

PHYS 109 SAMPLE PROBLEMS (1)

1) The unit of force in SI units is:

- a) kgm b) kgm^2 c) $kg\frac{m^2}{s}$ d) $kg\frac{m}{s^2}$ e) $kg\frac{m^2}{s^2}$

2) The unit of energy in SI units is:

- a) $kg\frac{m^2}{s^2}$ b) kgm^2 c) $kg\frac{m^2}{s}$ d) $kg\frac{m}{s^2}$ e) kgm

3) An athlete runs with an average speed $10m/s$. What is the average speed in units **kilometers/hour**?

- a) 2.78 b) 0.278 c) 3.6 d) 0.36 e) 36

4) The maximum speed limit at the highway is 90 kilometers/hour. Express this limit in SI units **meters/second**.

- a) 2.5 b) 25 c) 324 d) 900 e) 0.9

5) A liquid has mass $m=50$ grams and volume $V=0.25$ liters. What is the density of this liquid in units **milligrams/liters**? (1gr=1000 milligrams)

- a) 2×10^2 b) 2×10^{-2} c) 2×10^5 d) 2×10^{-5} e) 2

6) Express the density of the same liquid (mass $m=50$ grams and volume $V=0.25$ liters) in SI units **kilograms/meter cubes**.

- a) 2×10^5 b) 2×10^{-5} c) 2×10^2 d) 2×10^{-2} e) 0.5

7) $0.00078 \text{ cm} = \dots$ nanometers

- a) 7.8×10^{-11} b) 7.8×10^3 c) 7.8×10^{-4} d) 7.8×10^5 e) 7.8×10^{-13}

8) 879 nanometers = meters

- a) 8.79×10^{-7} b) 8.79×10^7 c) 8.79×10^2 d) 8.79×10^{11} e) 8.79×10^{-9}

9) A bottle contains 0.5 liters of syrup. A child drinks 2 fluid Oz of syrup. Calculate the amount of syrup that remains in the bottle, in **milliliters**? (1 fluid Oz = 29.6 milliliters)

- a) 29.1 b) 28.6 c) 59.2 d) 940.8 e) 440.8

10) A bottle of liquid has volume $V = 330$ milliliters. The liquid contains caffeine with density 0.12 grams/liter. How many **grams** of caffeine do you intake, if you drink this bottle of liquid?

- a) 3.96 b) 36.36 c) 3.96×10^{-4} d) 3.96×10^{-2} e) 39.6

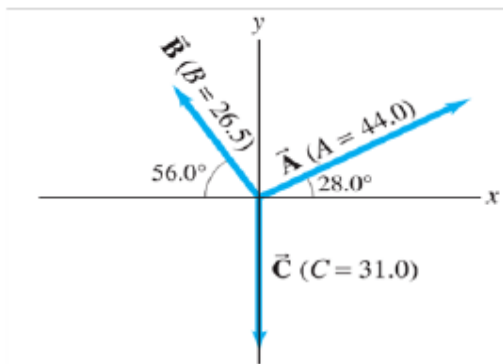
11) Assume $I = mr^2 \left(\frac{gt}{z} - 1 \right)$ is a valid physical formula where m is mass, r is the radius, g is the gravitational acceleration, and t is time. What should be the unit of z in SI units?

- a) *meters/second* b) *second / meters* c) *kilograms / (meters)²* d) *meters / (second)²*
e) Cannot be determined

12) What should be the unit of I in the same formula?

- a) *kilograms.(meter)²* b) *meters / (second)²* c) *kilograms / (meters)²* d) *meters / second*
e) Cannot be determined

13) Express the vectors $\vec{A}$, $\vec{B}$, $\vec{C}$ in terms of unit vectors $\hat{i}$ and $\hat{j}$.



14) $\vec{A} - 2\vec{B} = ?$; $\vec{C} - 2\vec{A} + \vec{B} = ?$

15) The following vectors are given in polar coordinates. (R denotes the magnitude of the vector and the angle θ determines the direction.) Express each vector in terms of unit vectors $\hat{i}$ and $\hat{j}$.

