

***University Physics with Modern Physics, 14e, Global Edition (Young/Freedman)***  
**Chapter 1 Units, Physical Quantities, and Vectors**

**1.1 Conceptual Questions**

- 1) The current definition of the standard meter of length is based on
- A) the distance between the earth's equator and north pole.
  - B) the distance between the earth and the sun.
  - C) the distance traveled by light in a vacuum.
  - D) the length of a particular object kept in France.

Answer: C

Var: 1

- 2) The current definition of the standard second of time is based on
- A) the frequency of radiation emitted by cesium atoms.
  - B) the earth's rotation rate.
  - C) the duration of one year.
  - D) the oscillation of a particular pendulum kept in France.

Answer: A

Var: 1

- 3) The current definition of the standard kilogram of mass is based on
- A) the mass of the earth.
  - B) the mass of the sun.
  - C) the mass a particular object kept in France.
  - D) the mass of a cesium-133 atom.

Answer: C

Var: 1

- 4) If a woman weighs 125 lb, her mass expressed in kilograms is  $x$  kg, where  $x$  is
- A) less than 125.
  - B) greater than 125.

Answer: A

Var: 1

- 5) If a tree is 15 m tall, its height expressed in feet is  $x$  ft, where  $x$  is
- A) less than 15.
  - B) greater than 15.

Answer: B

Var: 1

- 6) If a flower is 6.5 cm wide, its width expressed in millimeters is  $x$  mm, where  $x$  is
- A) less than 6.5.
  - B) greater than 6.5.

Answer: B

Var: 1

7) If an operation lasts for 5.75 min, its length expressed in seconds is  $x$  s, where  $x$  is

- A) less than 5.75.
- B) greater than 5.75.

Answer: B

Var: 1

8) Scientists use the metric system chiefly because it is more accurate than the English system.

- A) True
- B) False

Answer: B

Var: 1

9) When adding two numbers, the number of significant figures in the sum is equal to the number of significant figures in the least accurate of the numbers being added.

- A) True
- B) False

Answer: B

Var: 1

10) When determining the number of significant figures in a number, zeroes to the left of the decimal point are never counted.

- A) True
- B) False

Answer: B

Var: 1

11) Which of the following is an accurate statement?

- A) The magnitude of a vector can be zero even though one of its components is not zero.
- B) It is possible to add a scalar quantity to a vector.
- C) Even though two vectors have unequal magnitudes, it is possible that their vector sum is zero.
- D) Rotating a vector about an axis passing through the tip of the vector does not change the vector.
- E) The magnitude of a vector is independent of the coordinate system used.

Answer: E

Var: 1

12) If  $\vec{A} - \vec{B} = 0$ , then the vectors  $\vec{A}$  and  $\vec{B}$  have equal magnitudes and are directed in the opposite directions from each other.

- A) True
- B) False

Answer: B

Var: 1

13) Under what condition is  $|\vec{A} - \vec{B}| = A + B$ ?

- A) The magnitude of vector  $\vec{B}$  is zero.
- B) Vectors  $\vec{A}$  and  $\vec{B}$  are in opposite directions.
- C) Vectors  $\vec{A}$  and  $\vec{B}$  are in the same direction.
- D) Vectors  $\vec{A}$  and  $\vec{B}$  are in perpendicular directions.
- E) The statement is never true.

Answer: B

Var: 1

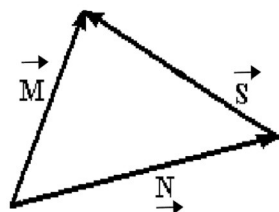
14) If  $A > B$ , under what condition is  $|\vec{A} - \vec{B}| = A - B$ ?

- A) The statement is never true.
- B) Vectors  $\vec{A}$  and  $\vec{B}$  are in opposite directions.
- C) Vectors  $\vec{A}$  and  $\vec{B}$  are in the same direction.
- D) Vectors  $\vec{A}$  and  $\vec{B}$  are in perpendicular directions.
- E) The statement is always true.

Answer: C

Var: 1

15) For the vectors shown in the figure, express vector  $\vec{S}$  in terms of vectors  $\vec{M}$  and  $\vec{N}$ .



Answer:  $\vec{S} = \vec{M} - \vec{N}$

Var: 1

16) The magnitude of a vector can never be less than the magnitude of one of its components.

- A) True
- B) False

Answer: A

Var: 1

17) If the magnitude of vector  $\vec{A}$  is less than the magnitude of vector  $\vec{B}$ , then the  $x$  component of  $\vec{A}$  is less than the  $x$  component of  $\vec{B}$ .

- A) True
- B) False

Answer: B

Var: 1

18) If the eastward component of vector  $\vec{A}$  is equal to the westward component of vector  $\vec{B}$  and their northward components are equal. Which one of the following statements about these two vectors is correct?

- A) Vector  $\vec{A}$  is parallel to vector  $\vec{B}$ .
- B) Vectors  $\vec{A}$  and  $\vec{B}$  point in opposite directions.
- C) Vector  $\vec{A}$  is perpendicular to vector  $\vec{B}$ .
- D) The magnitude of vector  $\vec{A}$  is equal to the magnitude of vector  $\vec{B}$ .
- E) The magnitude of vector  $\vec{A}$  is twice the magnitude of vector  $\vec{B}$ .

Answer: D

Var: 1

19) If all the components of a vector are equal to 1, then that vector is a unit vector.

- A) True
- B) False

Answer: B

Var: 1

20) If the dot product of two nonzero vectors is zero, the vectors must be perpendicular to each other.

- A) True
- B) False

Answer: A

Var: 1

21) If two nonzero vectors point in the same direction, their dot product must be zero.

- A) True
- B) False

Answer: B

Var: 1

22) The value of the dot product of two vectors depends on the particular coordinate system being used.

- A) True
- B) False

Answer: B

Var: 1

23) If two vectors are perpendicular to each other, their cross product must be zero.

- A) True
- B) False

Answer: B

Var: 1

24) If two vectors point in opposite directions, their cross product must be zero.

