

# Chapter 1 Models, Measurements and Vectors

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## Multiple Choice Questions

- 1) The following conversion equivalents are given:

$$1 \text{ gal} = 231 \text{ in}^3 \quad 1 \text{ ft} = 12 \text{ in} \quad 1 \text{ min} = 60 \text{ s}$$

A pipe delivers water at the rate of 95 gal/min. The rate in  $\text{ft}^3/\text{s}$ , is closest to:

- A) 0.21      B) 0.19      C) 0.17      D) 0.15      E) 0.14

Answer: A

Var: 50+

- 2) The following conversion equivalents are given:

$$1 \text{ m} = 100 \text{ cm} \quad 1 \text{ in} = 2.54 \text{ cm} \quad 1 \text{ ft} = 12 \text{ in}$$

A bin has a volume of  $1.5 \text{ m}^3$ . The volume of the bin, in  $\text{ft}^3$ , is closest to:

- A) 35      B) 41      C) 47      D) 53      E) 59

Answer: D

Var: 1

- 3) The following conversion equivalents are given:

$$1 \text{ mile} = 5280 \text{ ft} \quad 1 \text{ ft} = 12 \text{ in} \quad 1 \text{ m} = 39.37 \text{ in} \quad 1 \text{ hour} = 60 \text{ min} \quad 1 \text{ min} = 60 \text{ s}$$

A particle has a velocity of 4.7 miles per hour. The velocity, in  $\text{m/s}$ , is closest to:

- A) 2.1      B) 1.7      C) 1.9      D) 2.3      E) 2.5

Answer: A

Var: 50+

- 4) A speed of 65 miles per hour is the same as

- A) 24  $\text{m/s}$       B) 29  $\text{m/s}$       C) 32  $\text{m/s}$       D) 37  $\text{m/s}$       E) 42  $\text{m/s}$

Answer: B

Var: 1

- 5) The following conversion equivalents are given:

$$1 \text{ kg} = 1000\text{g} \quad 1 \text{ l} = 1000 \text{ cm}^3 \quad 1 \text{ l} = 0.0353 \text{ ft}^3$$

The density of a liquid is  $0.83 \text{ g/cm}^3$ . The density of the liquid, in  $\text{kg/ft}^3$ , is closest to:

- A) 24      B) 19      C) 21      D) 26      E) 28

Answer: A

Var: 50+

- 6) A weight lifter can bench press 0.27 kg. How many milligrams (mg) is this?

- A)  $2.7 \times 10^8 \text{ mg}$       B)  $2.7 \times 10^9 \text{ mg}$       C)  $2.7 \times 10^7 \text{ mg}$       D)  $2.7 \times 10^6 \text{ mg}$

Answer: A

Var: 50+

- 7) Your car gets 34.7 mi/gal on a trip. How many kilometers/liter did it get? ( $3.79 = 1 \text{ gal}$ ;  $1 \text{ mi} = 1.61 \text{ km}$ )

- A) 14.7  $\text{km/l}$       B) 9.16  $\text{km/l}$       C) 55.9  $\text{km/l}$       D) 32.4  $\text{km/l}$

Answer: A

Var: 50+

8) The wavelength of a certain laser is 0.66 microns, where 1 micron =  $1 \times 10^{-6}$  m. What is this wavelength in nanometers? (1 nm =  $10^{-9}$ m)

- A)  $6.6 \times 10^2$  nm      B)  $6.6 \times 10^3$  nm      C)  $6.6 \times 10^1$  nm      D)  $6.6 \times 10^4$  nm

Answer: A

Var: 50+

9) Add 1299 g and 45.1 kg and express your answer in milligrams (mg).

- A)  $4.64 \times 10^7$  mg      B)  $4.64 \times 10^4$  mg      C)  $4.64 \times 10^5$  mg      D)  $4.64 \times 10^6$  mg

Answer: A

Var: 50+

10) Express  $[2.2 \times 10^6]^{-1/2}$  in scientific notation.

- A)  $6.7 \times 10^{-4}$       B)  $1.5 \times 10^3$       C)  $1.5 \times 10^{-5}$       D)  $1.5 \times 10^4$

Answer: A

Var: 40

11) What is  $\frac{0.405}{0.76}$  to the proper number of significant figures?

- A) 0.53      B) 0.533      C) 0.5329      D) 0.5

Answer: A

Var: 50+

12) What is  $0.327^{2/3}$ , to the proper number of significant figures?

