

Chapter 1

Introduction to Vectors

1. Which of the following natural phenomena would serve as the best time standard?
- The mean orbit radius of the earth.
 - The period of audible sound waves.
 - The time for one inhalation or exhalation.
 - The time it takes a leaf to fall from a tree to the ground.
 - The speed of the Mississippi River.

ANS: b

2. Using the prefixes given in Table 1.4 of your text, how would you express 4×10^{-9} g?
- 4 Gg
 - 4 Tg
 - 4 mg
 - 4 ng
 - 4 cg

ANS: d

3. If $m = \rho V$, where ρ is a constant of proportionality, the kg is the unit of m , and the m^3 is the unit of V , what is the unit of ρ ?
- $\text{kg} \cdot \text{m}^3$
 - kg
 - m^3
 - kg/m^3
 - m^3/kg

ANS: d

4. If $x = \frac{1}{2}at^2$, with meters the units of x , and seconds the units of t , what are the units of a ?
- m
 - s^2
 - m/s^2
 - s^2/m
 - $\text{m} \cdot \text{s}^2$

ANS: c

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5. Assuming that m and t have different dimensions, which of the following would be physically meaningful?

- a. mt
- b. $m + t$
- c. $m - t$
- d. $\frac{m + t}{m}$
- e. $\frac{mt}{m - t}$

ANS: a

6. If the mass density of a 3×10^6 kg mass is 2×10^4 kg/m³, what volume in m³ does the mass occupy to the nearest order of magnitude?

- a. 10^1
- b. 10^2
- c. 10^3
- d. 10^4
- e. 10^5

ANS: b

7. What is the order of magnitude of the age of a 40-year-old person in seconds?

- a. 10^5
- b. 10^6
- c. 10^7
- d. 10^8
- e. 10^9

ANS: e

8. A woman walks 200 m west, then 300 m north, then 200 m south, then 200 m east. What is her displacement?

- a. 100 m E
- b. 100 m W
- c. 100 m N
- d. 100 m S
- e. The displacement is zero.

ANS: c

9. A car traveled 300 km west, then 250 km south, then 150 km east, then 250 km north. What distance did it travel in km?

- a. 950
- b. 850
- c. 150
- d. 250
- e. 300

ANS: a

10. The magnitude of vector \vec{A} is 3 m and that of vector \vec{B} is 4 m. What is the largest magnitude in meters that their sum may have?

- a. 5
- b. 6
- c. 7
- d. 8
- e. 9

ANS: c

11. The magnitude of vector \vec{A} is 3 m and that of vector \vec{B} is 4 m. What is the smallest magnitude in meters that their sum may have?

- a. 1
- b. 2
- c. 3
- d. 4
- e. 5

ANS: a

12. The magnitude of vector \vec{A} is 3 m and that of vector \vec{B} is 4 m. What is the largest magnitude in meters that their difference may have?

- a. 5
- b. 6
- c. 7
- d. 8
- e. 9

ANS: c

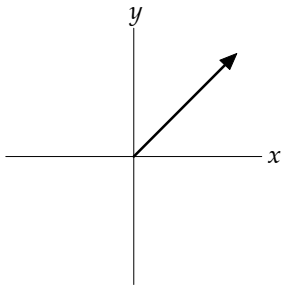
13. The magnitude of vector \vec{A} is 3 m and that of vector \vec{B} is 4 m. What is the smallest magnitude in meters that their difference may have?

- a. 1
- b. 2
- c. 3
- d. 4
- e. 5

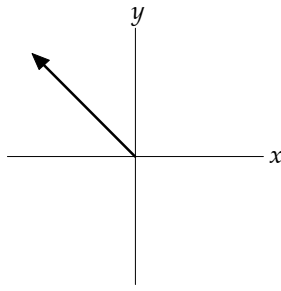
ANS: a

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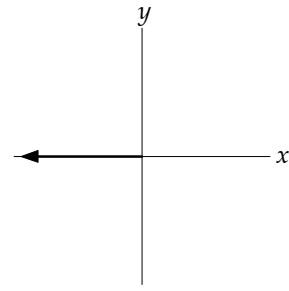
14. Given the vectors below, which vector has negative components in both the x and y directions?