- a) ($R = 10, \theta = 37$)
 b) ($R = 15, \theta = 127$)
 c) ($R = 20, \theta = 240$)
 d) ($R = 10, \theta = 330$)

16) Express the following vectors in polar coordinates R and θ .

a) $\vec{A} = 6\hat{i} - 8\hat{j}$

b) $\vec{B} = -10\hat{i}$

c) $\vec{C} = -6\hat{i} - 8\hat{j}$

d) $\vec{D} = -10\hat{j}$

17) A person starts from the origin and moves 10 km in the North-East direction ($R = 10, \theta = 45$). Then he moves 12 km to West. ($R = 12, \theta = 180$) Finally, he moves 15 km to South. ($R = 15, \theta = 270$).

a) Express the final position of this person in terms of unit vectors.

b) What is the distance to the origin at the final position?

18) A particle which is initially located at $\vec{x} = 2\hat{i}$ (where x is in meters), moves with constant velocity in one direction. After 2 seconds the particle's position is observed as $\vec{x} = -4\hat{i}$. What is the velocity of the particle?

A) $\vec{V} = -3(m/s)\hat{i}$ B) $\vec{V} = -3(m/s)$ C) $\vec{V} = 3(m/s)\hat{i}$ D) $\vec{V} = 2(m/s)\hat{i}$ E) $\vec{V} = -2(m/s)\hat{i}$

19) A particle which is initially located at $\vec{x} = 0$ (where x is in meters), moves with constant acceleration $\vec{a} = 2(m/s^2)\hat{i}$. The initial velocity of the particle is zero. What is the **velocity** of the particle at $t=3$ seconds?

A) $\vec{V} = -6(m/s)\hat{i}$ B) $\vec{V} = 6(m/s)\hat{j}$ C) $\vec{V} = 3(m/s)\hat{i}$ D) $\vec{V} = 6(m/s)\hat{i}$ E) $\vec{V} = 3(m/s)\hat{j}$

20) What is the position of the same particle at $t=3$ seconds?

A) $\vec{x} = 6(m)\hat{i}$ B) $\vec{x} = 4.5(m)\hat{i}$ C) $\vec{x} = 18(m)\hat{i}$ D) $\vec{x} = 9(m)\hat{j}$ E) $\vec{x} = 9(m)\hat{i}$

Questions (21-24): A particle is initially located at $\vec{x} = 0$ (where x is in meters), and it has an initial velocity $\vec{V}_0 = 8(m/s)\hat{i}$. This particle moves with constant acceleration $\vec{a} = -2(m/s^2)\hat{i}$.

21) What is the velocity of the particle after 2 seconds?

A) $\vec{V} = 6(m/s)\hat{i}$ B) $\vec{V} = 4(m/s)\hat{j}$ C) $\vec{V} = 4(m/s)\hat{i}$ D) $\vec{V} = 10(m/s)\hat{i}$ E) $\vec{V} = 2(m/s)\hat{j}$

22) What is the position of the same particle after 2 seconds?

A) $\vec{x} = 16(m)\hat{i}$ B) $\vec{x} = 12(m)\hat{i}$ C) $\vec{x} = -16(m)\hat{i}$ D) $\vec{x} = -4(m)\hat{i}$ E) $\vec{x} = 20(m)\hat{i}$

23) When does this particle momentarily stop?

A) Never B) $t=0$ C) $t=3$ D) $t=6$ E) $t=4$

24) Where does this particle momentarily stop?

A) At infinity B) $\vec{x} = 48(m)\hat{i}$ C) $\vec{x} = 16(m)\hat{i}$ D) $\vec{x} = 32(m)\hat{i}$ E) $\vec{x} = -16(m)\hat{i}$

Questions:(25-27) A particle is initially located at $\vec{r} = 3(m)\hat{i} + 5(m)\hat{j}$. The initial velocity of the particle is $\vec{V}_0 = 4(m/s)\hat{i} - 5(m/s)\hat{j}$. The particle moves with constant acceleration $\vec{a} = -2(m/s^2)\hat{i} + 3(m/s^2)\hat{j}$.

25) What is the velocity of the particle at t=3 seconds?