A) True

B) False

Answer: A

Var: 1

25) If  $\vec{A}$  and  $\vec{B}$  are nonzero vectors for which  $\vec{A} \cdot \vec{B} = 0$ , it must follow that

A)  $\vec{A} \times \vec{B} = 0$ .

B)  $\vec{A}$  is parallel to  $\vec{B}$ .

C)  $|\vec{A} \times \vec{B}| = AB$ .

D)  $|\vec{A} \times \vec{B}| = 1$ .

Answer: C

Var: 1

## 1.2 Problems

1) Convert  $1.2 \times 10^{-3}$  to decimal notation.

A) 1.200

B) 0.1200

C) 0.0120

D) 0.0012

E) 0.00012

Answer: D

Var: 5

2) Write out the number  $7.35 \times 10^{-5}$  in full with a decimal point and correct number of zeros.

A) 0.00000735

B) 0.0000735

C) 0.000735

D) 0.00735

E) 0.0735

Answer: B

Var: 5

3) 0.0001776 can also be expressed as

A)  $1.776 \times 10^{-3}$ .

B)  $1.776 \times 10^{-4}$ .

C)  $17.72 \times 10^4$ .

D)  $1772 \times 10^5$ .

E)  $177.2 \times 10^7$ .

Answer: B

Var: 5

4)  $0.00325 \times 10^{-8}$  cm can also be expressed in mm as

A)  $3.25 \times 10^{-12}$  mm.

B)  $3.25 \times 10^{-11}$  mm.

C)  $3.25 \times 10^{-10}$  mm.

D)  $3.25 \times 10^{-9}$  mm.

E)  $3.25 \times 10^{-8}$  mm.

Answer: C

Var: 1

5) If, in a parallel universe,  $\pi$  has the value 3.14149, express  $\pi$  in that universe to four significant figures.

A) 3.141

B) 3.142

C) 3.1415

D) 3.1414

Answer: A

Var: 1

6) The number 0.003010 has

A) 7 significant figures.

B) 6 significant figures.

C) 4 significant figures.

D) 2 significant figures.

Answer: C

Var: 1

7) 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

Answer: A

Var: 50+

8) What is the value of  $\pi(8.104)^2$ , written with the correct number of significant figures?

A) 206.324

B) 206.323

C) 206.3

D) 206

E) 200

Answer: C

Var: 1

9) What is the sum of 1123 and 10.3 written with the correct number of significant figures?

A)  $1.13 \times 10^3$

B) 1133.3000

C)  $1.1 \times 10^3$

D) 1133.3

E) 1133

Answer: E

Var: 1

10) What is the sum of  $1.53 + 2.786 + 3.3$  written with the correct number of significant figures?

A) 8

B) 7.6

C) 7.62

D) 7.616

E) 7.6160

Answer: B

Var: 3

11) What is the difference between 103.5 and 102.24 written with the correct number of significant figures?

A) 1

B) 1.3

C) 1.26

D) 1.260

E) 1.2600

Answer: B

Var: 3

12) What is the product of 11.24 and 1.95 written with the correct number of significant figures?

A) 22

B) 21.9

C) 21.92

D) 21.918

E) 21.9180

Answer: B

Var: 3

13) What is the result of  $1.58 \div 3.793$  written with the correct number of significant figures?

A)  $4.1656 \times 10^{-1}$

B)  $4.166 \times 10^{-1}$

C)  $4.17 \times 10^{-1}$

D)  $4.2 \times 10^{-1}$

E)  $4 \times 10^{-1}$

Answer: C

Var: 3

14) What is  $34 + (3) \times (1.2465)$  written with the correct number of significant figures?

- A) 37.7
- B) 37.74
- C)  $4 \times 10^1$
- D) 38
- E) 37.7395

Answer: D

Var: 5

15) What is  $56 + (32.00)/(1.2465 + 3.45)$  written with the correct number of significant figures?

- A) 62.8
- B) 62.812
- C) 62.81
- D) 63
- E) 62.8123846

Answer: D

Var: 1

16) Add 3685 g and 66.8 kg and express your answer in milligrams (mg).

- A)  $7.05 \times 10^7$  mg
- B)  $7.05 \times 10^4$  mg
- C)  $7.05 \times 10^5$  mg
- D)  $7.05 \times 10^6$  mg

Answer: A

Var: 50+

17) Express  $(4.3 \times 10^6)^{-1/2}$  in scientific notation.

- A)  $4.8 \times 10^{-4}$
- B)  $2.1 \times 10^3$
- C)  $2.1 \times 10^{-5}$
- D)  $2.1 \times 10^4$

Answer: A

Var: 40

18) What is  $0.205^{2/3}$ , expressed to the proper number of significant figures?

- A) 0.348
- B) 0.35
- C) 0.3
- D) 0.3477

Answer: A

Var: 50+



19) The length and width of a rectangle are 1.125 m and 0.606 m, respectively. Multiplying, your calculator gives the product as 0.68175. Rounding properly to the correct number of significant figures, the area should be written as

- A)  $0.7 \text{ m}^2$ .
- B)  $0.68 \text{ m}^2$ .
- C)  $0.682 \text{ m}^2$ .
- D)  $0.6818 \text{ m}^2$ .
- E)  $0.68175 \text{ m}^2$ .

Answer: C

Var: 1

20) The following exact conversion equivalents are given:  $1 \text{ m} = 100 \text{ cm}$ ,  $1 \text{ in} = 2.54 \text{ cm}$ , and  $1 \text{ ft} = 12 \text{ in}$ . If a computer screen has an area of  $1.27 \text{ ft}^2$ , this area is closest to

- A)  $0.00284 \text{ m}^2$ .
- B)  $0.0465 \text{ m}^2$ .
- C)  $0.118 \text{ m}^2$ .
- D)  $0.284 \text{ m}^2$ .
- E)  $4.65 \text{ m}^2$ .

