( y = 0 \), so \( 0 = y_0 - \frac{1}{2} \cdot g \cdot t^2 \)

\( t = 1.42 \text{ seconds} \)

How far apart are the balls 0.59 seconds after they are released?

For both balls you can use: \( y = y_0 + (v_{0y} \cdot t) + \left(\frac{1}{2} \cdot a \cdot t^2\right) \)

For the ball that is dropped \( v_{0y} = 0 \), so \( y = y_0 - \frac{1}{2} \cdot g \cdot t^2 \)

\( y = 10 \text{ m} - \left(\frac{1}{2} \cdot 9.8 \text{ m/s}^2 \cdot (0.59 \text{ s})^2\right) \)

\( y = 8.29 \text{ m} \)

For the ball that is thrown upward \( y = y_0 + (v_{0y} \cdot t) + \left(\frac{1}{2} \cdot a \cdot t^2\right) \)

\( y = 10 \text{ m} + (13.7 \text{ m/s} \cdot 0.59 \text{ s}) - \left(1/2 \cdot 9.8 \text{ m/s}^2 \cdot (0.59 \text{ s})^2\right) \)

\( y = 16.37 \text{ m} \)

So they are 16.37 m – 8.29 m apart, or 8.08 m apart

What is the maximum height ball 1 obtains?

\( y_{\text{max}} = y_0 + \left(\frac{1}{2} \cdot v_{0y}^2 \right) / g \)

\( = 10 \text{ m} + (1/2 \cdot (13.7 \text{ m/s})^2 / 9.8 \text{ m/s}^2) \)

\( = 19.57 \text{ m} \)
7. (15 pts) Granny Able is shot from a cannon at an angle of 60 degrees into the air. Her initial velocity is 29.5 m/s.

How far does she travel?

Max range is: 
\[ x = x_0 + \left( \frac{v_{0x} \cdot 2 \cdot v_{0y}}{g} \right) \]

Need to separate initial velocity into its x and y components:

\[ \cos 60 = \frac{v_{0x}}{v}, \ v_{0x} = 14.75 \text{ m/s} \]
\[ \sin 60 = \frac{v_{0y}}{v}, \ v_{0y} = 25.55 \text{ m/s} \]

so range in x = 0 + \left( 14.75 \text{ m/s} \cdot 2 \cdot 25.55 \text{ m/s} \right) / 9.8 \text{ m/s}^2

she travels 76.9 m

What is her maximum height above the ground?

Max height is: 
\[ y = y_0 + \left( \frac{1}{2} \cdot \frac{v_{0y}^2}{g} \right) \]

So max height \( y = 0 + \left( \frac{1}{2} \cdot \left( 25.55 \text{ m/s} \right)^2 / 9.8 \text{ m/s}^2 \right) \)

\[ y = 33.3 \text{ m} \]

What is her speed in the y direction when she lands on the ground?

You can use \( v_y = v_{0y} - g \cdot t \) and but you need to know time before we can find her final velocity in \( y \)

\[ v_{0y} \cdot t = \frac{1}{2} \cdot \left( \frac{g}{t^2} \right) \]
\[ v_{0y} = \frac{1}{2} \cdot \left( \frac{g}{t} \right) \]
\[ t = 5.21 \text{ s} \]

\[ v_y = v_{0y} - g \cdot t \]
\[ v_y = 25.55 \text{ m/s} - \left( 9.8 \text{ m/s}^2 \cdot 5.21 \text{ s} \right) \]
\[ = -25.51 \text{ m/s} \]
8. (15 pts) You're driving down I-75 at 75.0 mph for 10 seconds. You observe an accident ahead. You slam on your brakes when you are 50.0 m away from the accident. You slow down at a rate of -5 m/s² for 5 seconds.

Sketch a plot for your motion, in velocity vs time. Label all parts of your graph including the axes.

75 miles/hr * (1 km / 0.62 miles) * (1000 m / 1 km) * (1 hr / 60 min) * (1 min / 60 s)
= 33.6 m/s

\[ a = \frac{\text{change in } v}{t} = \frac{(v_{\text{final}} - v_{\text{initial}})}{t} \]

after 1st sec,
\[-5 \text{ m/s}^2 = \frac{(v_{\text{final}} - 31.36 \text{ m/s})}{1 \text{ s}} \]
and \( v_{\text{final}} = 26.36 \text{ m/s} \) etc.

9. (10 pts) What is the force of gravity on a 2500 lb piano at the surface of the Earth?

On surface can use \( F_{\text{grav}} = m \times 9.8 \text{ m/s}^2 \)

\( F_{\text{grav}} = 11,136.36 \text{ N} \)

What is the force of gravity at 1000 km above the surface of the Earth?

\( F_{\text{grav}} = \frac{G \times m_1 \times m_2}{d^2} \)

\( F_{\text{grav}} = \left( 6.7 \times 10^{-11} \text{ N m}^2/\text{kg}^2 \right) \times \left( 5.98 \times 10^{24} \text{ kg} \right) \times \left( 2500 \text{ lbs} \times \left( 1 \text{ kg} / 2.2 \text{ lbs} \right) \right) \)

\[ \left( (6378 \text{ km} \times (1000 \text{ m} / 1 \text{ km})) + (1000 \text{ km} \times (1000 \text{ m} / 1 \text{ km})) \right)^2 \]

\( F_{\text{grav}} = 8364 \text{ N} \)