1. Explain the difference between scalar and vector quantities.

2. A group of college students anxious to get to Florida on spring break drive the 630 mile trip with only minimum stops. The compute their average speed for the trip to be 55.3 mi/h. How many hours did the trip take?

3. Can an object simultaneously have an instantaneous velocity of 9.8 m/s in one direction and an acceleration of 9.8 m/s^2 in the same or opposite direction? Explain.

4. A race car travels northward on a straight, level track at a constant speed, traveling 0.750 km in 20.0 s. The return trip over the same track is made in 25.0 s. (A) What is the average velocity of the car in m/s for the first leg of the run? (B) What is the average velocity for the total trip?

5. Modern oil tankers weight over a half-million tons and have lengths of up to a quarter of a mile. Such massive ships require a distance of 5.0 km (about 3.0 miles) and a time of 20 minutes to come to a stop from a top speed of 30 km/h. (A) what is the magnitude of such a ship's average acceleration in m/s^2 in coming to a stop? (B) What is the magnitude of the ship's average velocity in m/s? Comment on the potential of a tanker running aground.

6. (A) Can a car be moving at a constant rate of 60 km/h and still be accelerating? Explain. (B) Are we accelerating due to Earth's spinning on its axis? Can you sense this motion? Explain.

7. A girl standing on a bridge drops a stone. (A) If it takes 2.50 s for the stone to hit the water below, what is the girl's distance above the water? (B) With what speed did the stone hit the water?

8. An airplane flies west at a speed of 200 m/s (448 mi/h). A package of supplies is dropped from the plane to some stranded campers. (A) What is the package's initial velocity? Give both speed and direction. (B) What are the magnitude and direction of the package's acceleration? (C) If the plane is at an altitude of 1000 m, how far from the campers should the package be dropped to land near them?

9. Taking into account air resistance or friction, how would you throw a ball to get the maximum range and why?

10. Roadways around curves are sometimes banked or at an incline toward the center of the curve. Why is this?
#1. Explain the difference between scalar and vector quantities.

A scalar tells the magnitude of a quantity but nothing about the direction.

A vector tells us both the magnitude and the direction of a quantity.

#2. A group of college students anxious to get to Florida on spring break drive the 630 mile trip with only minimum stops. They compute their average speed for the trip to be 55.3 mi/h. How many hours did the trip take?

\[ V = \frac{d}{t}, \quad t = \frac{d}{V} \quad (630 \text{ mile}) \left( \frac{h}{55.3 \text{ mi}} \right) = 11.4 \text{ h} \]

#3. Can an object simultaneously have an instantaneous velocity of 9.8 m/s in one direction and an acceleration of 9.8 m/s² in the same or opposite direction? Explain.

Yes, an acceleration is a change in speed or direction. We can only know if there was an acceleration by considering the next moment.

#4. A race car travels northward on a straight, level track at a constant speed, traveling 0.750 km in 20.0s. The return trip over the same track is made in 25.0s.

(A) What is the average velocity of the car in m/s for the first leg of the run?

\[ V = \frac{d}{t} = \frac{0.750 \text{ km}}{20.0 \text{ s}} = 0.0375 \text{ km/s} \]

\[ \left( \frac{0.0375 \text{ km}}{\text{s}} \right) \left( \frac{1000 \text{ m}}{1 \text{ km}} \right) = 37.5 \text{ m northward/s} \]

(B) What is the average velocity for the total trip?

\[ d = 0.750 \text{ km} + 0.750 \text{ km} = 1.5 \text{ km} \]
\[ t = 20.0 \text{ s} + 25.0 \text{ s} = 45.0 \text{ s} \]

\[ V = \frac{1.5 \text{ km}}{45.0 \text{ s}} = 0.0333 \text{ km/s} \]

\[ \left( \frac{0.0333 \text{ km}}{\text{s}} \right) \left( \frac{1000 \text{ m}}{1 \text{ km}} \right) = 33.3 \text{ m/s} \]
Modern oil tankers weigh over a half-million tons and have lengths of up to a quarter of a mile. Such massive ships require a distance of 5.0 km and a time of 20 minutes to come to a stop from a top speed of 30 km/h.

