PH 201 Homework Assignment Chapter on Vectors and Introductory Math Concepts – 21 Problems Total

1. A student sees a newspaper ad for an apartment that has 1330 square feet (ft^2) of floor space. How many square meters of area are there?

Solution for Problem 1

2. Suppose a man's scalp hair grows at a rate of 0.35 mm per day. What is this growth rate in feet per century?

Solution for Problem 2

3. A bottle of wine known as a magnum contains a volume of 1.5 liters. A bottle known as a jeroboam contains 0.792 U.S. gallons. How many magnums are there in one jeroboam?

Solution for Problem 3

4. A partly full paint can has 0.67 U.S. gallons of paint left in it. **(a)** What is the volume of the paint in cubic meters? **(b)** If all the remaining paint is used to coat a wall evenly (wall area = 13 m^2), how thick is the layer of wet paint? Give your answer in meters.

Solution for Problem 4

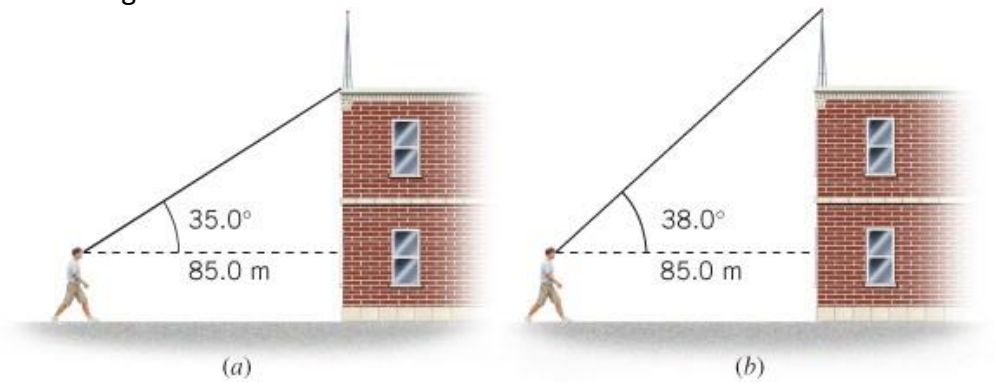
5. A spring is hanging down from the ceiling, and an object of mass *m* is attached to the free end. The object is pulled down, thereby stretching the spring, and then released. The object oscillates up and down, and the time *T* required for one complete up-and-down oscillation is given by the equation $T = 2\pi\sqrt{m/k}$, where *k* is known as the spring constant. What must be the dimension of *k* for this equation to be dimensionally correct?

Solution for Problem 5

6. You are driving into St. Louis, Missouri, and in the distance you see the famous Gateway to the West arch. This monument rises to a height of 192 m. You estimate your line of sight with the top of the arch to be 2.0° above the horizontal. Approximately how far (in kilometers) are you from the base of the arch?

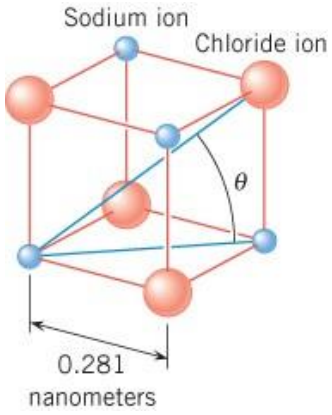
Solution for Problem 6

7. The drawing shows a person looking at a building on top of which an antenna is mounted. The horizontal distance between the person's eyes and the building is 85.0 m. In part (*a)* the person is looking at the base of the antenna, and his line of sight makes an angle of 35.0° with the horizontal. In part (*b)* the person is looking at the top of the antenna, and his line of sight makes an angle of 38.0° with the horizontal. How tall is the antenna?