Answer: C

Var: 1

21) In addition to  $1 \text{ m} = 39.37 \text{ in.}$ , the following exact conversion equivalents are given:  $1 \text{ mile} = 5280 \text{ ft}$ ,  $1 \text{ hour} = 60 \text{ min}$ , and  $1 \text{ min} = 60 \text{ s}$ . If a particle has a velocity of 8.4 miles per hour, its velocity, in m/s, is closest to

- A) 3.8 m/s.
- B) 3.0 m/s.
- C) 3.4 m/s.
- D) 4.1 m/s.
- E) 4.5 m/s.

Answer: A

Var: 50+

22) A weight lifter can bench press  $171 \text{ kg}$ . How many milligrams (mg) is this?

- A)  $1.71 \times 10^8 \text{ mg}$
- B)  $1.71 \times 10^9 \text{ mg}$
- C)  $1.71 \times 10^7 \text{ mg}$
- D)  $1.71 \times 10^6 \text{ mg}$

Answer: A

Var: 50+

23) How many nanoseconds does it take for a computer to perform one calculation if it performs  $6.7 \times 10^7$  calculations per second?

- A) 15 ns
- B) 67 ns
- C) 11 ns
- D) 65 ns

Answer: A

Var: 50+

24) The shortest wavelength of visible light is approximately 400 nm. Express this wavelength in centimeters.

- A)  $4 \times 10^{-5}$  cm
- B)  $4 \times 10^{-7}$  cm
- C)  $4 \times 10^{-9}$  cm
- D)  $4 \times 10^{-11}$  cm
- E)  $400 \times 10^{-11}$  cm

Answer: A

Var: 1

25) The wavelength of a certain laser is 0.35 micrometers, where 1 micrometer =  $1 \times 10^{-6}$  m. Express this wavelength in nanometers.

- A)  $3.5 \times 10^2$  nm
- B)  $3.5 \times 10^3$  nm
- C)  $3.5 \times 10^1$  nm
- D)  $3.5 \times 10^4$  nm

Answer: A

Var: 50+

26) A certain CD-ROM disk can store approximately  $6.0 \times 10^2$  megabytes of information, where  $10^6$  bytes = 1 megabyte. If an average word requires 9.0 bytes of storage, how many words can be stored on one disk?

- A)  $6.7 \times 10^7$  words
- B)  $5.4 \times 10^9$  words
- C)  $2.1 \times 10^7$  words
- D)  $2.0 \times 10^9$  words

Answer: A

Var: 9

27) A plot of land contains 5.8 acres. How many square meters does it contain?

[1 acre = 43,560 ft<sup>2</sup>]

A)  $2.3 \times 10^4$  m<sup>2</sup>

B)  $7.1 \times 10^3$  m<sup>2</sup>

C)  $7.0 \times 10^4$  m<sup>2</sup>

D)  $5.0 \times 10^4$  m<sup>2</sup>

Answer: A

Var: 50+

28) A person on a diet loses 1.6 kg in a week. How many micrograms/second ( $\mu\text{g/s}$ ) are lost?

A)  $2.6 \times 10^3$   $\mu\text{g/s}$

B)  $1.6 \times 10^5$   $\mu\text{g/s}$

C) 44  $\mu\text{g/s}$

D)  $6.4 \times 10^4$   $\mu\text{g/s}$

Answer: A

Var: 11

29) Albert uses as his unit of length (for walking to visit his neighbors or plowing his fields) the albert (A), the distance Albert can throw a small rock. One albert is 92 meters. How many square alberts are equal to one acre? (1 acre = 43,560 ft<sup>2</sup> = 4050 m<sup>2</sup>)

Answer: 1.29 A<sup>2</sup>

Var: 50+

30) Convert a speed of 4.50 km/h to units of ft/min. (1.00 m = 3.28 ft)

A) 0.246 ft/min

B) 82.3 ft/min

C) 165 ft/min

D) 246 ft/min

E) 886 ft/min

Answer: D

Var: 1

31) The exhaust fan on a typical kitchen stove pulls 600 CFM (cubic feet per minute) through the filter. Given that 1.00 in. = 2.54 cm, how many cubic meters per second does this fan pull?

A) 0.283 m<sup>3</sup>/sec

B) 0.328 m<sup>3</sup>/sec

C) 3.05 m<sup>3</sup>/sec

D) 32.8 m<sup>3</sup>/sec

Answer: A

Var: 1

32) The mass of a typical adult woman is closest to

- A) 20 kg.
- B) 35 kg.
- C) 75 kg.
- D) 150 kg.

Answer: C

Var: 1

33) The height of the ceiling in a typical home, apartment, or dorm room is closest to

- A) 100 cm.
- B) 200 cm.
- C) 400 cm.
- D) 500 cm.

Answer: B

Var: 1

34) Approximately how many times does an average human heart beat in a year?

- A)  $4 \times 10^5$
- B)  $4 \times 10^6$
- C)  $4 \times 10^7$
- D)  $4 \times 10^8$
- E)  $4 \times 10^9$

Answer: C

Var: 1

35) Approximately how many times does an average human heart beat in a lifetime?

- A)  $3 \times 10^{11}$
- B)  $3 \times 10^{10}$
- C)  $3 \times 10^9$
- D)  $3 \times 10^8$
- E)  $3 \times 10^7$

Answer: C

Var: 1

36) Approximately how many pennies would you have to stack to reach an average 8-foot ceiling?

A)  $2 \times 10^2$

B)  $2 \times 10^3$

C)  $2 \times 10^4$

D)  $2 \times 10^5$

E)  $2 \times 10^6$

Answer: B

Var: 1

37) Estimate the number of times the earth will rotate on its axis during a human's lifetime.

A)  $3 \times 10^4$

B)  $3 \times 10^5$

C)  $3 \times 10^6$

D)  $3 \times 10^7$

E)  $3 \times 10^8$

Answer: A

Var: 1

38) Estimate the number of pennies that would fit in a box one foot long by one foot wide by one foot tall.

A)  $5 \times 10^2$

B)  $5 \times 10^3$

C)  $5 \times 10^4$

D)  $5 \times 10^5$

E)  $5 \times 10^6$

Answer: C

Var: 1

39) A marathon is 26 mi and 385 yd long. Estimate how many strides would be required to run a marathon. Assume a reasonable value for the average number of feet/stride.