- A) 0.475      B) 0.47      C) 0.5      D) 0.4746

Answer: A

Var: 50+

13) Which of the following is a reasonable estimate of the number of characters (typed letters or numbers) in a 609 page book? Assume an average of 194 words/page and a reasonable average number of letters/word.

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

Answer: A

Var: 50+

14) 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

15) Estimate the number of times an average person's heart beats in a lifetime. Assume the average heart rate is 69 beats/min and a life span of 75 yr.

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

Answer: A

Var: 50+

16) The components of vector  $\vec{A}$  are given as follows:

$$A_x = +7.6$$

$$A_y = -6.4$$

The magnitude of  $\vec{A}$  is closest to:

A) 9.9

B) 7.9

C) 8.9

D) 11

E) 12

Answer: A

Var: 50+

17) The components of vector  $\vec{A}$  are given as follows:

$$A_x = +6.1$$

$$A_y = -8.6$$

The angle measured counterclockwise from the x-axis to vector  $\vec{A}$ , in degrees, is closest to:

A) 305

B) 125

C) 215

D) 145

E) 55

Answer: A

Var: 50+

18) The components of vectors  $\vec{A}$  and  $\vec{B}$  are given as follows:

$$A_x = +7.6$$

$$B_x = -5.1$$

$$A_y = -9.2$$

$$B_y = -6.8$$

The magnitude of the vector difference  $\vec{B} - \vec{A}$ , is closest to:

A) 13

B) 3.5

C) 16

D) 170

E) 3.4

Answer: A

Var: 50+

19) The components of vectors  $\vec{B}$  and  $\vec{C}$  are given as follows:

$$B_x = -9.2 \quad C_x = -4.5$$

$$B_y = -6.1 \quad C_y = +4.3$$

The angle (less than 180 degrees) between vectors  $\vec{B}$  and  $\vec{C}$ , in degrees, is closest to:

A) 77

B) 103

C) 10

D) 170

E) 84

Answer: A

Var: 50+

20) The magnitude of  $\vec{A}$  is 5.5. Vector  $\vec{A}$  lies in the second quadrant and forms an angle of 34 degrees with the y-axis. The components,  $A_x$  and  $A_y$ , are closest to:

- A)  $A_x = -3.1, A_y = +4.6$
- B)  $A_x = +3.1, A_y = -4.6$
- C)  $A_x = +4.6, A_y = -3.1$
- D)  $A_x = -4.6, A_y = +3.1$
- E)  $A_x = -4.6, A_y = -3.1$

Answer: A

Var: 50+

21) Vector  $\vec{A}$  has length 2 units and directed to the north. Vector  $\vec{B}$  has length 5 units and is directed to the south. Calculate the magnitude and direction of  $\vec{A} - \vec{B}$ .

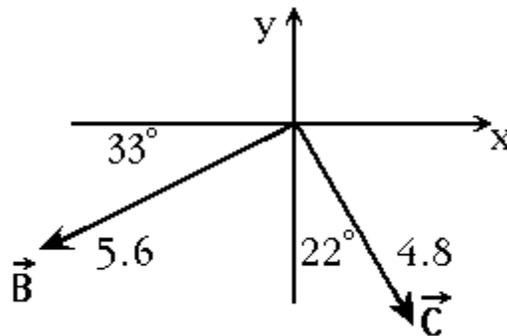
- A) 7 units, north
- B) 7 units, south
- C) 3 units, north
- D) 3 units, south

Answer: A

Var: 39

Figure 1.1

Vectors  $\vec{B}$  and  $\vec{C}$  are shown. Vector  $\vec{D}$  is given by  $\vec{D} = \vec{B} - \vec{C}$



22) In Figure 1.1, the magnitude of  $\vec{D}$  is closest to:

- A) 3.2
- B) 5.3
- C) 6.6
- D) 8.0
- E) 9.2

Answer: C

Var: 1

23) In Figure 1.1, the angle, measured counterclockwise from the x-axis to vector  $\vec{D}$ , in degrees, is closest to:

- A) 12
- B) 102
- C) 168
- D) 192
- E) 258

Answer: C

Var: 1

24) You walk 35 m to the north, then turn 60° to your right and walk another 45 m. How far are you from where you originally started?