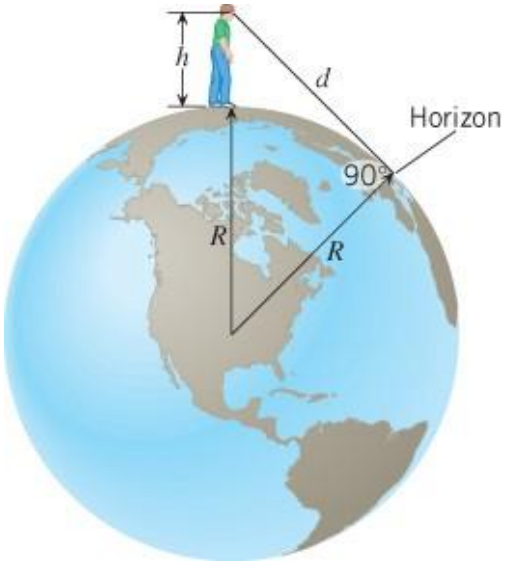
Solution for Problem 7

8. The drawing shows sodium and chloride ions positioned at the corners of a cube that is part of the crystal structure of sodium chloride (common table salt). The edges of the cube are each 0.281 nm (1 nm = 1 nanometer = 10^{-9} m) in length. What is the value of the angle θ in the drawing?



Solution for Problem 8

9. A person is standing at the edge of the water and looking out at the ocean (see the drawing). The height of the person's eyes above the water is h = 1.6 m, and the radius of the earth is $R = 6.38 \times 10^6$ m. **(a)** How far is it to the horizon? In other words, what is the distance d from the person's eyes to the horizon? *(Note: At the horizon the angle between the line of sight and the radius of the earth is 90°.)* **(b)** Express this distance in miles.



Solution for Problem 9

10. (a) Two workers are trying to move a heavy crate. One pushes on the crate with a force $\vec{A}$, which has a magnitude of 445 newtons and is directed due west. The other pushes with a force $\vec{B}$, which has a magnitude of 325 newtons and is directed due north. What are the magnitude and direction of the resultant force $\vec{A} + \vec{B}$ applied to the crate? **(b)** Suppose that the second worker applies a force $-\vec{B}$ instead of $\vec{B}$. What then are the magnitude and direction of the resultant force $\vec{A} - \vec{B}$ applied to the crate? In both cases express the direction relative to due west.

Solution for Problem 10

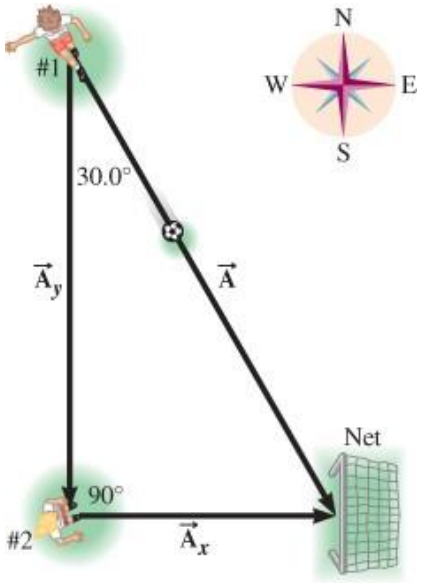
11. Consider the following four force vectors:
$\overrightarrow{\boldsymbol{F_1}} = 50.0$ newtons, due east
$\overrightarrow{\boldsymbol{F_2}} = 10.0$ newtons, due east
$\overrightarrow{\boldsymbol{F_3}} = 40.0$ newtons, due west
$\overrightarrow{\boldsymbol{F_4}} = 30.0$ newtons, due west
Which two vectors add together to give a resultant with the smallest magnitude, and which two vectors add to give a resultant with the largest magnitude? In each case specify the magnitude and direction of the resultant.

Solution for Problem 11

12. Vector $\vec{\boldsymbol{A}}$ has a magnitude of 12.3 units and points due west. Vector $\vec{\boldsymbol{B}}$ points due north. **(a)** What is the magnitude of $\vec{\boldsymbol{B}}$ if $\vec{\boldsymbol{A}} + \vec{\boldsymbol{B}}$ has a magnitude of 15.0 units? **(b)** What is the direction of $\vec{\boldsymbol{A}} + \vec{\boldsymbol{B}}$ relative to due west? **(c)** What is the magnitude of $\vec{\boldsymbol{B}}$ if $\vec{\boldsymbol{A}} - \vec{\boldsymbol{B}}$ has a magnitude of 15.0 units? **(d)** What is the direction of $\vec{\boldsymbol{A}} - \vec{\boldsymbol{B}}$ relative to due west?

