Section instructor _____ ***Section number*** _____

Last/First name A Daylor

Last 3 Digits of Student ID Number: _____

Show all work. Show all formulas used for each problem prior to substitution of numbers. Label diagrams and include appropriate units for your answers. *You may use an alphanumeric calculator during the exam as long as you do not program any formulas into memory. By using an alphanumeric calculator you agree to allow us to check its memory during the exam. Simple scientific calculators are always OK!*

A Formula Sheet Is Attached To The Back Of This Examination

Be Prepared to Show your Student ID Card

Score on each problem:

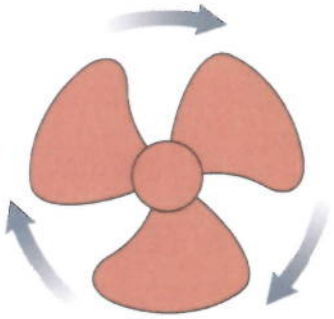
1. *(30)* ____
2. *(20)* ____
3. *(20)* ____
4. *(20)* ____

Total Score (out of 90 pts) ____

1. Conceptual Questions

(30 point) Put a circle around the letter that you think is the best answer.

1.1. (6pts) The fan blade is slowing down. What are the signs of ω and α?



A) ω is positive and α is positive

B) ω is positive and α is negative

C) ω is negative and α is negative

D) ω is negative and α is positive

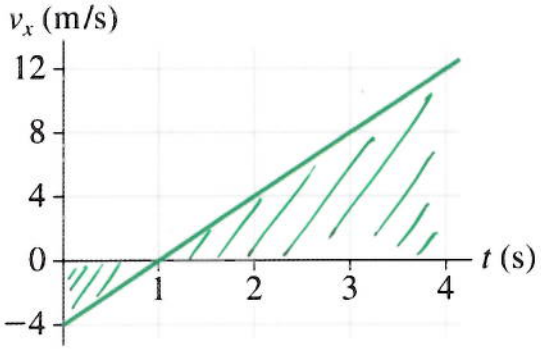
E) ω is positive and α is zero

ω - negative (CW rotation)

(less negative → more negative)

$$\alpha = \frac{\omega_f - \omega_i}{t_f - t_i} > 0$$

1.2. **(6pts)** *An object starts from x_0=8 m at t_0=0 and moves with the velocity graph shown in the figure. What is the object's position at 4 seconds?*



A) 8 m

B) 18 m

C) 24 m

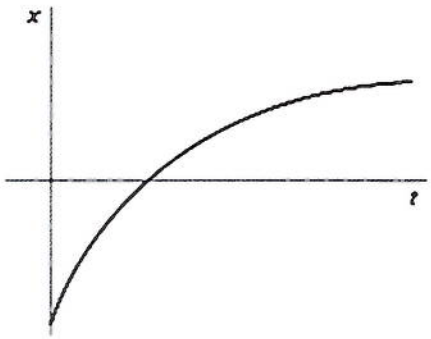
D) 26 m

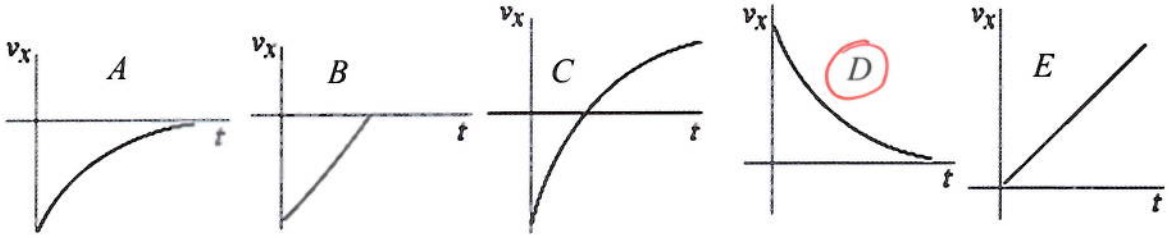
E) 48 m

x = Area under v-vs-t + x_0

$$x(4\,s) = \frac{1}{2}(-4\,m/s)\cdot 1s + \frac{1}{2}12\,m/s\cdot(4-1)s + 8m = 24m$$

1.3.(6pts) *The figure shows the graph of the position x as a function of time for an object moving in the straight line (the x-axis). Which of the following graphs (A-E) best describes the velocity along the x-axis as a function of time for this object?*





1.4. (6pts) What is $\frac{0.674}{0.74}$ *to the proper number of significant figures?*