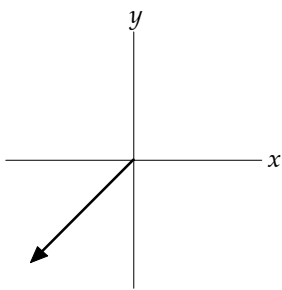
a.



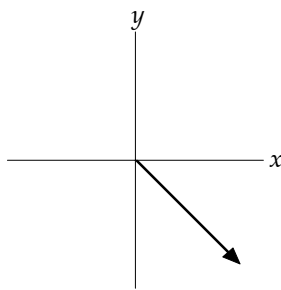
b.



c.



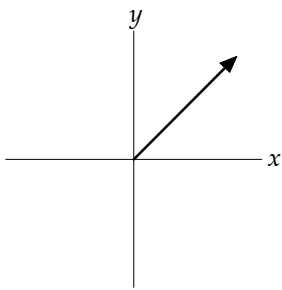
d.



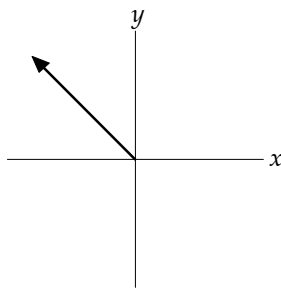
e.

ANS: d

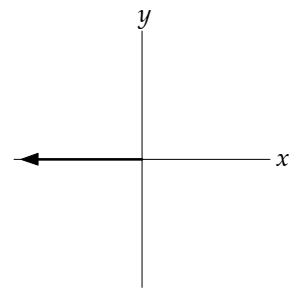
15. Given the vectors below, which vector has a negative component in the x direction and a positive component in the y direction?



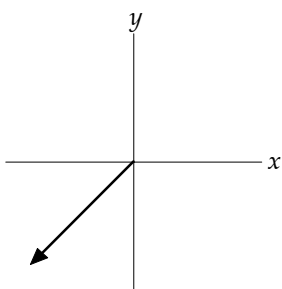
a.



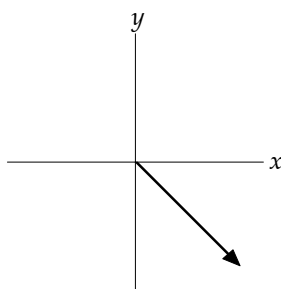
b.



c.



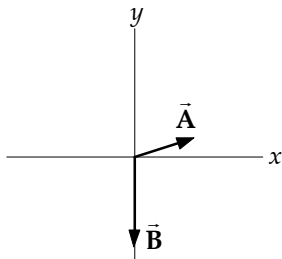
d.



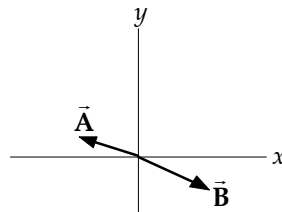
e.

ANS: b

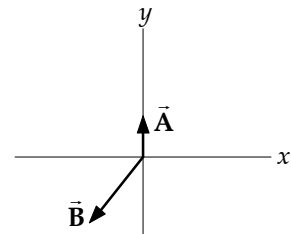
16. In which diagram does the sum $\vec{A} + \vec{B}$ of the vectors \vec{A} and \vec{B} have a positive component in the y direction?



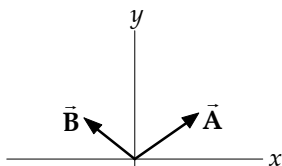
a.



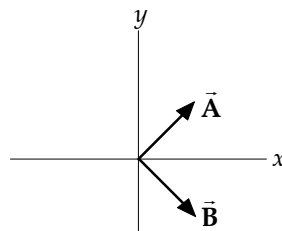
b.



c.



