PHY2020
Fall 2013, Test 1

80 points total

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:

$G = 6.67\ 10^{-11}\ N\ m^2 / kg^2$

$M_{Earth} = 5.98 * 10^{24}\ kg$

$R_{Earth} = 6378\ km$

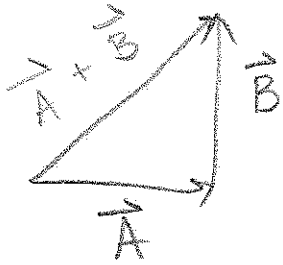
1 km = 0.62 miles

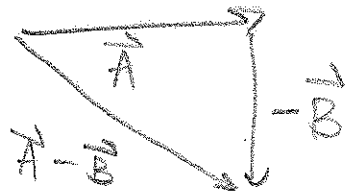
1 km = 3280.84 ft

1 kg = 2.2 lbs

from: 2nd lecture, done explicitly in class, plus chapter 5

1. (6 pts) Illustrate with a sketch how you add a pair of vectors A and B, along with the resultant sum. Illustrate with a sketch how you subtract a pair of vectors A and B, with the resultant difference.





2. (8 pts) What causes and keeps a satellite in orbit around the Earth? Be very specific as was described in lecture.

See lecture notes, plus entire paragraph in text.

mention: velocity of satellite
Fgrav of Earth on satellite
centripetal motion – if Fgrav not exactly counteracted by $\vec{v}$ of satellite, will either fall to Earth or fly off into space

Satellite "falling" to Earth at same rate - it curves

Lecture 2 clicker question, slide 1
Lecture 3 clicker question, slide 3

3. (6 pts) A bicyclist is moving with an average speed of 12.9 km/hr.

How fast is this in m/s?

$$12.9 \frac{km}{hr}\left[\frac{1\,hr}{3600\,sec}\right]\left[\frac{1000\,m}{1\,km}\right] = 3.58\ m/s$$

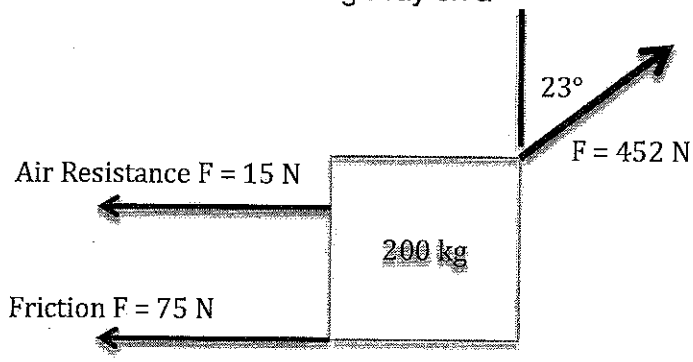
How far will a bicyclist travel in 230 minutes?

$$V = \frac{d}{t} \rightarrow v \cdot t = d$$

$$d = 3.58\frac{m}{s}\left(230\,min \times \frac{60\,sec}{1\,min}\right) = 49404\ m \text{ or } 49.4\ km$$

Exam review, slide 9

4. (10 pts) A 200 kg object is being pulled across a 15 m wide highway on a windy day.



What is the total force acting on this object in the x direction?

$$F_{pull,x} = (452\,N)\sin 23° \quad \text{or} \quad (452\,N)(\cos 67°)$$

$$= 176.61\,N$$

$$F_{TOTAL} = (176.6\,N) - (15\,N) - (75\,N)$$

$$= 86.61\,N$$

Lecture 6 1/2 waypoint review, slide 10

How long will it take to move the object across the highway, if it starts from rest?

$$d = v_0 t + \frac{1}{2} a t^2$$

v_0: at rest, at start

t: need to find

$$F_{NET} = m\, a_{NET}, \quad a_{NET} = \frac{F_{NET}}{m} = \frac{86.6\,N}{200\,kg}$$

$$a_{NET} = 0.43\ m/s^2$$

$$15m = \frac{1}{2}\,(0.43\ m/s^2)\, t^2$$

$$t = 8.32\ sec$$

Exam 1, fall 2011

5. (15 pts) Two students are standing on a ledge 12 m above the ground. One student throws the first ball, ball 1, upward at 12.3 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?