A) 0.91

B) 0.911

C) 0.9108

D) 0.9

1.5. (6pts) *You are adding vectors of length 10 and 50 units. What is the only possible resultant magnitude that you can obtain out of the following choices?*

A) 10

B) 37

C) 48

D) 63

E) 72

min = 50 − 10 = 40 units

max = 50 + 10 = 60 units

Problem 2. (20 pts)

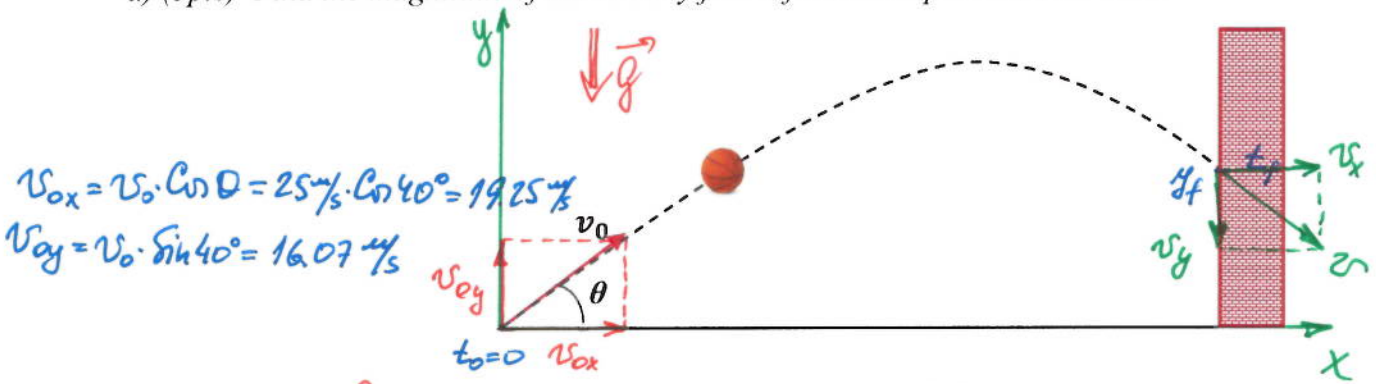
You throw a ball with a speed of 25 m/s at an angle of 40° above the horizontal directly toward a wall as shown in the figure. The wall is 22 m from the release point of the ball.

a) (5pts) How long is the ball in the air before it hits the wall?

b) (5pts) How far above the release point does the ball hit the wall?

c) (5pts) What are the horizontal and vertical components of its velocity as it hits the wall?

d) (5pts) Find the magnitude of the velocity just before the impact with the wall?



$v_{ox} = v_0 \cdot \cos\theta = 25\,m/s \cdot \cos 40° = 19.25\,m/s$

$v_{oy} = v_0 \cdot \sin 40° = 16.07\,m/s$

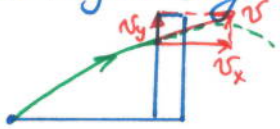
a) t_f - ? $x_f = x_0 + v_{ox} t_f \Rightarrow t_f = \frac{x_f}{v_{ox}} = \frac{22\,m}{19.25\,m/s} = 1.14\,s$

b) y_f - ? $y_f = y_0 + v_{oy} \cdot t_f - g t_f^2/2 = 16.07\,m/s \cdot 1.14\,s - \frac{9.8\,m/s^2}{2} \cdot (1.14\,s)^2 = 11.95\,m \approx 12\,m$

c) Since $a_x = 0 \Rightarrow v_x = v_{ox} = 19.25\,m/s$

$v_y = v_{oy} - g \cdot t_f = 16.07\,m/s - 9.8\,m/s^2 \cdot 1.14\,s = 4.9\,m/s$

Notice! $v_y > 0$ (in + y direction, upward). It means that the ball when it hits the wall has not passed the highest point on its trajectory. So, the original picture is not very accurate.



d) $v = \sqrt{v_x^2 + v_y^2} = \sqrt{(19.25\,m/s)^2 + (4.9\,m/s)^2} = 19.86\,m/s \approx 20\,m/s$

Problem 3. (20 pts)

Starting from rest, a disc rotates about its axis with constant angular acceleration. After 5.0 s, it has rotated through 25 rad.