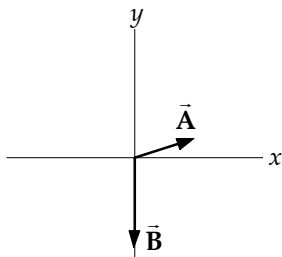
d.



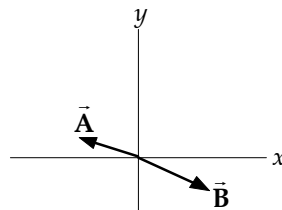
e.

ANS: d

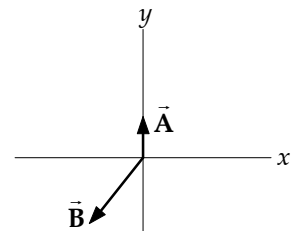
17. In which diagram does the difference $\vec{A} - \vec{B}$ of the vectors \vec{A} and \vec{B} have a negative component in the x direction?



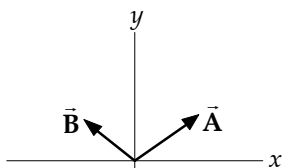
a.



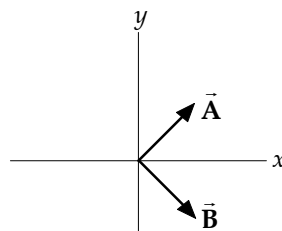
b.



c.



d.

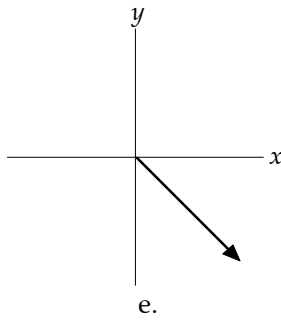
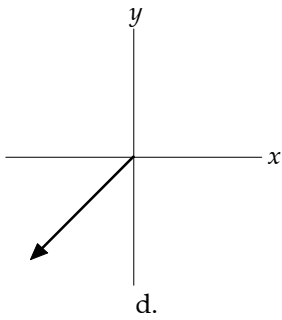
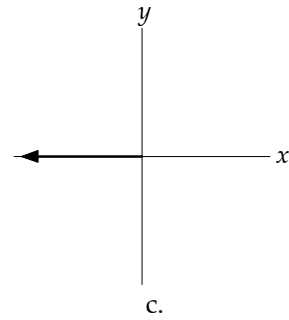
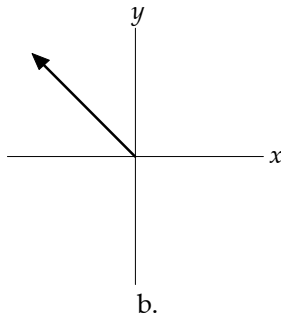
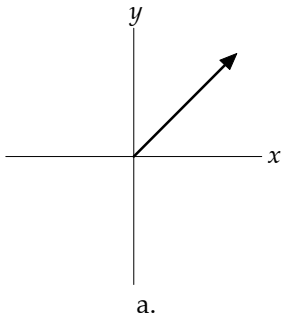


e.

ANS: b

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18. Given the vectors below, which vector has a zero component in the y direction?



ANS: c

19. Which of the following is a scalar?

- a. Displacement
- b. Force
- c. Velocity
- d. Acceleration
- e. Distance

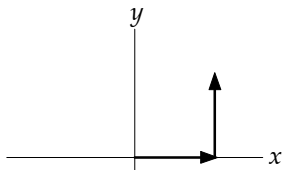
ANS: e

20. Which of the following is a vector?

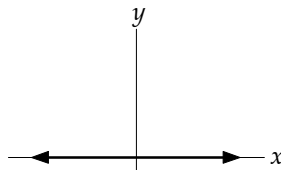
- a. Momentum
- b. Temperature
- c. Volume
- d. Mass
- e. Density

ANS: a

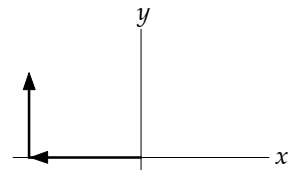
21. Two vectors are shown in each diagram below. In which diagram is the sum of the two vectors equal to zero?