- A) 69 m
- B) 40 m
- C) 76 m
- D) 36 m

Answer: A

Var: 31

- 25) A rabbit trying to escape a fox runs north for 4.0 m, darts northwest for 8.0 m, then drops 1.0 m down a hole into its burrow. What is the magnitude of the net displacement of the rabbit?  
 A) 11 m                      B) 8.9 m                      C) 81 m                      D) 13 m

Answer: A

Var: 50+

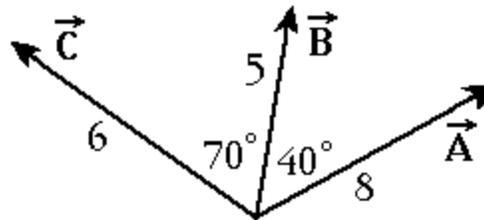
- 26) Which of the following is an accurate statement about vectors?  
 A) The magnitude of a vector can be zero even though one of its components is not zero.  
 B) It is possible to add a scalar quantity to a vector.  
 C) Even though two vectors have unequal magnitudes, it is possible that their vector 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 positive even if all of its components are negative.

Answer: E

Var: 1

Figure 1.2

Three vectors are given as shown.



- 27) In Figure 1.2, the magnitude of the resultant of the three vectors is closest to:  
 A) 19                      B) 16                      C) 13                      D) 10                      E) 7

Answer: C

Var: 1

- 28) An airplane undergoes the following displacements: First, it flies 59 km in a direction 30° east of north. Next, it flies 58 km due south. Finally, it flies 100 km 30° north of west. Using analytical methods, determine how far the airplane ends up from its starting point.  
 A) 71.5 km                      B) 73 km                      C) 74.4 km                      D) 70.1 km                      E) 68.7 km

Answer: A

Var: 50+

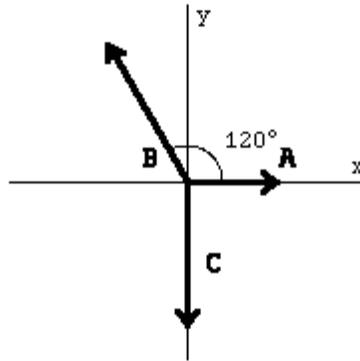
### Short Answer Questions

- 1) Albert defines his own unit of length, the albert, to be the distance Albert can throw a small rock. One albert is 27 meters. How many square alberts is one acre?  
 (1 acre = 43,560 ft<sup>2</sup> = 4050 m<sup>2</sup>)

Answer: 5.55555556 A<sup>2</sup>

Var: 50+

Figure 1.3



- 2) Find the magnitude and direction of the resultant  $\vec{R}$  of the three vectors shown in Figure 1.3. The vectors have the following magnitudes:  $A = 5.0$ ,  $B = 7.9$ , and  $C = 8.0$ . Express the direction of the vector sum by specifying the angle it makes with the positive  $x$ -axis, with the counterclockwise angles taken to be positive.

Answer: magnitude:  $R = 1.6$ , direction:  $\Theta = 312^\circ$

Var: 1

- 3) Two boys, Joe and Sam, who are searching for buried treasure start underneath the same tree. Joe walks 12 m east and then 12 m north, while Sam walks 15 m west and then 10 m south. Both boys then stop. Find the magnitude and direction of the vector from Sam to Joe. Express the direction of this vector by specifying the angle it makes with the west-to-east direction.

Answer: 35 m at  $39^\circ$

Var: 1

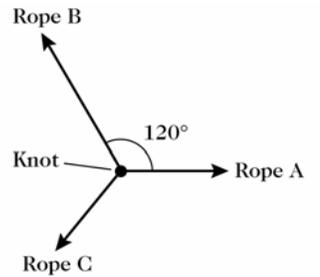
- 4) A vector in the  $x$ - $y$  plane has an  $x$ -component of  $-7.50$  units. What must be the  $y$ -component of this vector so that its magnitude is 10.0 units. (Note: There are two possible answers.)

Answer:  $+6.61$  units and  $-6.61$  units

Var: 1

- 5) Three ropes are tied in a knot as indicated in Figure 1.4. One student pulls on rope A with 1 pound of force, and another student pulls on rope B with 7 pounds of force. How hard and in what direction must you pull on rope C to balance the first two pulls? Give the direction by specifying the angle of the pull with the direction of rope A and its direction (clockwise or counterclockwise).

Figure 1.4



Answer: 6.6 pounds at  $68^\circ$  clockwise from rope A  
Var: 1