A)  $4.5 \times 10^4$  strides

B)  $4.5 \times 10^3$  strides

C)  $4.5 \times 10^5$  strides

D)  $4.5 \times 10^6$  strides

Answer: A

Var: 1

40) The period of a pendulum is the time it takes the pendulum to swing back and forth once. If the only dimensional quantities that the period depends on are the acceleration of gravity,  $g$ , and the length of the pendulum,  $\ell$ , what combination of  $g$  and  $\ell$  must the period be proportional to?

(Acceleration has SI units of  $\text{m} \cdot \text{s}^{-2}$ .)

- A)  $g/\ell$
- B)  $g\ell^2$
- C)  $g\ell$
- D)  $\sqrt{g\ell}$
- E)  $\sqrt{\ell/g}$

Answer: E

Var: 1

41) The speed of a wave pulse on a string depends on the tension,  $F$ , in the string and the mass per unit length,  $\mu$ , of the string. Tension has SI units of  $\text{kg} \cdot \text{m} \cdot \text{s}^{-2}$  and the mass per unit length has SI units of  $\text{kg} \cdot \text{m}^{-1}$ . What combination of  $F$  and  $\mu$  must the speed of the wave be proportional to?

- A)  $F / \mu$
- B)  $\mu / F$
- C)  $\sqrt{\mu / F}$
- D)  $\sqrt{\mu F}$
- E)  $\sqrt{F / \mu}$

Answer: A

Var: 1

42) The position  $x$ , in meters, of an object is given by the equation  $x = A + Bt + Ct^2$ , where  $t$  represents time in seconds. What are the SI units of  $A$ ,  $B$ , and  $C$ ?

- A) m, m, m
- B) m, s, s
- C) m, s,  $\text{s}^2$
- D) m, m/s,  $\text{m/s}^2$
- E) m/s,  $\text{m/s}^2$ ,  $\text{m/s}^3$

Answer: A

Var: 1

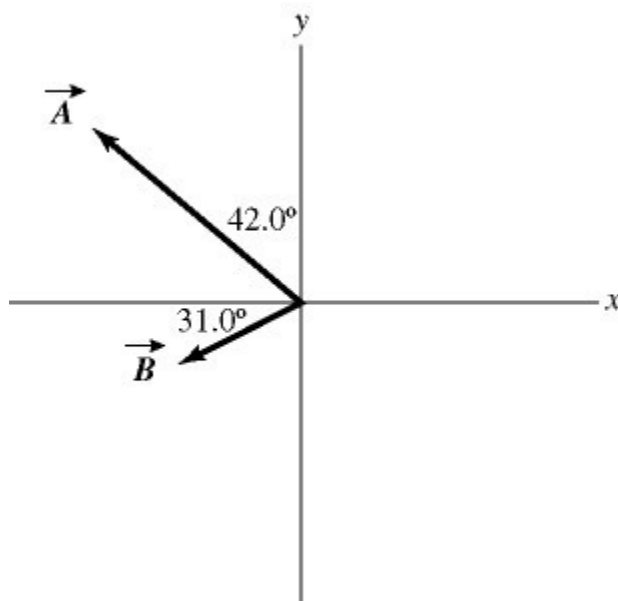
43) You walk 55 m to the north, then turn  $60^\circ$  to your right and walk another 45 m. How far are you from where you originally started?

- A) 87 m
- B) 50 m
- C) 94 m
- D) 46 m

Answer: A

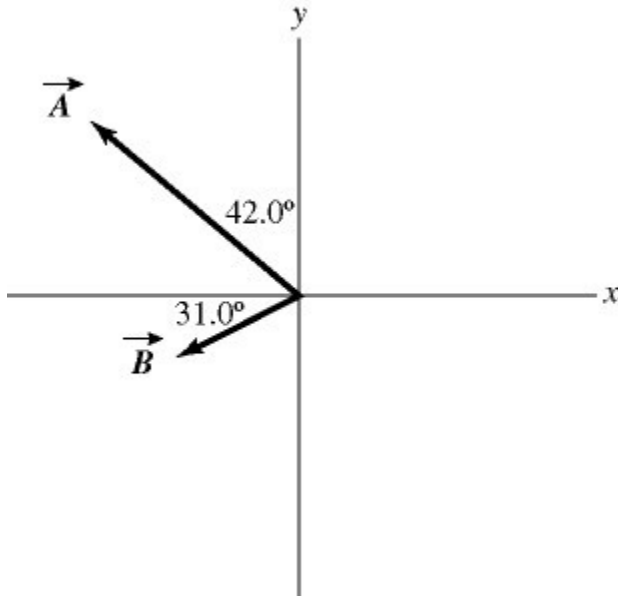
Var: 31

44) 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. What is the magnitude of vector  $\vec{C}$ ?



- A) 9.00
  - B) 9.53
  - C) 15.5
  - D) 16.2
  - E) 17.5
- Answer: D  
Var: 1

45) 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. What is the angle of vector  $\vec{C}$ , measured counterclockwise from the +x-axis?



- A) 16.9°
  - B) 22.4°
  - C) 73.1°
  - D) 287°
  - E) 292°
- Answer: D  
Var: 1

46) A rabbit trying to escape a fox runs north for 8.0 m, darts northwest for 1.0 m, then drops 1.0 m down a hole into its burrow. What is the magnitude of the net displacement of the rabbit?

- A) 8.8 m
- B) 8.1 m
- C) 66 m
- D) 10 m

Answer: A  
Var: 50+

47) You walk 53 m to the north, then turn 60° to your right and walk another 45 m. Determine the direction of your displacement vector. Express your answer as an angle relative to east.

- A) 63° N of E
- B) 50° N of E
- C) 57° N of E
- D) 69° N of E

Answer: A  
Var: 50+



48) Vector  $\vec{A}$  has a magnitude 5.00 and points in a direction  $40.0^\circ$  clockwise from the negative  $y$  axis. What are the  $x$  and  $y$  components of vector  $\vec{A}$ .