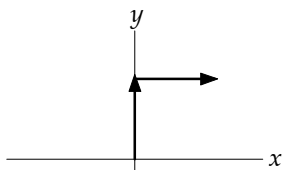
a.



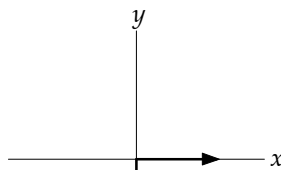
b.



c.



d.



e.

ANS: b

22. A woman starts from the origin and walks 50 m west. Then she walks 15 m east. What is her displacement?

- a. 15 m W
- b. 35 m W
- c. 50 m W
- d. 65 m W
- e. 75 m E

ANS: b

23. A scuba diver dives at an angle of 60° with the horizontal and swims 30 m to the top of a reef. How far under water in meters is the top of the reef?

- a. 15
- b. 26
- c. 24
- d. 18
- e. 12

ANS: b

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24. A woman starts at the origin and walks 9 m along the x -axis. She then turns 90° and walks parallel to the y -axis for 12 m. How far in meters is she from the origin?

- a. 9
- b. 12
- c. 15
- d. 18
- e. 21

ANS: c

25. What is the density in kg/m^3 of a solid cube that measures 0.700 m on a side and has a mass of 343 kg?

- a. 100
- b. 280
- c. 490
- d. 1000
- e. 1530

ANS: d

26. What is the mass in kilograms of two liters of helium, where $1.00 \ell = 1.00 \times 10^3 \text{ cm}^3$? $\rho_{\text{He}} = 0.179 \text{ kg}/\text{m}^3$

- a. 3.58×10^{-6}
- b. 3.58×10^{-4}
- c. 3.58×10^{-3}
- d. 8.65×10^{-2}
- e. 86.5

ANS: b

27. If $T = 2\pi \sqrt{\frac{\ell}{g}}$, where T is measured in seconds and ℓ is measured in meters, what are the units of g ?

- a. m/s^2
- b. s^2/m
- c. kg/s^2
- d. s^2/kg
- e. $\frac{1}{\text{s}^2}$

ANS: a

28. If $K = \frac{1}{2}mv^2$, where m is measured in kilograms and v in m/s, what are the units of K ?

- a. s^2/kg
- b. m^2/s^2
- c. $\frac{\text{kg} \cdot \text{s}^2}{\text{m}^2}$
- d. $\frac{\text{kg} \cdot \text{m}^2}{\text{s}^2}$
- e. $\frac{\text{s}^2}{\text{kg} \cdot \text{m}^2}$

ANS: d

29. A light year is the distance light travels in a year. If the speed of light is $c = 3.00 \times 10^8$ m/s, how many meters are there in a light year? Use 365 days/year, 24 hours/day, 60 minutes/hour, 60 seconds/minute and 2.54 cm/inch.

- a. 1.58×10^{15}
- b. 3.94×10^{14}
- c. 8.23×10^{14}
- d. 3.72×10^{15}
- e. 9.46×10^{15}

ANS: e

30. 1.00 cubic foot of water spills on a floor. It covers 25.8 ft^2 . How deep is the water in centimeters?

- a. 2.34
- b. 1.18
- c. 0.0462
- d. 0.178
- e. 0.923

ANS: b

31. If an average human heart beats 70 times per minute, the best estimate of the number of times a heart will beat in 80 years is:

- a. 10^5
- b. 10^6
- c. 10^7
- d. 10^8
- e. 10^9

ANS: e

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32. Suppose that the average number of books each student carries is 2 and that one of the states of the United States has ten percent of the 100 million students in the country. How many books are being carried in the state in question?

- a. 10^6
- b. 10^8
- c. 10^{10}
- d. 10^7
- e. 10^9

ANS: d

33. What is the area in cm^2 of a computer disk whose diameter is 5.25 inches?

- a. 21.6
- b. 55.0
- c. 140.
- d. 87
- e. 54.9

ANS: c

34. Four of the products below give conversions from miles per hour to cm per second that are dimensionally or numerically incorrect. Which one is correct?

