2.1 Motion | Practice Problems

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Position

#1) Find the distance between the following points:

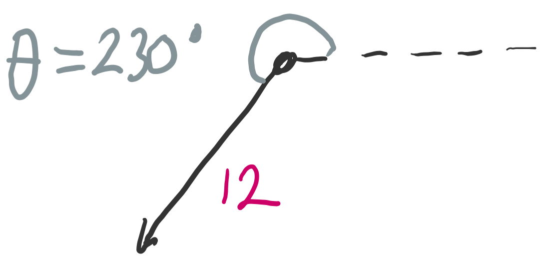
$P_1 = (-33, -11.8)$

$P_2 = (41.46, 25.4)$

Vectors

#2) Find the x and y components of the following vector.

$$\vec{V} = (12, 230°)$$



#3) Find the magnitude and direction of the following vector. Magnitude in meters/second, and direction in degrees from the positive x-axis.

$$\vec{w} = \begin{bmatrix} 33 \\ -20 \end{bmatrix}$$

#4) Find the sum of the following vectors.

Find $\vec{v} + \vec{w}$ where

$$\vec{v} = \begin{bmatrix} -2.5 \\ \pi \end{bmatrix}, \quad \vec{w} = (3, 12^\circ)$$

#5) Find the unit vector of the following vector: $\vec{q}$ where,

$$\vec{q} = \begin{bmatrix} 13 \\ -13 \end{bmatrix}$$

#6) Determine if the following vectors are parallel. (**hint:** vectors are parallel if their unit vectors are equal)

$$\vec{p} = \begin{bmatrix} 14 \\ 25 \end{bmatrix} \quad \vec{g} = (5\ ,\ 47^\circ)$$

#7) Scale the following vector by 150%.

$$\vec{v} = \begin{bmatrix} 41 \\ 46 \end{bmatrix}$$

Velocity

#8) A robot begins the match at position (0 ft, 0 ft) it accelerates to position (4ft, 12ft) in the first 3.2 seconds of the match. Find the magnitude of the average velocity of the robot in the first 3.2 seconds. Your answer should be in feet per second.

#9) Your robot uses a flywheel to shoot a ball into a goal. Currently, the shooter assembly has a "muzzle velocity" of 2.34 meters per second. The shooter is angled 45 degrees above the horizontal. You have an idea for an improvement to the assembly that you estimate would increase the muzzle velocity by **27%**. Find the x and y components of the ball velocity vector after the assembly improvement.

Angular Velocity

#10) You want your robot to move straight forward at 12ft per second. How fast would the wheel need to turn using a 4" diameter Colson wheel. (Colson is a wheel brand) How fast would it need to turn using an 8" pneumatic wheel? Give your answers in Revolutions per Minute (RPM).

#11) Assuming no wheel slip, if your 4" diameter Colson wheel has an angular velocity of 270 degrees per second, how fast will the robot chassis be traveling?

#12) A robot is lining up to shoot a ball into a goal. The robot needs to turn 30 degrees clockwise in order to line up with the goal. The wheels on the left side of the chassis will turn in reverse of the direction of the wheels on the right side of the chassis. If the robot chassis is 23" wide, and has 4" diameter wheels, how many revolutions must the wheels turn in order to achieve the 30-degree heading adjustment? Assume no wheel slip.

Acceleration

#13) Your robot accelerates forwards at $2ft/s^2$. How fast is the robot moving after 5 seconds? How long will it take for the robot to have a velocity of 12.5 m/s?

#14) 3 seconds into the match, a robot is traveling at 6 ft/s. 5 seconds into the match the robot is traveling 3 ft/s. What was the robot's acceleration during the specified time interval?

Frequency

#15) Your robot stores and carries over 50 balls inside of a large hopper assembly. In order to make sure that the balls don't get stuck when being fed through the hopper, you design an oscillator that moves the walls of the hopper back and forth. If the assembly makes 120 oscillations in one minute. What is the frequency of the oscillations in Hertz? How many seconds does it take to complete one oscillation?

#16) Given the same hopper robot from problem #15. You and your team are trying to find the most effective frequency to run your oscillating wall assembly. In order to empirically find the most effective frequency, you set up a test. You are optimizing for the *highest* cycle rate of the hopper.

Trial #	**Test Length (seconds)**	**Number of balls cycled**	**Number of wall oscillation's**
1	*15.23*	*23*	*20*
2	*13.4*	*27*	*26*
3	*18.3*	*31*	*32*
4	*14.5*	*25*	*36*
5	*13.4*	*20*	*40*

Which trial had the best results? What was the rate of shots, in *Balls per Minute* (BPM) , of this trial? What was the oscillation frequency (in Hertz) of this trial?