- A)  $A_x = 3.83$  and  $A_y = 3.21$
- B)  $A_x = 3.83$  and  $A_y = -3.21$
- C)  $A_x = -3.21$  and  $A_y = -3.83$
- D)  $A_x = -3.21$  and  $A_y = 3.83$
- E)  $A_x = 4.29$  and  $A_y = 2.16$

Answer: C

Var: 5

49) The components of vector  $\vec{A}$  are  $A_x = +3.90$  and  $A_y = -4.00$ . What is the angle measured counterclockwise from the  $+x$ -axis to vector  $\vec{A}$ ?

- A)  $314^\circ$
- B)  $134^\circ$
- C)  $224^\circ$
- D)  $136^\circ$
- E)  $46.0^\circ$

Answer: A

Var: 1

50) Vector  $\vec{A}$  has a magnitude of 5.5 cm and points along the  $x$ -axis. Vector  $\vec{B}$  has a magnitude of 7.5 cm and points at  $+30^\circ$  above the negative  $x$ -axis.

- (a) Determine the  $x$  and  $y$  components of Vector  $\vec{A}$ .
- (b) Determine the  $x$  and  $y$  components of Vector  $\vec{B}$ .
- (c) Determine  $x$  and  $y$  components of the sum of these two vectors.
- (d) Determine the magnitude and direction of the sum of these two vectors.

Answer:

- (a)  $A_x = 5.5$  cm,  $A_y = 0$
- (b)  $B_x = -6.5$  cm,  $B_y = 3.8$  cm
- (c)  $R_x = -1.0$  cm,  $R_y = 3.8$  cm
- (d) 3.9 cm at  $75^\circ$  above  $-x$ -axis

Var: 1

51) Vector  $\vec{A}$  has a magnitude of 75.0 cm and points at  $30^\circ$  above the positive  $x$ -axis. Vector  $\vec{B}$  has a magnitude of 25.0 cm and points along the negative  $x$ -axis. Vector  $\vec{C}$  has a magnitude of 40.0 cm and points at  $45^\circ$  below the negative  $x$ -axis.

(a) Determine the  $x$  and  $y$  components of Vector  $\vec{A}$ .

(b) Determine the  $x$  and  $y$  components of Vector  $\vec{B}$ .

(c) Determine the  $x$  and  $y$  components of Vector  $\vec{C}$ .

(d) Determine  $x$  and  $y$  components of the sum of these three vectors.

(e) Determine the magnitude and direction of the sum of these three vectors.

Answer:

(a)  $A_x = 65$  cm,  $A_y = 38$  cm

(b)  $B_x = -25$  cm,  $B_y = 0$

(c)  $C_x = -28$  cm,  $C_y = -28$  cm

(d)  $R_x = 12$  cm,  $R_y = 9.2$  cm

(e) 15 cm at  $38^\circ$  above  $+x$ -axis

Var: 1

52) A helicopter is flying horizontally with a speed of 444 m/s over a hill that slopes upward with a 2% grade (that is, the "rise" is 2% of the "run"). What is the component of the helicopter's velocity perpendicular to the sloping surface of the hill?

A) 8.9 m/s

B) 220 m/s

C) 435 m/s

D) 444 m/s

Answer: A

Var: 50+

53) An apple falls from an apple tree growing on a  $20^\circ$  slope. The apple hits the ground with an impact velocity of 16.2 m/s straight downward. What is the component of the apple's impact velocity parallel to the surface of the slope?

A) 5.5 m/s

B) 8.7 m/s

C) 12 m/s

D) 15 m/s

Answer: A

Var: 50+

54) The components of vector  $\vec{A}$  are  $A_x = +2.2$  and  $A_y = -6.9$ , and the components of vector  $\vec{B}$  are given are  $B_x = -6.1$  and  $B_y = -2.2$ . What is the magnitude of the vector  $\vec{B} - \vec{A}$ ?

- A) 9.5
- B) 6.1
- C) 9.9
- D) 91
- E) 0.76

Answer: A

Var: 50+

55) The components of vector  $\vec{B}$  are  $B_x = -3.5$  and  $B_y = -9.7$ , and the components of vector  $\vec{C}$  are  $C_x = -6$  and  $C_y = +8.1$ . What is the angle (less than 180 degrees) between vectors  $\vec{B}$  and  $\vec{C}$ ?

- A)  $124^\circ$
- B)  $56^\circ$
- C)  $17^\circ$
- D)  $163^\circ$
- E)  $106^\circ$

Answer: A

Var: 50+

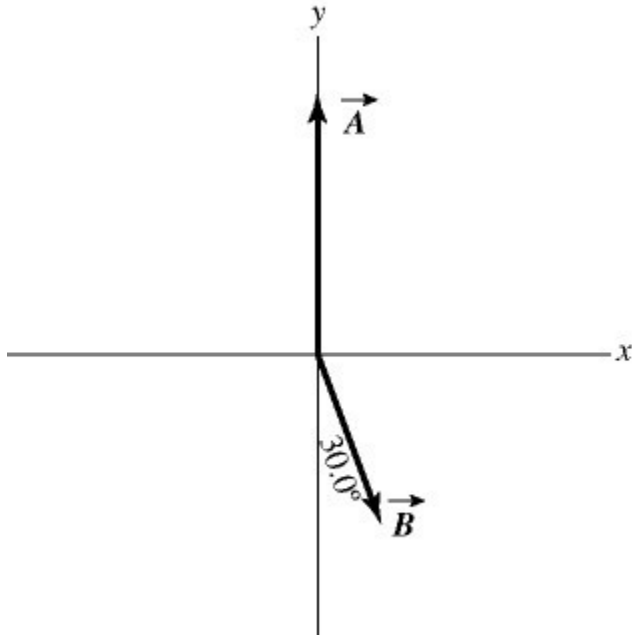
56) An airplane undergoes the following displacements: First, it flies 66 km in a direction  $30^\circ$  east of north. Next, it flies 49 km due south. Finally, it flies 100 km  $30^\circ$  north of west. Using vector components, determine how far the airplane ends up from its starting point.