- A) $\vec{V} = 6(m/s)\hat{i} - 3(m/s)\hat{j}$ B) $\vec{V} = 8(m/s)\hat{i} - 1(m/s)\hat{j}$ C) $\vec{V} = 2(m/s)\hat{i} - 3(m/s)\hat{j}$
 D) $\vec{V} = -2(m/s)\hat{i} + 4(m/s)\hat{j}$ E) $\vec{V} = -2(m/s)\hat{i} - 14(m/s)\hat{j}$

26) What is the speed of the particle at t=3 seconds?

- A) $\vec{V} = 4(m/s)\hat{i} - 3(m/s)\hat{j}$ B) $V = 4.47(m/s)$ C) $\vec{V} = 6(m/s)\hat{i} - 3(m/s)\hat{j}$
 D) $V = 3.46(m/s)$ E) $V = -3.46(m/s)$

27) What is the position of the particle at t=3s?

- A) $\vec{r} = 6(m)\hat{i} + 3.5(m)\hat{j}$ B) $\vec{r} = 3(m)\hat{i} - 1.5(m)\hat{j}$ C) $\vec{r} = -9(m)\hat{i} + 13.5(m)\hat{j}$
 D) $\vec{r} = 12(m)\hat{i} - 15(m)\hat{j}$ E) $\vec{r} = 6(m)\hat{i} + 8(m)\hat{j}$

A particle is released from a height $y = 19.6m$. at t=0. (Questions 28-29)

28) When does this particle hit the ground?

- A) t=4s B) t=6s C) t=2s D) t=3s E) t=9.8 s

29) What is the velocity of the particle as it hits the ground?

- A) $\vec{V} = 4(m/s)\hat{j}$ B) $V = 4(m/s)$ C) $\vec{V} = 9.8(m/s)\hat{j}$ D) $\vec{V} = -9.8(m/s)\hat{j}$ E)
 $\vec{V} = -19.6(m/s)\hat{j}$

A particle is vertically thrown up from an initial height $y_{in} = 2m$. with $\vec{V}_0 = 14.7(m/s)\hat{j}$. The particle reaches maximum height, and falls back to hit the ground. ($y_{fin} = 0$)

(Questions.30-35)

30) When does the particle reach maximum height?

- A) t=1s B) t=1.5s C) t=2s D) t=9.8s E) t=14.7 s

31) What is the maximum height for this particle?

- A)11.025m B) 19.6m C)14.7 m D) 13.025m E) 9.8m

32) When does the particle first pass from y=10m as it is going up?

- A)0.714s B) 2.286s C) 1.5s D) 9.8s E)1.712s

33) When does the particle pass from y=10m for the second time, as it is going down?

- A)0.714s B) 2.286s C) 1.5s D) 9.8s E)1.712s

34) When does the particle hit the ground?

- A)0.714s B) 2.286s C) 1.5s D) 0.202s E)3.059s

35) What is the velocity of the particle as it hits the ground?

- A) $V = 14.7(m/s)$ B) $V = 14.7(m/s)\hat{j}$ C) $\vec{V} = -14.7(m/s)\hat{j}$ D) $\vec{V} = 44.68(m/s)\hat{j}$ E)
 $\vec{V} = -15.28(m/s)\hat{j}$

Answer Key:

1D , 2A, 3E, 4B, 5C, 6C, 7B, 8A, 9E, 10 D, 11 B, 12 A

13) $A = 38.85\hat{i} + 20.66\hat{j}$, $B = -14.82\hat{i} + 21.97\hat{j}$, $C = -31\hat{j}$

14) $A - 2B = 68.49\hat{i} - 23.28\hat{j}$

$C - 2A + B = -92.52\hat{i} - 50.35\hat{j}$

15) a) $8\hat{i} + 6\hat{j}$ b) $-9\hat{i} + 12\hat{j}$ c) $-10\hat{i} - 17.32\hat{j}$ d) $8.66\hat{i} - 5\hat{j}$

16) a) $R = 10, \theta = 307^\circ$, b) $R = 10, \theta = 180^\circ$ c) $R = 10, \theta = 233^\circ$ d) $R = 10, \theta = 270^\circ$

17) Final position: $-4.93\hat{i} - 7.93\hat{j}$ Distance = 9.34 km

18 A, 19 D, 20 E, 21 C, 22 B, 23 E, 24 C, 25 D, 26 B, 27 A, 28 C, 29 E, 30 B, 31 E, 32 A,
33 B, 34 E, 35 E