(A) What is the magnitude of such a ship's average acceleration in m/s² in coming to a stop?

\[ a = \frac{\Delta v}{t} = \frac{0 \text{ km/h} - 30 \text{ km/h}}{20 \text{ min} \left( \frac{1 \text{ hr}}{60 \text{ min}} \right)} = \frac{-30 \text{ km/h}}{0.33 \text{ h}} = \frac{-90.9 \text{ km/h}}{\text{h}^2} \]

\[ \left( \frac{-90.9 \text{ km/h}}{\text{h}^2} \right) \left( \frac{1000 \text{ m}}{1 \text{ km}} \right) \left( \frac{1 \text{ h}}{3600 \text{ s}} \right)^2 = \frac{-7.0 \times 10^{-3} \text{ m/s}^2}{5^2} \]

(B) \[ V = \frac{d}{t} = \frac{5.0 \text{ km}}{20 \text{ min}} = \frac{0.25 \text{ km}}{\text{min}} \]

\[ \left( \frac{0.25 \text{ km}}{\text{min}} \right) \left( \frac{1000 \text{ m}}{1 \text{ km}} \right) \left( \frac{1 \text{ min}}{60 \text{ s}} \right) = \frac{4.2 \text{ m}}{\text{s}} \]

There is a very high probability of ships running aground.

6. (A) Can a car be moving at a constant rate of 60 km/h and still be accelerating?

- Yes, if there is a change in direction. If there is no change in direction, then moving at a constant rate there would be no acceleration.

(B) Are we accelerating due to Earth's spinning on its axis? Can you sense this motion? Explain.

- Yes, we are accelerating, but the change in direction is too small for us to sense.
7. A girl standing on a bridge drops a stone.
(A) If it takes 2.50s for the stone to hit the water below, what is the girl's distance above the water?
\[
\begin{align*}
  t &= 2.50s \\
  d &= ? \\
  a &= 9.8 \text{ m/s}^2 \\
  d &= \frac{1}{2} gt^2 \\
  d &= \frac{1}{2} \left(9.8 \text{ m/s}^2\right)(2.50s)^2 \\
  d &= 30.6 \text{ m}
\end{align*}
\]

(B) With what speed did the stone hit the water?
\[
\begin{align*}
  t &= 2.50s \\
  d &= 30.6 \text{ m} \\
  v &= \frac{d}{t} \\
  v &= \frac{30.6 \text{ m}}{2.50s} = 12.2 \text{ m/s} = v
\end{align*}
\]

8. An airplane flies west at a speed of 200 m/s. A package of supplies is dropped from the plane to some stranded campers.
(A) What is the package's initial velocity? Give both speed and direction.
\[
\begin{align*}
  v_{ox} &= 200 \text{ m/s} \\
  v_{oy} &= 0 \text{ m/s} \\
  a_x &= 0 \text{ m/s}^2 \\
  a_y &= 9.8 \text{ m/s}^2 \\
  d_x &= ? \\
  d_y &= 1000 \text{ m}
\end{align*}
\]

(B) What are the magnitude and direction of the package's acceleration?

The acceleration in the x-direction (neglecting air resistance) = 0 m/s^2
The acceleration in the y-direction is 9.8 m/s^2 downward

(C) If the plane is at an altitude of 1000 m, how far from the campers should the package be dropped?

- We need to know the time the package is in the air.
\[
\begin{align*}
  t &= \sqrt{\frac{2d}{a_y}} = \sqrt{\frac{1000 \text{ m}}{0.5 \left(9.8 \text{ m/s}^2\right)}} = 14.3 \text{ s} \\
  d_x &= v_x \cdot t \\
  d_x &= (200 \text{ m/s})(14.3 \text{ s}) \\
  d &= 2857 \text{ m} \\
  &= 2.86 \times 10^3 \text{ m}
\end{align*}
\]
9. Taking into account air resistance or friction, how would you throw a ball to get the maximum range and why?

- Air resistance reduces the distance; air resistance slows the velocity in the x-direction much more than the y-direction.

10. Roadways around curves are sometimes banked or at an incline toward the center of the curve. Why is this?

- Although the inward acceleration necessary for a vehicle to go around a curve is supplied by friction on the tires, on a banked curve, some of the acceleration is supplied by gravity.