- A) 79 km
- B) 81 km
- C) 82 km
- D) 78 km
- E) 76 km

Answer: A

Var: 1

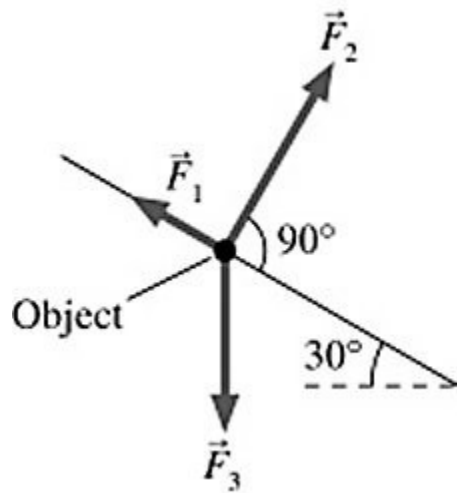
57) In the figure, the magnitude of vector  $\vec{A}$  is 18.0 units, and the magnitude of vector  $\vec{B}$  is 12.0 units. What vector  $\vec{C}$  must be added to the vectors  $\vec{A}$  and  $\vec{B}$  so that the resultant of these three vectors points in the  $-x$  direction and has a magnitude of 7.50 units? Use vector components to find your answer, and express vector  $\vec{C}$  by giving its magnitude and the angle it makes with the  $+x$ -axis taking counterclockwise to be positive.



Answer: 15.5,  $209^\circ$

Var: 1

58) Three forces are exerted on an object placed on a tilted floor. Forces are vectors. The three forces are directed as shown in the figure. If the forces have magnitudes  $F_1 = 1.0 \text{ N}$ ,  $F_2 = 8.0 \text{ N}$  and  $F_3 = 7.0 \text{ N}$ , where N is the standard unit of force, what is the component of the *net force*  $\vec{F}_{\text{net}} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3$  parallel to the floor?

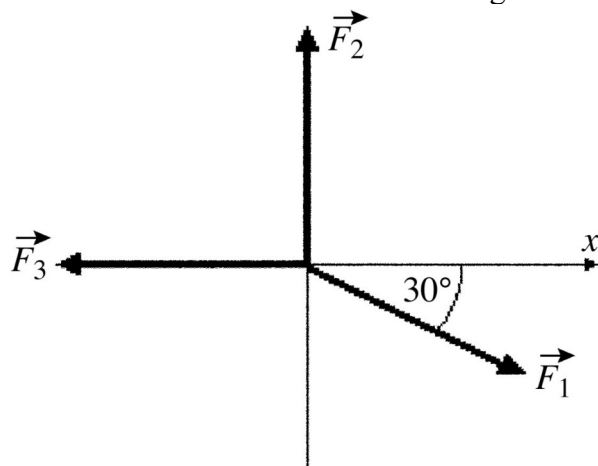


- A) 2.5 N
- B) 5.1 N
- C) 6.0 N
- D) 7.8 N

Answer: A

Var: 29

59) As shown in the figure, three force vectors act on an object. The magnitudes of the forces as shown in the figure are  $F_1 = 80.0 \text{ N}$ ,  $F_2 = 60.0 \text{ N}$ , and  $F_3 = 40.0 \text{ N}$ , where N is the standard SI unit of force. The resultant force acting on the object is given by



- A) 180 N at an angle  $60.0^\circ$  with respect to  $+x$ -axis.
- B) 60.0 N at an angle  $90.0^\circ$  with respect to  $+x$ -axis.
- C) 20.0 N at an angle  $34.3^\circ$  with respect to  $+x$ -axis.
- D) 35.5 N at an angle  $34.3^\circ$  with respect to  $+x$ -axis.
- E) 40.0 N at an angle  $60.0^\circ$  with respect to  $+x$ -axis.

Answer: D

Var: 1

60) A teacher sends her students on a treasure hunt. She gives the following instructions:

1. Walk 300 m north.
2. Walk 400 m northwest.
3. Walk 700 m east-southeast and the treasure is buried there.

As all the other students walk off following the instructions, Jane physics student quickly adds the displacements and walks in a straight line to find the treasure. How far and in what direction does Jane need to walk?

- A) 187 m in a direction  $67.3^\circ$  north of east
- B) 481 m in a direction  $40.9^\circ$  north of east
- C) 399 m in a direction  $52.5^\circ$  north of east
- D) 284 m in a direction  $28.2^\circ$  west of north
- E) The treasure position cannot be reached in one straight walk.

Answer: B

Var: 1

61) Vector  $\vec{A} = -3.00\hat{i} + 3.00\hat{j}$  and vector  $\vec{B} = 3.00\hat{i} + 4.00\hat{j}$ . What is vector  $\vec{C} = \vec{A} + \vec{B}$ ?

A)  $0.00\hat{i} + 3.00\hat{j}$

B)  $7.00\hat{i} + 7.00\hat{j}$

C)  $-3.00\hat{i} + 7.00\hat{j}$

D)  $0.00\hat{i} + 7.00\hat{j}$

E)  $-3.00\hat{i} - 3.00\hat{j}$

Answer: D

Var: 1

62) Vector  $\vec{A} = 1.00\hat{i} + -2.00\hat{j}$  and vector  $\vec{B} = 3.00\hat{i} + 4.00\hat{j}$ . What are the magnitude and direction of vector  $\vec{C} = \vec{A} + \vec{B}$ ?

A) 7.21 in a direction  $33.7^\circ$  counterclockwise from the positive  $x$  axis

B) 6.00 in a direction  $63.4^\circ$  counterclockwise from the positive  $x$  axis

C) 4.47 in a direction  $6.34^\circ$  counterclockwise from the positive  $x$  axis

D) 4.47 in a direction  $26.6^\circ$  counterclockwise from the positive  $x$  axis

E) 7.21 in a direction  $56.3^\circ$  counterclockwise from the positive  $x$  axis

Answer: D

Var: 1

63) What is the magnitude of  $\vec{A} + \vec{B} + \vec{C}$ , where  $\vec{A} = 1.00\hat{i} + 4.00\hat{j} - 1.00\hat{k}$ ,  $\vec{B} = 3.00\hat{i} - 1.00\hat{j} - 4.00\hat{k}$  and  $\vec{C} = -1.00\hat{i} + 1.00\hat{j}$ ?

