# AP Physics C – Summer Assignment Problems

**Chapter 1 Problems**

**3.** The standard kilogram is a platinum-iridium cylinder 39.0 mm in height and 39.0 mm in diameter. What is the density of the material?

**10.** A small cube of iron is observed under a microscope. The edge of the cube is $5.00 \times 10^{-6}$ cm long. Find (a) the mass of the cube and (b) the number of iron atoms in the cube. The atomic mass of iron is 55.9 u, and its density is 7.86 g/cm$^3$.

**16.** (a) A fundamental law of motion states that the acceleration of an object is directly proportional to the resultant force exerted on the object and inversely proportional to its mass. If the proportionality constant is defined to have no dimensions, determine the dimensions of force. (b) The newton is the SI unit of force. According to the results for (a), how can you express a force having units of newtons using the fundamental units of mass, length, and time?

**17.** Newton's law of universal gravitation is represented by

$$F = \frac{GMm}{r^2}$$

Here $F$ is the gravitational force exerted by one small object on another, $M$ and $m$ are the masses of the objects, and $r$ is a distance. Force has the SI units kg·m/s$^2$. What are the SI units of the proportionality constant $G$?

**19.** Suppose your hair grows at the rate 1/32 in. per day. Find the rate at which it grows in nanometers per second. Because the distance between atoms in a molecule is on the order of 0.1 nm, your answer suggests how rapidly layers of atoms are assembled in this protein synthesis.

**24.** Find the height or length of these natural wonders in kilometers, meters and centimeters. (a) The longest cave system in the world is the Mammoth Cave system in central Kentucky. It has a mapped length of 348 miles. (b) In the U.S. the waterfall with the greatest single drop is Ribbon Falls, which falls 1 612 ft. (c) Mount McKinley is America's highest mountain at 20 320 feet. (d) The deepest canyon in the U.S. is King's Canyon in California with a depth of 8 200 ft. (1 mi = 1.609 km; 3.28 ft = 1 m)

**29.** At the time of this book's printing, the U. S. national debt is about $6 trillion. (a) If payments were made at the rate of $1 000 per second, how many years would it take to pay off the debt, assuming no interest were charged? (b) A dollar bill is about 15.5 cm long. If six trillion dollar bills were laid end to end around the Earth's equator, how many times would they encircle the planet? Take the radius of the Earth at the equator to be 6 378 km. (*Note* : Before doing any of these calculations, try to guess at the answers. You may be very surprised.)

**38.** The mean radius of the Earth is $6.37 \times 10^6$ m, and that of the Moon is $1.74 \times 10^8$ cm. From these data calculate (a) the ratio of the Earth's surface area to that of the Moon and (b) the ratio of the Earth's

volume to that of the Moon. Recall that the surface area of a sphere is $4\pi r^2$ and the volume of a sphere is $\frac{4}{3}\pi r^3$.

**Chapter 3 Problems**

**1.** The polar coordinates of a point are $r = 5.50$ m and $\theta = 240°$. What are the Cartesian coordinates of this point?

**2.** Two points in a plane have polar coordinates (2.50 m, 30.0°) and (3.80 m, 120.0°). Determine (a) the Cartesian coordinates of these points and (b) the distance between them.

**7.** A surveyor measures the distance across a straight river by the following method: starting directly across from a tree on the opposite bank, she walks 100 m along the riverbank to establish a baseline. Then she sights across to the tree. The angle from her baseline to the tree is 35.0°. How wide is the river?

**9.** A plane flies from base camp to lake A, a distance of 280 km at a direction of 20.0° north of east. After dropping off supplies it flies to lake B, which is 190 km at 30.0° west of north from lake A. Graphically determine the distance and direction from lake B to the base camp.

**15.** Each of the displacement vectors **A** and **B** shown in Fig. P3.15 has a magnitude of 3.00 m. Find graphically (a) **A** + **B**, (b) **A** − **B**, (c) **B** − **A**, (d) **A** − 2**B**. Report all angles counterclockwise from the positive $x$ axis.

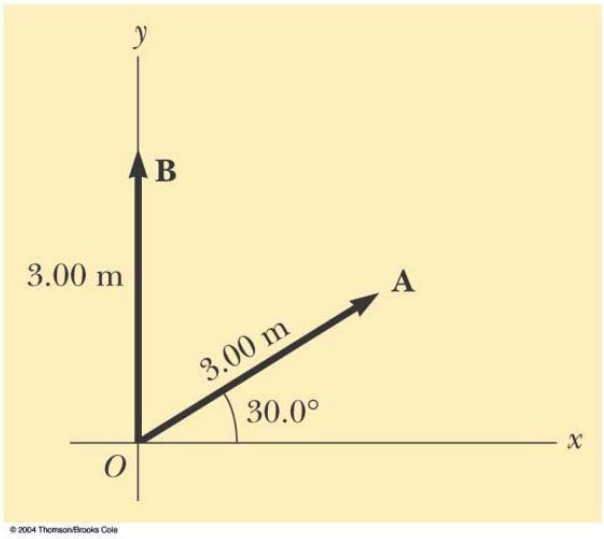


**Fig P3.15** Problems 15 and 37

**20.** A person walks 25.0° north of east for 3.10 km. How far would she have to walk due north and due east to arrive at the same location?