- a. $\frac{70 \text{ mi}}{\text{h}} \cdot \frac{5280 \text{ f}}{\text{mi}} \cdot \frac{2.54 \text{ cm}}{\text{f}} \cdot \frac{1 \text{ h}}{60 \text{ min}} \cdot \frac{1 \text{ min}}{60 \text{ s}}$
- b. $\frac{70 \text{ mi}}{\text{h}} \cdot \frac{5280 \text{ in}}{\text{mi}} \cdot \frac{2.54 \text{ cm}}{\text{f}} \cdot \frac{100 \text{ cm}}{\text{m}} \cdot \frac{1 \text{ h}}{60 \text{ min}} \cdot \frac{1 \text{ min}}{60 \text{ s}}$
- c. $\frac{70 \text{ mi}}{\text{h}} \cdot \frac{5280 \text{ yd}}{\text{mi}} \cdot \frac{36 \text{ in}}{\text{yd}} \cdot \frac{2.54 \text{ cm}}{\text{f}} \cdot \frac{1 \text{ h}}{60 \text{ min}} \cdot \frac{1 \text{ min}}{600 \text{ s}}$
- d. $\frac{70 \text{ mi}}{\text{h}} \cdot \frac{5280 \text{ in}}{\text{mi}} \cdot \frac{2.54 \text{ cm}}{\text{in}} \cdot \frac{1 \text{ h}}{60 \text{ min}} \cdot \frac{1 \text{ min}}{60 \text{ s}}$
- e. $\frac{70 \text{ mi}}{\text{h}} \cdot \frac{5280 \text{ f}}{\text{mi}} \cdot \frac{12 \text{ in}}{\text{f}} \cdot \frac{2.54 \text{ cm}}{\text{in}} \cdot \frac{1 \text{ h}}{60 \text{ min}} \cdot \frac{1 \text{ min}}{60 \text{ s}}$

ANS: e

35. Two points in the xy plane have coordinates $(1.0, -1.0)$ and $(5.0, 2.0)$ in centimeters. What is the distance between the points in centimeters?

- a. 1.0
- b. 2.0
- c. 3.0
- d. 4.0
- e. 5.0

ANS: e

36. What are the polar coordinates of the point (8.0, 6.0)?

- a. $r = 8.0, \theta = 53^\circ$
- b. $r = 10, \theta = 37^\circ$
- c. $r = 10, \theta = 53^\circ$
- d. $r = 6.5, \theta = 30^\circ$
- e. $r = 7.5, \theta = 61^\circ$

ANS: b

37. What are the Cartesian coordinates of the point $(r, \theta) = \left(2.0, \frac{\pi}{4}\right)$?

- a. (1.4, 1.4)
- b. (2.8, 2.8)
- c. (1.0, 3.0)
- d. $\left(\frac{\pi}{2}, \frac{\pi}{4}\right)$
- e. (0.0, 2.0)

ANS: a

38. If $x = 14$ and $y = 13$, what is r ?

- a. 15
- b. 16
- c. 17
- d. 18
- e. 19

ANS: e

39. If $x = 12$ and $y = 13$, what is r ?

- a. 12
- b. 14
- c. 16
- d. 18
- e. 25

ANS: d

40. If $x = 14.0$ cm and $y = 15.0$ cm, what is θ ?

- a. 46.15°
- b. 43.0°
- c. 47.0°
- d. 48.9°
- e. 43.1°

ANS: c

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41. If $x = 12$ cm and $y = 14$ cm, what is θ ?

- a. 50°
- b. 48°
- c. 7.2°
- d. 41°
- e. 6.1°

ANS: b

42. If a vector has an x component of 11 and a y component of 13, what is the magnitude of this vector?

- a. 16
- b. 17
- c. 18
- d. 19
- e. 20

ANS: b

43. Three vectors are given by $\vec{A} = 2\hat{i} + 3\hat{j}$, $\vec{B} = 3\hat{i} - 2\hat{j}$ and $\vec{C} = -2\hat{i} + \hat{j}$. What is the sum of the three vectors?