A) 7.07

B) 2.00

C) 10.76

D) 6.78

E) 8.12

Answer: A

Var: 9

64) If  $\vec{A} = +4\hat{i} - 2\hat{j} - 3\hat{k}$  and  $\vec{C} = -4\hat{i} - 2\hat{j} - 3\hat{k}$ , which of the following numbers is closest to the magnitude of  $\vec{A} - \vec{C}$ ?

A) 8

B) 7

C) 9

D) 10

E) 11

Answer: A

Var: 50+

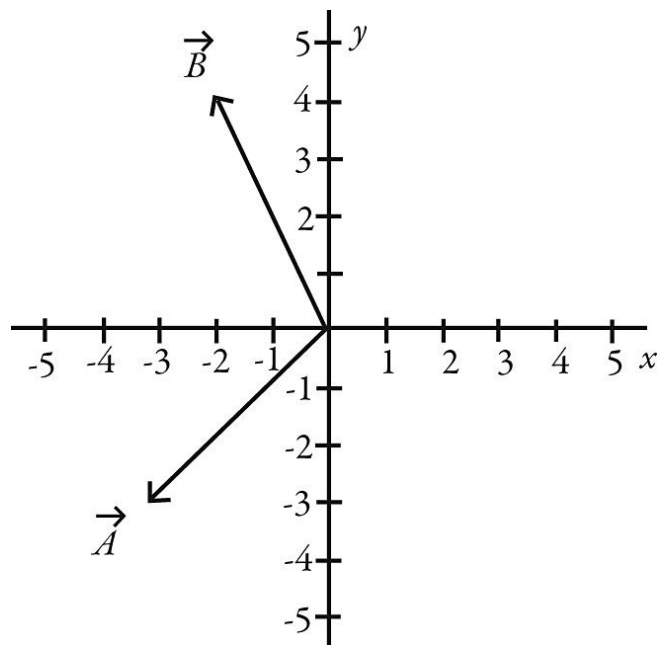
65) Vector  $\vec{A} = -1.00\hat{i} + -2.00\hat{j}$  and vector  $\vec{B} = 3.00\hat{i} + 4.00\hat{j}$ . What are the magnitude and direction of vector  $\vec{C} = 3.00\vec{A} + 2.00\vec{B}$ ?

- A) 3.61 in a direction  $-56.3^\circ$  counterclockwise from the positive  $x$ -axis
- B) 3.61 in a direction  $56.3^\circ$  counterclockwise from the positive  $x$ -axis
- C) 3.61 in a direction  $33.7^\circ$  counterclockwise from the positive  $x$ -axis
- D) 5.00 in a direction  $56.3^\circ$  counterclockwise from the positive  $x$  axis
- E) 6.72 in a direction  $34.4^\circ$  counterclockwise from the positive  $x$ -axis

Answer: C

Var: 1

66) Vectors  $\vec{A}$  and  $\vec{B}$  are shown in the figure. What is  $|-5.00\vec{A} + 4.00\vec{B}|$ ?



- A) 31.8
- B)  $-32.0\hat{i} - 2.00\hat{j}$
- C) 1028
- D) 34.0
- E)  $-2.00\hat{i} - 32.0\hat{j}$

Answer: A

Var: 1



67) Determine the scalar product of  $\vec{A} = 6.0\hat{i} + 4.0\hat{j} - 2.0\hat{k}$  and  $\vec{B} = 5.0\hat{i} - 6.0\hat{j} - 3.0\hat{k}$ .

A)  $30\hat{i} + 24\hat{j} + 6\hat{k}$

B)  $30\hat{i} - 24\hat{j} + 6\hat{k}$

C) 12

D) 60

E) undefined

Answer: C

Var: 5

68) Determine the angle between the directions of vector  $\vec{A} = 3.00\hat{i} + 1.00\hat{j}$  and vector  $\vec{B} = -3.00\hat{i} + 3.00\hat{j}$ .

A)  $26.6^\circ$

B)  $30.0^\circ$

C)  $88.1^\circ$

D)  $117^\circ$

E)  $45.2^\circ$

Answer: D

Var: 5

69) The scalar product of vector  $\vec{A} = 3.00\hat{i} + 2.00\hat{j}$  and vector  $\vec{B}$  is 10.0. Which of the following vectors could be vector  $\vec{B}$ ?

A)  $2.00\hat{i} + 4.00\hat{j}$

B)  $4.00\hat{i} + 6.00\hat{j}$

C)  $5.00\hat{i} + 4.00\hat{j}$

D)  $12.0\hat{i}$

E)  $2.00\hat{i} + 2.00\hat{j}$

Answer: E

Var: 5

70) The angle between vector  $\vec{A} = 2.00\hat{i} + 3.00\hat{j}$  and vector  $\vec{B}$  is  $45.0^\circ$ . The scalar product of vectors  $\vec{A}$  and  $\vec{B}$  is 3.00. If the x component of vector  $\vec{B}$  is positive, what is vector  $\vec{B}$ .

A)  $4.76\hat{i} + 0.952\hat{j}$

B)  $1.15\hat{i} + 0.231\hat{j}$

C)  $2.96\hat{i} + -0.973\hat{j}$

D)  $0.871\hat{i} + 0.419\hat{j}$

E)  $3.42\hat{i} + 0.684\hat{j}$

Answer: B

Var: 5

71) What is the angle between the vector  $\vec{A} = +3\hat{i} - 2\hat{j} - 3\hat{k}$  and the +y-axis?

- A)  $115^\circ$
- B)  $65^\circ$
- C)  $25^\circ$
- D)  $155^\circ$
- E)  $90^\circ$

Answer: A

Var: 16

72) If  $\vec{A} = 3\hat{i} - \hat{j} + 4\hat{k}$  and  $\vec{B} = x\hat{i} + \hat{j} - 5\hat{k}$ , find  $x$  so  $\vec{B}$  will be perpendicular to  $\vec{A}$ .

