Useful Equations

\[ A_x = A \sin(\theta) \quad A = \sqrt{A_x^2 + A_y^2} \quad \theta = \tan^{-1}\left(\frac{A_x}{A_y}\right) \]

\[ \mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k} \quad \mathbf{A} \cdot \mathbf{B} = |\mathbf{A}| |\mathbf{B}| \cos(\theta) \quad |\mathbf{A} \times \mathbf{B}| = |\mathbf{A}| |\mathbf{B}| \sin(\theta) \]

\[ \mathbf{A} \times \mathbf{B} = A_x B_y - A_y B_x \quad \mathbf{A} \times \mathbf{B} = (A_x B_y - A_y B_x) \mathbf{i} + (A_z B_x - A_x B_z) \mathbf{j} + (A_y B_x - A_x B_y) \mathbf{k} \]

\[ \mathbf{v} = \frac{d\mathbf{r}}{dt} \quad \mathbf{v}_x = \frac{\Delta x}{\Delta t} \quad v_x = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt} \quad x_i = x_i + v_x t \quad \ddot{a} = \frac{\Delta \ddot{v}}{\Delta t} \]

\[ a_x = \lim_{\Delta t \to 0} \frac{\Delta v_x}{\Delta t} = \frac{dv_x}{dt} \quad v_x = v_x + a_x t \quad x_i = x_i + \frac{1}{2} (v_{xi} + v_{xf}) t \]

\[ x_i = x_i + v_x t + \frac{1}{2} a_x t^2 \quad v_i^2 = v_x^2 + 2a(x_i - x_i) \]

\[ \mathbf{r} = x_i \mathbf{i} + y_i \mathbf{j} \quad v_y = v_i \cos(\theta) = constant \quad v_y = v_i \sin(\theta) - gt \quad x_f = x_i + v_i \cos(\theta) t \]

\[ y_f = y_i + v_i \cos(\theta) t - \frac{1}{2} g t^2 \quad a_x = \frac{v_i^2}{r} \quad a_i = \frac{d|v|}{dt} \quad y_j = (\tan(\theta)) x_j - \frac{g}{2v_i^2 \cos^2(\theta)} x_j^2 \]

\[ T = \frac{2\pi r}{v} \quad h = \frac{r^2}{2g} \quad R = \frac{r^2}{g} \quad a_r = -a_c = \frac{v_i^2}{r} \quad \mathbf{v}_{ro} = \mathbf{v}_{ro} - \mathbf{v}_{o'o} \]

\[ \sum \mathbf{F} = 0 \quad \mathbf{F}_{12} = -\mathbf{F}_{21} \quad \mathbf{F}_g = m \vec{g} \quad \sum \mathbf{F} = m \ddot{a} \quad \frac{m_1}{m_2} \equiv \frac{a_2}{a_1} \]

Useful Constants

\[ g = 9.80 \text{ m/s}^2 = 32.0 \text{ ft/s}^2 \]
1. (5 pts) A particle starts from rest at the origin and then moves along the x-axis, initially in the positive direction. Which of the following statements can not be true of the motion.

a.) Its instantaneous velocity at some point is smaller than its average velocity.
b.) Its instantaneous velocity at some point is larger than its average velocity.
c.) Its average velocity is zero, while its instantaneous velocity at some points is non-zero
d.) Its average velocity is zero and its instantaneous acceleration is always zero
e.) At very point in its motion, its instantaneous velocity is equal to its average velocity

2. (5 pts) Vector $\mathbf{A} = 12.0 \mathbf{i} - 3.00 \mathbf{j}$ and vector $\mathbf{B} = -4.00 \mathbf{i} - 1.00 \mathbf{j}$. What is the scalar product of $\mathbf{A}$ and $\mathbf{B}$?

a.) 45.0  
b.) -45.0  
c.) 51.0  
d.) -51.0  
e.) none of the above

3. (5 pts) Two forces are acting on a trashcan with a mass of 30.0 kg. The first force is 10.0 N and the second force is 20.0 N. What is the magnitude of the resulting acceleration?