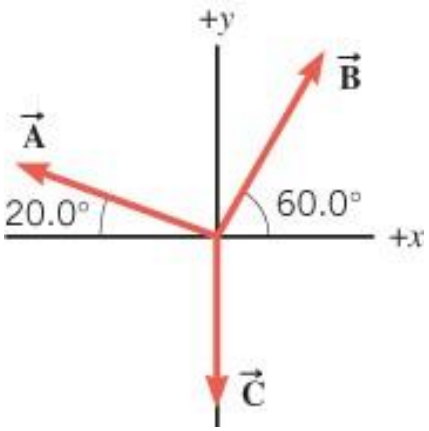
Solution for Problem 12

13. Soccer player #1 is 8.6 m from the goal (see the drawing). If she kicks the ball directly into the net, the ball has a displacement labeled $\vec{\boldsymbol{A}}$. If, on the other hand, she first kicks it to player #2, who then kicks it into the net, the ball undergoes two successive displacements, $\overrightarrow{\boldsymbol{A_y}}$ and $\overrightarrow{\boldsymbol{A_x}}$. What are the magnitudes and directions of $\overrightarrow{\boldsymbol{A_x}}$ and $\overrightarrow{\boldsymbol{A_y}}$?



Solution for Problem 13

14. The three displacement vectors in the drawing have magnitudes of *A* = 5.00 m, *B* = 5.00 m, and *C* = 4.00 m. Find the resultant (magnitude and directional angle) of the three vectors by means of the component method. Express the directional angle as an angle above the positive or negative *x* axis.



Solution for Problem 14

15. Displacement vector $\vec{A}$ points due east and has a magnitude of 2.00 km. Displacement vector $\vec{B}$ points due north and has a magnitude of 3.75 km. Displacement vector $\vec{C}$ points due west and has a magnitude of 2.50 km. Displacement vector $\vec{D}$ points due south and has a magnitude of 3.00 km. Find the magnitude and direction (relative to due west) of the resultant vector $\vec{A} + \vec{B} + \vec{C} + \vec{D}$.

Solution for Problem 15

16. Two geological field teams are working in a remote area. A global positioning system (GPS) tracker at their base camp shows the location of the first team as 38 km away, 19° north of west, and the second team as 29 km away, 35° east of north. When the first team uses its GPS to check the position of the second team, what does the GPS give for the second team's **(a)** distance from them and **(b)** direction, measured from due east?

Solution for Problem 16

17. A chimpanzee sitting against his favorite tree gets up and walks 51 m due east and 39 m due south to reach a termite mound, where he eats lunch. **(a)** What is the shortest distance between the tree and the termite mound? **(b)** What angle does the shortest distance make with respect to due east?

Solution for Problem 17

18. The speed of an object and the direction in which it moves constitute a vector quantity known as the velocity. An ostrich is running at a speed of 17.0 m/s in a direction of 68.0° north of west. What is the magnitude of the ostrich's velocity component that is directed **(a)** due north and **(b)** due west?

Solution for Problem 18

19. The volume of liquid flowing per second is called the volume flow rate *Q* and has the dimensions of $[L]^3/[T]$. The flow rate of a liquid through a hypodermic needle during an injection can be estimated with the following equation:

$$Q = \frac{\pi R^n \left(P_2 - P_1\right)}{8\eta L}$$

The length and radius of the needle are *L* and *R*, respectively, both of which have the dimension [L]. The pressures at opposite ends of the needle are P_2 and P_1, both of which have the dimensions of $[M]/\{[L][T]^2\}$. The symbol η represents the viscosity of the liquid and has the dimensions of $[M]/\{[L][T]\}$. The symbol π stands for pi and, like the number 8 and the exponent *n*, has no dimensions. Using dimensional analysis, determine the value of *n* in the expression for *Q*.

Solution for Problem 19

20. A pilot flies her route in two straight-line segments. The displacement vector $\vec{A}$ for the first segment has a magnitude of 244 km and a direction 30.0° north of east. The displacement vector $\vec{B}$ for the second segment has a magnitude of 175 km and a direction due west. The resultant displacement vector is $\vec{R} = \vec{A} + \vec{B}$ and makes an angle θ with the direction due east. Using the component method, find the magnitude of $\vec{R}$ and the directional angle θ.

Solution for Problem 20

21. What are the *x* and *y* components of the vector that must be added to the following three vectors, so that the sum of the four vectors is zero? Due east is the+*x* direction, and due north is the +*y* direction.

$\vec{A} = 113$ units, 60.0° south of west

$\vec{B} = 222$ units, 35.0° south of east

$\vec{C} = 177$ units, 23.0° north of east

Solution for Problem 21

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