- a. $-3\hat{i} + \hat{j}$
- b. $2\hat{j} - 3\hat{i}$
- c. $2\hat{j} + 3\hat{i}$
- d. $\hat{i} + 2\hat{j}$
- e. $3\hat{i} + 2\hat{j}$

ANS: e

44. A person walks 50 m north, then 50 m west, then 25 m south. At what angle measured from the east direction would the person have had to walk to go directly to the destination reached?

- a. 26°
- b. 153°
- c. 63°
- d. 116°
- e. 27°

ANS: b

45. If $\vec{a} = [15, 80^\circ]$, and $\vec{b} = 12\hat{i} - 16\hat{j}$, what is the magnitude of $\vec{a} - \vec{b}$?

- a. 15
- b. 35
- c. 32
- d. 5.0
- e. 23

ANS: c

46. A vector, \vec{B} , when added to the vector $\vec{C} = 3\hat{i} + 4\hat{j}$, yields a resultant vector which is in the positive y direction and has a magnitude equal to that of \vec{C} . What is the magnitude of \vec{B} ?

- a. 3.2
- b. 6.3
- c. 9.5
- d. 18
- e. 5.0

ANS: a

47. If vector \vec{B} is added to vector \vec{A} , the result is $6\hat{i} + \hat{j}$. If \vec{B} is subtracted from \vec{A} , the result is $-4\hat{i} + 7\hat{j}$. What is the magnitude of \vec{A} ?

- a. 5.1
- b. 4.1
- c. 5.4
- d. 5.8
- e. 8.2

ANS: b

48. If $\vec{C} = [2.5 \text{ cm}, 80^\circ]$, i.e., the magnitude and direction of \vec{C} are 2.5 cm and 80° , $\vec{D} = [3.5 \text{ cm}, 120^\circ]$, and $\vec{E} = \vec{D} - 2\vec{C}$, what is the direction of \vec{E} to the nearest degree?

- a. 247°
- b. 235°
- c. 243°
- d. 234°
- e. 216°

ANS: e

49. If $\vec{A} = 12\hat{i} - 16\hat{j}$ and $\vec{B} = -24\hat{i} + 10\hat{j}$, what is the magnitude of the vector $\vec{C} = 2\vec{A} - \vec{B}$?

- a. 42
- b. 22
- c. 64
- d. 90
- e. 13

ANS: c

50. A vector \vec{A} is added to $\vec{B} = 6\hat{i} - 8\hat{j}$. The resultant vector is in the positive x direction and has a magnitude equal to \vec{A} . What is the magnitude of \vec{A} ?

- a. 11
- b. 5.1
- c. 7.1
- d. 8.3
- e. 12.2

ANS: d

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51. If $\vec{A} = 12\hat{i} - 16\hat{j}$ and $\vec{B} = -24\hat{i} + 10\hat{j}$, what is the direction of the vector $\vec{C} = 2\vec{A} - \vec{B}$?

- a. -49°
- b. -41°
- c. -90°
- d. $+49^\circ$
- e. $+221^\circ$

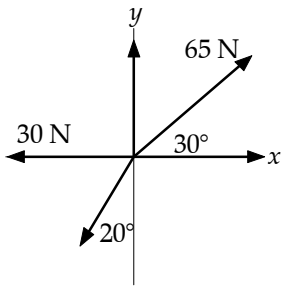
ANS: b

52. If $\vec{C} = (10 \text{ m}, 30^\circ)$ and $\vec{D} = (25 \text{ m}, 130^\circ)$, what is the magnitude of the sum of these two vectors in meters?

