Name: _____ DISC: _____ Score: _____ / 20

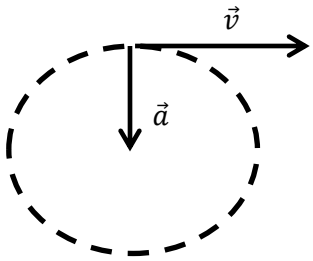
Instructions:
- Do your own work.
- Answer the questions below in the space provided.
- Make sure you show all your work and any equations that you use.
- Please place a box around your answers.
- Remember to give the correct units with all numerical answers

Q1	Q2	Q3	Q4
10	10	5	5

1. You are spinning a ball attached to a massless string of length $R = 2\ m$ in a circle.

a. Draw a diagram of the motion of the ball including the vectors for the velocity and acceleration.

Diagram (2pts):



Remember: the velocity can point in any direction chosen, as long as it is tangent to the circle.

(Lecture 8 pp.3-4)

b. Let's consider the circular motion of the ball:

Yes/no:
Explanation (2 pts):

i. Does the ball move at constant *speed* (yes/no) ? yes

ii. For *uniform circular motion* the acceleration of a rotating object is $a = \frac{v^2}{r}$. If the ball moves at a constant *speed*, why is there an acceleration?

The ball can move with constant speed but still experience acceleration because the direction of the velocity vector is changing with time. Both the magnitude and direction of a vector can change with time. Both types of change require an acceleration.

(Lecture 8, p.3)

c. The ball experiences a radial acceleration $a = g$. What is the speed of the ball? (Use $g = 9.81\ m/s^2$.)

Speed (2 pts):

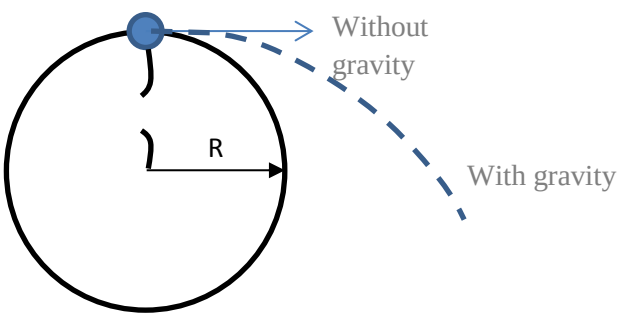
(Lecture 8, p. 3)

$$a = \frac{v^2}{r} = g$$

$$v = \sqrt{gr} = \sqrt{(9.81\frac{m}{s^2})(2\ m)} = 4.43\ m/s$$

d. The string is spontaneously cut at the point shown in the diagram below. Draw the path on the diagram representing the motion of the ball *after* the string has been cut. Include labels. **(Application)**

Diagram (2 pts):



Remember the student could choose a different rotation direction, and that's fine.

2. You are an airplane pilot. You are traveling from San Francisco to Chicago, a 3000 km trip due East. There is a wind blowing 20 km/h *from* the North. It takes you 4 hours to make the trip. You want to know the air speed of your airplane (remember: $\Delta x = vt$). **(Lecture 7, pp. 8 and following)**

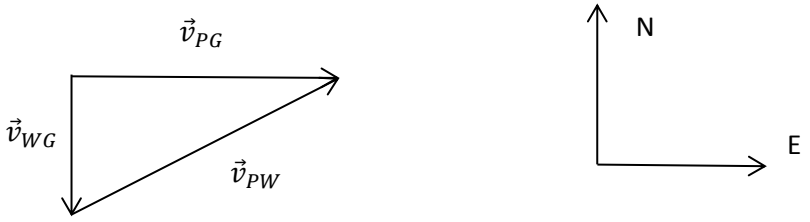
a. To keep your airplane heading East you must:

Selection:

i. Stear the airplane into the wind (North).
ii. Stear the airplane with the wind (South).
iii. Stear the airplane due East

b. Draw a vector diagram showing the velocities important in this problem. Include a coordinate system and labels for the vectors.

Diagram (coord. System = 0.5 pts):
Vector Lables:



c. Describe in your own words the steps you need to take to calculate the airspeed of the airplane.

Problem solving steps (2 pts):

First I would need to find the groundspeed ($\vec{v}_{PG}$) of the airplane. I already know the direction so I only need the magnitude. Then I can use my vector diagram with the wind speed and direction with respect to the ground to do the vector addition to find the magnitude and direction of the airplane's velocity with respect to the wind.

d. Select the equation, or equations, you need from the list below. Then find the air speed, $\vec{v}_{PW}$ (remember: vectors!!!). (Hint: Write out the components of the airplane's ground velocity, $\vec{v}_{PG}$ and the wind velocity $\vec{v}_{WG}$)

Selection:
Solution (2 pts):

i. $\Delta x = vt$
ii. $\vec{v}_{PW} + \vec{v}_{WG} = \vec{v}_{PG}$
iii. $v^2 = v_0^2 + 2\,a\quad \Delta x$

$|\vec{v}_{PG}| = {}^{3000\ km}/_{4\ h} = 750\ km/h$ we know the plane eventually travels due east. Now lay out the components of the vectors:

$\vec{v}_{PW} = (v_{PWx}, v_{PWy})$ This is the quantity we want to know

$\vec{v}_{PG} = \left(750\frac{km}{h}, 0\ km/h\right)$ This is the plane's ground speed

$\vec{v}_{WG} = \left(0\frac{km}{h}, -20\ km/h\right)$ This is the wind speed with respect to the ground. Now all we need to do is the correct arithmetic to calculate the airspeed of the plane. We use equation ii. for this. Rearranging terms:

$\vec{v}_{PW} = \vec{v}_{PG} - \vec{v}_{WG}$ Now all we need to do is the term-by-term arithmetic:

X: $750\frac{km}{h} - 0\frac{km}{h} = 750\ km/h$

y: $0\frac{km}{h} - (-20)\frac{km}{h} = 20\ km/h$

So the airspeed of the airplane is: $\vec{v}_{PW} = \left(v_{PWx}, v_{PWy}\right) = \left(750\frac{km}{h}, 20\frac{km}{h}\right)$ which completes the problem.