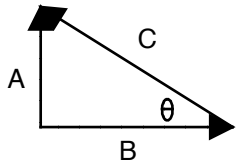
# ~Test 2: *Vectors, Circles & Relative(s)*

Equations and Constants:

$\bar{v} = \frac{\Delta x}{\Delta t}$ $v = \frac{dx}{dt}$ $\bar{a} = \frac{\Delta v}{\Delta t}$ $a = \frac{dv}{dt}$ $\bar{v} = \frac{1}{2}(v_i + v_f)$ $|g| = 10\ m/s^2$

$x = \frac{1}{2}at^2 + v_i t + x_i$ $v = at + v_i$ $v_f^2 = v_i^2 + 2a\Delta x$ $a_c = \frac{v^2}{r}$

**Multiple Choice:** *Choose the letter of the best answer. 3 points each.*




1. _____ Three vectors are shown in the diagram above. Which of the following expressions would match the diagram?
   a. **A** + **B** = **C**. b. **A** + **C** = **B**. c. **C** + **B** = **A**. d. **B** – **A** = **C**. e. **C** – **B** = **A**.

*Questions 2 and 3 refer to the following vectors:*

$\vec{A} = 5\hat{i} - 3\hat{j} + 4\hat{k}$ $\vec{B} = -4\hat{i} - 2\hat{j} + 3\hat{k}$ $\vec{C} = 4\hat{i} + 5\hat{j} - 3\hat{k}$

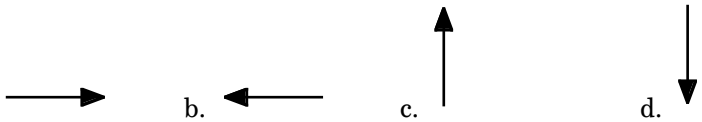
2. _____ What is **B** – **A**?
   a. $-9\hat{i} + \hat{j} - \hat{k}$ b. $-9\hat{i} - 5\hat{j} + 7\hat{k}$ c. $-\hat{i} - 5\hat{j} + 7\hat{k}$ d. $\hat{i} + \hat{j} - \hat{k}$

3. _____ Which two vectors have the same magnitude?
   a. **A** & **B**. b. **A** & **C**. c. **B** & **C**. d. none, they are all different.

4. _____ The initial velocity of an object is 2**i** + 3**j** m/s. It undergoes a constant acceleration of –**i** + 2**j** m/s$^2$ for 4 seconds. What is its final velocity?
   a. **i** + 5**j** m/s b. 3**i** + **j** m/s c. 7**i** + 14**j** m/s d. –6**i** – 5**j** m/s e. –2**i** + 11**j** m/s

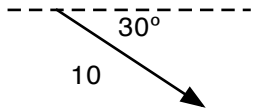
5. _____ If a moving object has an acceleration that is always perpendicular to its velocity, what must be happening?
   a. It must always be slowing down.
   b. It must have a constant speed.
   c. Its path must be a parabola.
   d. It must slow down, stop and then speed up in the opposite direction.
   e. What? It is clearly impossible for this situation to exist.


6. _____ Vectors $\mathbf{r}_i$ and $\mathbf{r}_f$ are shown above. Which of the following would best represent $\Delta\mathbf{r}$?



a. b. c. d. e. none of these.

7. _____ What is the vector in unit-vector notation for the vector shown in the diagram to the right?
   a. 8.7**i** – 5**j**. b. 8.7**i** + 5**j**. c. 5**i** + 8.7**j**.
   d. 1.5**i** – 9.9**j** . e. 1.5**i** – 9.9**j**.



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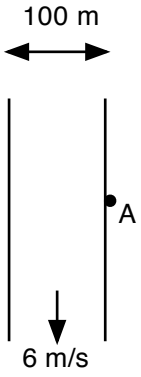
*Questions 8 to 10 refer to the following:*
Charlie is riding a Ferris Wheel of radius 7 meters. He is moving with a constant speed of 3 m/s.

8. _____ What is the magnitude of his acceleration when he is at his lowest point?
a. 16.3 m/s$^2$. b. 1.3 m/s$^2$. c. 0.8 m/s$^2$. d. 8.7 m/s$^2$. e. 6.3 m/s$^2$.

9. _____ When he is at the lowest point on the ride, which of the following vectors best represent his acceleration?
a. ←. b. →. c. ↑. d. ↓. e. none of these.

10. _____ With how many "rpm"s is he rotating?
a. 0.068 rpm. b. 4.09 rpm. c. 14.7 rpm. d. 43.9 rpm. e. 180 rpm.

*Questions 11 to 13 refer to the following:*
A river is 100 m wide and has a current that is flowing at 6 m/s. A duck has a water speed of 8 m/s.

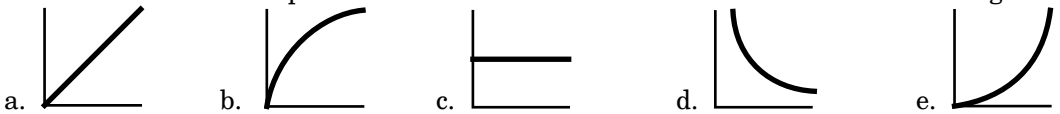



11. _____ What would be the minimum time the duck needs to cross the river?
a. 16.7 s. b. 12.5 s. c. 10.0 s. d. 7.14 s.

12. _____ What would be the fastest possible speed of the duck with respect to the ground?
a. 5.3 m/s. b. 8 m/s. c. 10 m/s. d. 14 m/s.

13. _____ If the duck had a water velocity directed due west, what would be the velocity of the duck with respect to the ground?
a. $-8\mathbf{i} - 6\mathbf{j}$ m/s. b. $8\mathbf{i} + 6\mathbf{j}$ m/s. c. $8\mathbf{i} - 10\mathbf{j}$ m/s. d. $-10\mathbf{i} - 8\mathbf{j}$ m/s.

14. _____ Which of the following would best represent the acceleration of an object traveling in a circle with a constant speed as a function of the radius of the circle it was moving in?




**Problem Solving:** *Show all work. 10 points each.*

15. The position in meters as a function of time in seconds for an object is given by

$$\vec{r} = (-t^3 + t^2 + 5)\hat{i} + (-5t^2 + 15t)\hat{j}$$

What is the average velocity of the object for the first 4 seconds?

16. Some students do a lab recording the postion of an object that is rotating with a constant speed. They notice that at one time, hte position of the object is $-4\mathbf{i} + 2\mathbf{j}$. Then 3.5 seconds later the, object has made exactly half a rotation and the postion is $6\mathbf{i} + 2\mathbf{j}$. In unit-vector notation, what is the acceleration of the object when it is at the second position?

17. A plane is flying with an airpseed of 75 km/h. The pilot wants to go straight to an airport that is 300 km SE of her current position. Ground Control reports that there is a constant wind velocity of 25 km/h E. She orients the plane in such a way that she flies directly to the airport. How long will it take her to reach the airport?

18. The earth has a radius of 6400 km. How long would one day be if the earth rotated so fast that the centripetal acceleration of someone standing on the equator was equal to 9.8 $m/s^2$? (Also, in this situation, what would be the centripetal acceleration for someone at the North Pole?)