$y = y_0 + v_{oy}t + \frac{1}{2}at^2$

y: ↓ ø b/c on ground

$v_{oy}t$: ↳ ø b/c dropped

$0 = 12m - \frac{1}{2}(9.8\ m/s^2)\,t^2$

$t = 1.56$ sec

How far apart are the balls 0.65 seconds after they are released?

use $y = y_0 + v_{oy}t + \frac{1}{2}at^2$ for each

dropped: $y = 12m + \text{ø} - \frac{1}{2}(9.8\ m/s^2)(0.65\ sec)^2$

$= 9.93\ m$

thrown: $y = 12m + (12.3\ m/s)(0.65\ sec) - \frac{1}{2}(9.8\ \frac{m}{s^2})(0.65\ sec)^2$

$= 17.92\ m$

they are $(17.92 - 9.93) = 7.99$ m apart

What is the maximum height ball 1 obtains?

$y_{max} = y_0 + \frac{1}{2}\frac{v_{oy}^2}{g}$

$= 12m + \frac{1}{2}\frac{(12.3\ m/s)^2}{9.8\ m/s^2}$

$= 19.72\ m$

Lecture 7, slide 2

6. (15 pts) A pool ball leaves a 0.65 meter high table with an initial horizontal velocity of 2.9 m/s.

How long does it take for the ball to hit the ground?

$y = y_0 + V_{oy}t + \frac{1}{2}at^2$

y → ø b/c lands on ground

ø b/c horizontal only

$0 = 0.65\,m - \frac{1}{2}(9.8\,m/s^2)t^2$

$t = 0.36$ sec

How far from the table's edge will the ball land?

$x = x_0 + V_{ox}t$

$x = \text{ø} + (2.9\,m/s)(0.36\,sec)$

$= 1.04$ m away

What is the speed of the ball in the y direction when it lands on the ground?

Use $a = \frac{\Delta V}{t}$, or $-9.8\,m/s^2 = \frac{V_{f,y} - V_{iy}}{t}$

$V_f = (-9.8\,m/s^2)(0.36\,sec)$

$= -3.53$ m/s, downward

Lecture 8, slide 5

7. (10 pts) The maximum lift force acting on a 500 kg airplane is 10,000 N.

What is the centripetal acceleration of the airplane?

$$a = \frac{F}{m} = \frac{10{,}000\,N}{500\,kg} = 20\ m/s^2$$

If the plane travels at 120 m/s, what is its shortest possible turning radius?

$a = \frac{v^2}{r}$, so $r = \frac{v^2}{a}$

$$r = \frac{(120\ m/s)^2}{20\ m/s^2} = 720\ m$$

Lecture 9 slides 1, 6

8. (10 pts) What is the force of gravity on a 12,500 lb airplane at the surface of the Earth?

Can use $F = m \cdot a$, $a = g$

$$F = (12500\,lb)\left(\frac{1\,kg}{2.2\,lb}\right) 9.8\ m/s^2 =$$

$$5.5681 \times 10^5\ N$$

What is the force of gravity when the plane is 30,000 ft above the surface of the Earth?

$$F = \frac{G m_1 m_2}{d^2} = \frac{\left(6.67 \times 10^{-11}\ \frac{N m^2}{kg^2}\right)\left(\frac{12500}{2.2}\ kg\right)(5.98 \times 10^{24}\ kg)}{\left[6378\ km\left(\frac{1000\,m}{1\,km}\right) + 30000\,ft\left(\frac{1\,km}{3280.84\,ft}\right)\left(\frac{1000\,m}{1\,km}\right)\right]^2}$$

$$F = 5.5546 \times 10^5\ N$$