Answer: 7

Var: 1

73) Two boys searching for buried treasure are standing underneath the same tree. One boy walks 18 m east and then 18 m north. The other boy walks 16 m west and then 11 m north. Find the scalar product of their net displacements from the tree.

Answer:  $-90 \text{ m}^2$

Var: 50+

74) A rectangular box is positioned with its vertices at the following points:

$$A = (0,0,0) \quad C = (2,4,0) \quad E = (0,0,3) \quad G = (2,4,3)$$

$$B = (2,0,0) \quad D = (0,4,0) \quad F = (2,0,3) \quad H = (0,4,3)$$

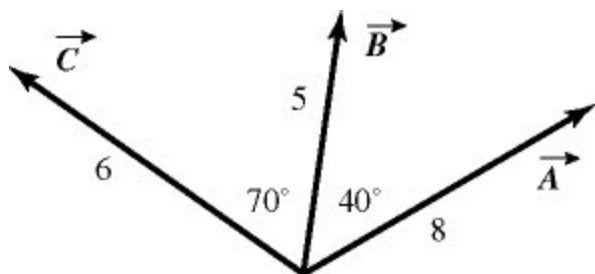
If the coordinates all have three significant figures, the angle between the line segments  $AG$  and  $AH$  is closest to:

- A)  $21.8^\circ$ .
- B)  $22.5^\circ$ .
- C)  $26.6^\circ$ .
- D)  $36.9^\circ$ .
- E)  $45.0^\circ$ .

Answer: A

Var: 1

75) For the vectors shown in the figure, assume numbers are accurate to two significant figures. The scalar product  $\vec{A} \times \vec{C}$  is closest to



- A) zero.
- B) 16.
- C) 45.
- D) -16.
- E) -45.

Answer: D

Var: 1

76) What is the vector product of  $\vec{A} = 2.00 \hat{i} + 3.00 \hat{j} + 1.00 \hat{k}$  and  $\vec{B} = 1.00 \hat{i} - 3.00 \hat{j} - 2.00 \hat{k}$ ?

- A)  $-3.00 \hat{i} + 5.00 \hat{j} - 9.00 \hat{k}$
- B)  $-5.00 \hat{i} + 2.00 \hat{j} - 6.00 \hat{k}$
- C)  $-9.00 \hat{i} - 3.00 \hat{j} - 3.00 \hat{k}$
- D)  $-4.00 \hat{i} + 3.00 \hat{j} - 1.00 \hat{k}$
- E)  $2.00 \hat{i} - 9.00 \hat{j} - 2.00 \hat{k}$

Answer: A

Var: 1

77) What is the magnitude of the cross product of a vector of magnitude 2.00 m pointing east and a vector of magnitude 4.00 m pointing  $30.0^\circ$  west of north?

- A) 6.93
- B) -6.93
- C) 4.00
- D) -4.00
- E) 8.00

Answer: A

Var: 1

78) If the magnitude of the cross product of two vectors is one-half the dot product of the same vectors, what is the angle between the two vectors?

Answer:  $26.6^\circ$

Var: 1

79) If  $\vec{C} = -4\hat{i} - 2\hat{j} - 3\hat{k}$ , what is  $\vec{C} \times \hat{j}$ ?

- A)  $+3\hat{i} - 4\hat{k}$
- B)  $+3\hat{i} + 4\hat{k}$
- C)  $-3\hat{i} + 4\hat{k}$
- D)  $+3\hat{i} + 2\hat{j} - 4\hat{k}$
- E)  $-3\hat{i} - 2\hat{j} + 4\hat{k}$

Answer: A

Var: 50+

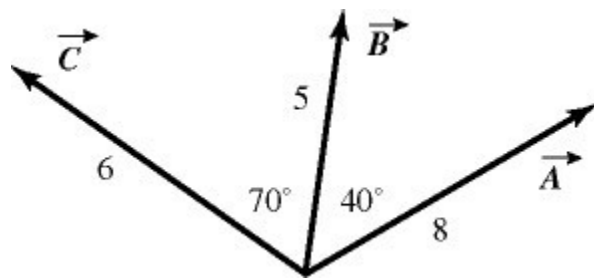
80) If  $\vec{B} = -2\hat{i} - 6\hat{j} + 2\hat{k}$  and  $\vec{C} = -2\hat{i} - 2\hat{j} - 3\hat{k}$ , which of the following numbers is closest to the magnitude of  $\vec{C} \times \vec{B}$ ?

- A) 25
- B) 21
- C) 17
- D) 13
- E) 9

Answer: A

Var: 50+

81) For the vectors shown in the figure, find the magnitude and direction of  $\vec{B} \times \vec{A}$ , assuming that the quantities shown are accurate to two significant figures.

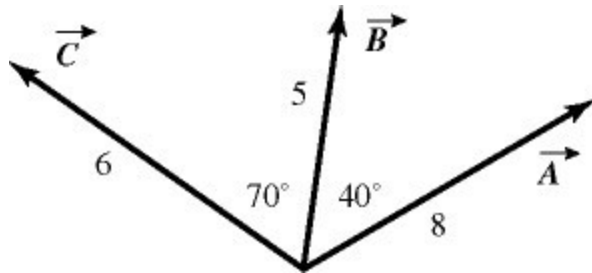


- A) 26, directed into the plane
- B) 26, directed out of the plane
- C) 31, directed on the plane
- D) 31, directed into the plane
- E) 31, directed out of the plane

Answer: A

Var: 1

82) For the vectors shown in the figure, find the magnitude and direction of the vector product  $\vec{A} \times \vec{C}$ , assuming that the quantities shown are accurate to two significant figure.



- A) 16, directed into the plane
- B) 16, directed out of the plane
- C) 45, directed on the plane
- D) 45, directed into the plane
- E) 45, directed out of the plane

Answer: E

Var: 1