a.) 1.00 m/s  
b.) 0.33 m/s  
c.) 3.00 m/s  
d.) 0.738 m/s  
e.) not enough information to tell
4. (5 pts) You best friend is about to be eaten by a lion on the other side of a wide, deep river. The speed of the river current is 0.500 m/s. You are not a very fast swimmer and can only swim at 0.500 m/s, but are an excellent runner and can run at 20.0 m/s. To get to your friend as quickly as possible, you should:

a.) swim heading straight across the river
b.) swim heading up river at an angle of 45 degrees with respect to the bank
c.) swim heading down river at an angle of 45 degrees with respect to the bank
d.) swim up river at 45 degrees for the first half, then down river at 45 degree for the second half
e.) not enough information to tell

5. (5 pts) Bottle A and bottle B are both launched separately from a liquid nitrogen cannon at an angle of 45 degrees above the horizontal. Bottle B has twice the mass of bottle A. If the pressure inside the cannon is the same when both bottles are launched, then when they each hit the ground, (ignore the height of the cannon, assume the acceleration time of both bottles are the same)

a.) Bottle A will have gone twice as far horizontally as bottle B
b.) Bottle A will have gone half as far horizontally as bottle B
c.) Bottle A will have gone four times as far horizontally as bottle B
d.) Bottle A will have gone one fourth as far horizontally as bottle B
e.) None of the above

6. (5 pts) Two ants are riding around in separate cars on a circular race track. Ant Sam is driving at a constant speed of 100. m/s. Ant Jane is driving at a constant speed of 200. m/s. Which ant experiences the larger acceleration and by how much?

a.) Ant Sam's acceleration is four times as large as Ant Jane's
b.) Ant Sam's acceleration is twice as large as Ant Jane's
c.) Ant Sam's acceleration is half as large as Ant Jane's
d.) Ant Sam's acceleration is one fourth as large as Ant Jane's
e.) Both ants experience the same acceleration

7. (5 pts) If vector C = A x B, then the scalar product of A and C is

a.) 0
b.) |A| * |C|
c.) - |A| * |C|
d.) |A| / |C|
e.) none of the above
8. (5 pts) You throw a ball straight up in the air and catch it when it comes back down. At what point in its motion is the magnitude of its velocity the smallest?

a.) Just after it leaves your hand.
b.) When it reaches its highest point.
c.) Just before it returns to your hand.
d.) The magnitude of the ball's velocity does not change
e.) none of the above

9. (5 pts) In the diagram below, what is the magnitude of the normal force of the table on block 1?

a.) 0 N
b.) 39.2 N
c.) 19.6 N
d.) 58.8 N
e.) none of the above

10.(5 pts) Your infinitely wise physics instructor gives you a graph of the position of a yellow rubber duck versus time and asks you to determine the average velocity of the duck as it travels from point A to point B. You correctly determine this from the graph by

a.) computing the area under the section of the graph between point A and point B
b.) drawing a line tangent to the graph at point A and compute the line's slope
c.) drawing a line from the origin of the graph to point B and compute the line's slope
d.) drawing a line from point A to point B and compute the line's slope
e.) telling your instructor that the average velocity can't be determined from the graph

11.(5 pts) For a baseball batter to maximize the distance that the ball will travel horizontally, he must hit the ball so that the angle its initial velocity makes with the horizontal is

a.) 75 degrees
b.) 60 degrees
c.) 45 degrees
d.) 30 degrees
e.) 15 degrees
12. (5 pts) To impress your friends, you tell them you can tell which of two buildings is
taller and by how much while blindfolded. You drop a ball from building A and you
hear it hit the ground 3.00 s after you drop it. You drop a ball from building B and
you hear it hit the ground 6.00 s after you drop it. The then correctly tell your friends
that (ignore the travel time of the sounds)

a.) building A is four times as tall as building B
b.) building B is four times as tall as building A
c.) building B is twice as tall as building A
d.) building A is twice as tall as building B
e.) none of the above
a.) Determine the distance that the first particle traveled up the incline.

b.) Determine the initial speed of the second particle (circle your final answers and show all work)
14. (20 pts) You just changed your major at UCI to drama and have landed the part of Robin Hood in a local play. During the play you shoot an arrow at a target which is 40.0 m away. You aim at the center of the 5 cm diameter central circle of the target and release the arrow. If the arrow is initially flying horizontally, what is the minimum velocity the arrow has to have so your arrow sticks within the central circle? (ignore air resistance) (circle your final answer and show all work)