- a. 20
- b. 35
- c. 15
- d. 25
- e. 5

ANS: d

53. The three forces shown act on a particle. What is the magnitude of the resultant of these three forces?



- a. 27 N
- b. 33 N
- c. 36 N
- d. 24 N
- e. 105 N

ANS: d

54. In scientific notation with the correct number of significant figures, the correct value of the sum $3.272 \times 10^5 + 3.272 \times 10^4$ is:

- a. 3.5992×10^4
- b. 3.599×10^4
- c. 3.599×10^5
- d. 3.5992×10^5
- e. 3.600×10^5

ANS: c

55. In scientific notation with the correct number of significant figures, the correct value of the difference $3.272 \times 10^5 - 3.2720 \times 10^4$ is:

- a. 2.945×10^5
- b. 2.9450×10^5
- c. 2.94500×10^5
- d. 2.9448×10^5
- e. 2.94480×10^5

ANS: a

56. A batter in a baseball game hits a home run and runs around the bases. The magnitude of her displacement when she returns to home plate is:

- a. 0 m.
- b. twice the distance from home plate to second base.
- c. the total distance around the bases.
- d. not defined unless we know the angles between the lines from base to base.
- e. not defined since a real game is not a physics problem.

ANS: a

57. Given two non-zero vectors \vec{A} and \vec{B} such that $|A_x| = |B_x|$ and $|A_y| = |B_y|$, which one of the following can never be correct?

- a. $\vec{A} + \vec{B} = 2\vec{A}$
- b. $\vec{A} + \vec{B} = 2\vec{B}$
- c. $|\vec{A} + \vec{B}| = 0$
- d. $\vec{A} + \vec{B} = \vec{A} - \vec{B}$
- e. $|\vec{A} + \vec{B}| = 2A_x$

ANS: d

58. Of the possible representations of a 100 m race given below, the one that physicists would not usually use is a

- a. mental representation.
- b. graphical representation.
- c. pictorial representation.
- d. theatrical representation.
- e. mathematical representation.

ANS: d

16 Introduction and Vectors

59. Which answer below has the correct units and correct number of significant figures for z when z is

obtained by the calculation $z = \frac{8.439 \text{ m}^2 - 8.341 \text{ m}^2}{1.212 \text{ m} + 2.33 \text{ m}}$?

- a. $2.767 \times 10^{-2} \text{ m}^2$
- b. $2.77 \times 10^{-2} \text{ m}^2$
- c. $2.8 \times 10^{-2} \text{ m}^2$
- d. $2.8 \times 10^{-2} \text{ m}$
- e. $2.77 \times 10^{-2} \text{ m}$

ANS: d

60. The dimension of distance is length, $[\ell]$, and the dimension of time is time, $[t]$. What are the dimensions of flow rate for a liquid exiting a pipe, where the flow rate is the volume leaving the pipe in unit time?

- a. $\left[\frac{\ell}{t} \right]$
- b. $\left[\frac{\ell^2}{t} \right]$
- c. $\left[\frac{\ell^3}{t} \right]$
- d. $\left[\frac{\ell^3}{t^3} \right]$
- e. $\left[\ell^3 t \right]$

ANS: c

61. The dimension of distance is length, $[\ell]$, and the dimension of time is time, $[t]$. What are the dimensions of the quantity defined by $\sqrt{\frac{g}{L}}$, where L is the length of a pendulum and g is the acceleration of gravity,

9.80 m/s^2 ?

- a. $\left[\frac{\ell}{t} \right]$
- b. $\left[\frac{\ell}{t^2} \right]$
- c. $\left[\frac{\ell^2}{t^2} \right]$
- d. $\left[\frac{1}{t^2} \right]$
- e. $\left[\frac{1}{t} \right]$

ANS: e

62. Gold has a density of $19.3 \times 10^3 \text{ kg/m}^3$. One atomic mass of gold, 197 g, contains 6.02×10^{23} atoms. What volume in cubic meters does this 6.02×10^{23} atom mass occupy?