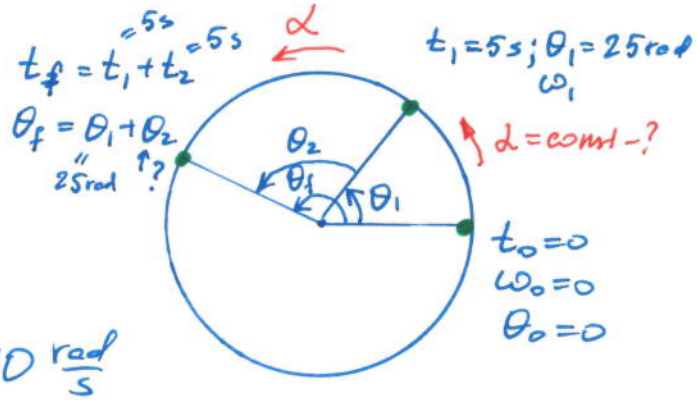
a) *(7pts) What was the angular acceleration during this time?*

b) *(6pts)What is the instantaneous angular velocity of the disc at the end of the 5.0s?*

c) *(7pts))Assuming that the acceleration does not change, through what additional angle will the disc turn during the next 5.0 s?*

a) $\theta_1 = \theta_0 + \omega_0 t_1 + \frac{\alpha t_1^2}{2}$

$\alpha = \frac{2\cdot\theta_1}{t_1^2} = \frac{2\cdot 25\,rad}{(5.0s)^2} = 2.0\ rad/s^2$



b) $\omega_1 = \omega_0 + \alpha\cdot t = 2.0\ \frac{rad}{s^2}\cdot 5s = 10\ \frac{rad}{s}$

c) What is the average angular velocity?

$\bar{\omega}_1 \equiv \frac{\theta_1 - \theta_0}{t_1 - t_0} = \frac{25\,rad}{5.0s} = 5.0\ rad/s$

d) $\theta_f = \theta_1 + \omega_1 (t_f - t_1) + \frac{\alpha (t_f - t_1)^2}{2}$

The additional angle is $\theta_2 = \theta_f - \theta_1$ and $t_f - t_1 = 5.0s$ (addit. time)

$\theta_2 = \theta_f - \theta_1 = \omega_1 (t_f - t_1) + \frac{\alpha (t_f - t_1)^2}{2} = 10\ \frac{rad}{s}\cdot 5.0s + \frac{\left(2\ \frac{rad}{s^2}\right)\cdot (5.0s)^2}{2} = 75\,rad$

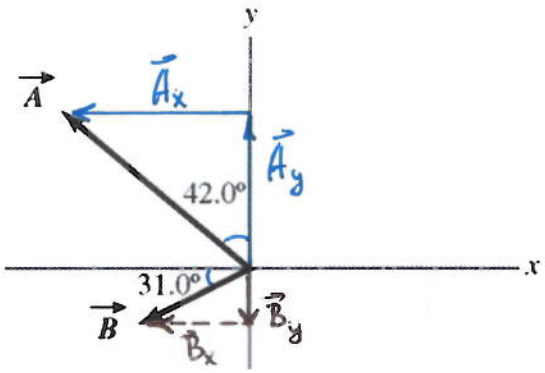
Problem 4 (20 pts).

Vectors $\vec{A}$ and $\vec{B}$ are shown in the figure. Vector $\vec{C}$ is given by $\vec{C} = \vec{B} - \vec{A}$. The magnitude of vector $\vec{A}$ is 16.0 units, and the magnitude of vector $\vec{B}$ is 7.00 units.

a) *(6pts)* Find x- and y-components of the vector $\vec{A}$

b) *(6pts)* Find x- and y-components of the vector $\vec{B}$

c) *(8pts)* What is the magnitude of vector $\vec{C}$?



a) $A_x = -A \cdot \sin 42.0° = -16.0 \text{ units} \cdot \sin 42.0°$

$A_x = -10.71 \approx -10.7 \text{ units}$

$A_y = +A \cdot \cos 42.0° = 11.89 \text{ units}$

$A_y \approx 11.9 \text{ units}$

$\vec{A} = -10.7 \cdot \hat{i} + 11.9 \cdot \hat{j}$

b) $B_x = -B \cdot \cos 31.0° = -7.00 \cdot \cos 31.0° = -6.00 \text{ units}$

$B_y = -B \cdot \sin 31.0° = -3.61 \text{ units}$

$\vec{B} = -6.00 \cdot \hat{i} - 3.61 \cdot \hat{j}$

c) $\vec{C} = \vec{B} - \vec{A} = (-6.00 - (-10.7)) \cdot \hat{i} + (-3.61 - 11.9) \cdot \hat{j}$

$\vec{C} = 4.7 \cdot \hat{i} - 15.51 \cdot \hat{j}$

$C = |\vec{C}| = \sqrt{(4.7)^2 + (-15.51)^2} = \sqrt{262.50} = 16.2 \text{ units}$