**24.** In 1992, Akira Matsushima, from Japan, rode a unicycle across the United States, covering about 4 800 km in six weeks. Suppose that, during that trip, he had to find his way through a city with plenty of one-way streets. In the city center, Matsushima had to travel in sequence 280 m north, 220 m east, 360 m north, 300 m west, 120 m south, 60.0 m east, 40.0 m south, 90.0 m west (road construction) and then 70.0 m north. At that point, he stopped to rest. Meanwhile, a curious crow decided to fly the distance from his starting point to the rest location directly ("as the crow flies"). It took the crow 40.0 s to cover that distance. Assuming the velocity of the crow was constant, find its magnitude and direction.

**27.** Given the vectors $\mathbf{A} = 2.00\hat{\mathbf{i}} + 6.00\hat{\mathbf{j}}$ and $\mathbf{B} = 3.00\hat{\mathbf{i}} - 2.00\hat{\mathbf{j}}$, (a) draw the vector sum **C** = **A** + **B** and the vector difference **D** = **A** – **B.** (b) Calculate **C** and **D,** first in terms of unit vectors and then in terms of polar coordinates, with angles measured with respect to the +*x* axis.

**35.** The helicopter view in Fig. P3.35 shows two people pulling on a stubborn mule. Find (a) the single force that is equivalent to the two forces shown, and (b) the force that a third person would have to exert on the mule to make the resultant force equal to zero. The forces are measured in units of newtons (abbreviated N).

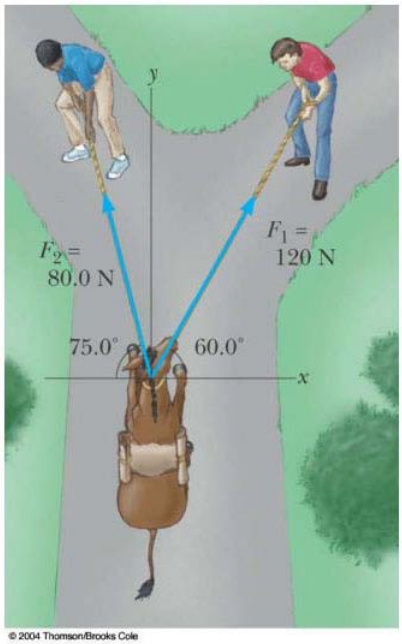


**Fig P3.35**

**42.** Instructions for finding a buried treasure include the following: Go 75.0 paces at 240°, turn to 135° and walk 125 paces, then travel 100 paces at 160°. The angles are measured counterclockwise from an axis pointing to the east, the +*x* direction. Determine the resultant displacement from the starting point.

**43.** Given the displacement vectors $\mathbf{A} = \left(3\hat{\mathbf{i}} - 4\hat{\mathbf{j}} + 4\hat{\mathbf{k}}\right)\text{m}$ and $\mathbf{B} = \left(2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} - 7\hat{\mathbf{k}}\right)\text{m}$, find the magnitudes of the vectors (a) **C** = **A** + **B** and (b) **D** = 2**A** – **B**, also expressing each in terms of its rectangular components.

**44.** A radar station locates a sinking ship at range 17.3 km and bearing 136° clockwise from north. From the same station a rescue plane is at horizontal range 19.6 km, 153° clockwise from north, with elevation 2.20 km. (a) Write the position vector for the ship relative to the plane, letting $\hat{\mathbf{i}}$ represent east, $\hat{\mathbf{j}}$ north, and $\hat{\mathbf{k}}$ up. (b) How far apart are the plane and ship?

**45.** As it passes over Grand Bahama Island, the eye of a hurricane is moving in a direction 60.0° north of west with a speed of 41.0 km/h. Three hours later, the course of the hurricane suddenly shifts due north, and its speed slows to 25.0 km/h. How far from Grand Bahama is the eye 4.50 h after it passes over the island?

**51.** Two vectors **A** and **B** have precisely equal magnitudes. In order for the magnitude of **A** + **B** to be one hundred times larger than the magnitude of **A** – **B**, what must be the angle between them?

**Answers:**

Chapter 1:

3: $2.14 \times 10^4$ kg/m$^3$

10: $9.83 \times 10^{-16}$ g

16: $ML/T^2$, kg m/s$^2$

17: $\mathrm{m}^3/\mathrm{kg}\cdot\mathrm{s}^2$

19: 9.19 nm/s

24: 560 km, 491 km, 6.19 km, 2.5 km

29: 190 years, $2.32 \times 10^4$ times

38: 13.4, 49.1

Chapter 3:

1: –2.75 m, –4.76 m

2: (2.17, 1.25) m

7: 70.0 m

9: 310 km at 57° S of W

15: 5.2 m at 60°, 3.0 m at 330°, 3.0 m at 150°, 5.2 m at 300°

20: 1.31 km north, 2.81 km east

24: 14 m/s at 11.3° W of N

27: $5.00\hat{\mathbf{i}} + 4.00\hat{\mathbf{j}}$, 6.4 at 38.7°, $-1.00\hat{\mathbf{i}} + 8.00\hat{\mathbf{j}}$, 8.06 at 97.2°

35: 185 N, 77.8°, $(-39.3\hat{\mathbf{i}} - 181\hat{\mathbf{j}})$ N

42: $(-220\hat{\mathbf{i}} + 57.6\hat{\mathbf{j}})$, 227 paces at 165°

43: $(5.00\hat{\mathbf{i}} - 1.00\hat{\mathbf{j}} - 3.00\hat{\mathbf{k}})$ m, 5.92 m, $(4.00\hat{\mathbf{i}} - 11.0\hat{\mathbf{j}} + 15.0\hat{\mathbf{k}})$ m, 19.0 m

44: $(3.12\hat{\mathbf{i}} + 5.02\hat{\mathbf{j}} - 2.20\hat{\mathbf{k}})$ m, 6.31 km

45: 157 km

51: 1.15°