- a. 1.0×10^{-5}
- b. 1.0×10^{-3}
- c. 1.0×10^{-2}
- d. 3.8×10^3
- e. 3.8×10^6

ANS: a

63. A problem may be solved more easily when alternative representations are used. The best strategy is to formulate representations in an order that assists in understanding the physical principles involved. Of the orders given below, the one that will work best most often is:

- a. pictorial representation, mathematical representation, tabular representation, mental representation
- b. pictorial representation, mental representation, mathematical representation, tabular representation
- c. mathematical representation, pictorial representation, tabular representation, mental representation
- d. mathematical representation, tabular representation, mental representation, pictorial representation
- e. mental representation, pictorial representation, tabular representation, mathematical representation

ANS: e

64. If each frame of a motion picture film is 35 cm high, and 24 frames go by in a second, estimate how many frames are needed to show a two hour long movie.

- a. 1 400
- b. 25 000
- c. 50 000
- d. 170 000
- e. This cannot be determined without knowing how many reels were used.

ANS: d

65. A scientific explanation of an observation is provided by

- a. repeating the experiment and getting the same numbers.
- b. describing the procedures for performing the experiment.
- c. listing all the equations that were solved.
- d. giving definitions of the symbols used in the equations.
- e. combining the experimental results with reasoning to answer the question "how do we know?"

ANS: e

66. The magnitude of the vector \vec{A} is written as A . The magnitude $|\vec{A} + \vec{A}|$ of the vector sum $\vec{A} + \vec{A}$, is

- a. A .
- b. $\sqrt{2}A$.
- c. $2A$.
- d. $2\sqrt{2}A$.
- e. $4A$.

ANS: c

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67. Given two non-zero vectors, $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$, such that $|\vec{\mathbf{A}}| = A = B = |\vec{\mathbf{B}}|$, the sum $\vec{\mathbf{A}} + \vec{\mathbf{B}}$ satisfies

- a. $0 \leq |\vec{\mathbf{A}} + \vec{\mathbf{B}}| \leq 2A$.
- b. $0 < |\vec{\mathbf{A}} + \vec{\mathbf{B}}| < 2A$.
- c. $A \leq |\vec{\mathbf{A}} + \vec{\mathbf{B}}| \leq 2A$.
- d. $A < |\vec{\mathbf{A}} + \vec{\mathbf{B}}| < 2A$.
- e. $0 \leq |\vec{\mathbf{A}} + \vec{\mathbf{B}}| \leq 4A$.

ANS: a

68. Given two non-zero vectors, $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$, such that $|\vec{\mathbf{A}}| = A = B = |\vec{\mathbf{B}}|$, the difference $\vec{\mathbf{A}} - \vec{\mathbf{B}}$ satisfies

- a. $0 \leq |\vec{\mathbf{A}} - \vec{\mathbf{B}}| \leq A$.
- b. $0 < |\vec{\mathbf{A}} - \vec{\mathbf{B}}| < A$.
- c. $0 \leq |\vec{\mathbf{A}} - \vec{\mathbf{B}}| \leq 2A$.
- d. $0 < |\vec{\mathbf{A}} - \vec{\mathbf{B}}| < 2A$.
- e. $0 \leq |\vec{\mathbf{A}} - \vec{\mathbf{B}}| \leq 4A$.

ANS: c

69. The population of the United States is now over 290 million people. The number of bars of soap used at home in a year is closest to

- a. 10^8 .
- b. 10^{10} .
- c. 10^{12} .
- d. 10^{14} .
- e. 10^{16} .

ANS: b

70. You find that a line to the top of a cylindrical water tower makes an angle of 28° with a line to the base of the tower when you are 100 m from the base of the tower. How tall is the tower?

- a. 47 m.
- b. 53 m.
- c. 88 m.
- d. 100 m.
- e. 188 m.

ANS: b

71. If $\vec{C} = (10 \text{ m}, 30^\circ)$ and $\vec{D} = (25 \text{ m}, 150^\circ)$, what is the direction of the sum of these two vectors?
- a. 37°
 - b. 53°
 - c. 127°
 - d. 143°
 - e. 150°

ANS: c

72. An analysis model consists of
- a. a detailed summary of all characteristics of all parts of the system.
 - b. a summary in which insignificant details have been ignored.
 - c. a problem of the same general type that has been solved before.
 - d. a view in three dimensions following engineering graphics rules.
 - e. a combination of (a) and (d) above.

ANS: c