Unit 3: **Name: _____**

Kinematics in Two Dimensions; Vectors **Date: _____ Period_____**

Questions:

1. One car travels due east at $40\,\text{km/h}$, and a second car travels north at $40\,\text{km/h}$. Are their velocities equal? Explain.

2. Can the displacement vector for a particle moving in two dimensions ever be longer than the length of path traveled by the particle over the same time interval? Can it ever be less? Discuss.

3. If $\vec{\mathbf{V}} = \vec{\mathbf{V}}_1 + \vec{\mathbf{V}}_2$, is V necessarily greater than V_1 and/or V_2 ? Discuss.

4. Can two vectors of unequal magnitude add up to give the zero vector? Can *three* unequal vectors? Under what conditions?

5. Can a particle with constant speed be accelerating? What if it has constant velocity?

6. It was reported in World War I that a pilot flying at an altitude of 2 km caught in his bare hands a bullet fired at the plane! Using the fact that a bullet slows down considerably due to air resistance, explain how this incident occurred.

7. If you are riding on a train that speeds past another train moving in the same direction on an adjacent track, it appears that the other train is moving backward. Why?

8. A person sitting in an enclosed train car, moving at constant velocity, throws a ball straight up into the air in her reference frame. (*a*) Where does the ball land? What is your answer if the car (*b*) accelerates, (*c*) decelerates, (*d*) rounds a curve, (*e*) moves with constant velocity but is open to the air?

9. How do you think a baseball player "judges" the flight of a fly ball? Which equation in this Chapter becomes part of the player's intuition?

10. A projectile is launched at an angle of 30° to the horizontal with a speed of $30\,\text{m/s}$. How does the horizontal component of its velocity 1.0 s after launch compare with its horizontal component of velocity 2.0 s after launch?

Problems

3–2 to 3–4 Vector Addition

1. (I) A car is driven 215 km west and then 85 km southwest. What is the displacement of the car from the point of origin (magnitude and direction)? Draw a diagram.

2. (II) $\vec{\mathbf{V}}$ is a vector 14.3 units in magnitude and points at an angle of 34.8° above the negative x axis. (*a*) Sketch this vector. (*b*) Find V_x and V_y. (*c*) Use V_x and V_y to obtain (again) the magnitude and direction of $\vec{\mathbf{V}}$. [*Note*: Part (*c*) is a good way to check if you've resolved your vector correctly.]

3. (II) An airplane is traveling $735\,\text{km/h}$ in a direction 41.5° west of north (Fig. 3–31). (*a*) Find the components of the velocity vector in the northerly and westerly directions. (*b*) How far north and how far west has the plane traveled after 3.00 h?

4. (II) The summit of a mountain, 2450 m above base camp, is measured on a map to be 4580 m horizontally from the camp in a direction 32.5° west of north. What are the components of the displacement vector from camp to summit? What is its magnitude? Choose the *x* axis east, *y* axis north, and *z* axis up.

3–5 and 3–6 Projectile Motion (neglect air resistance)

5. (I) A tiger leaps horizontally from a 6.5-m-high rock with a speed of $3.5\,\text{m/s}$. How far from the base of the rock will she land?

6. (II) A ball is thrown horizontally from the roof of a building 45.0 m tall and lands 24.0 m from the base. What was the ball's initial speed?

7. (II) A football is kicked at ground level with a speed of $18.0\,\text{m/s}$ at an angle of 35.0º to the horizontal. How much later does it hit the ground?

8. (II) The pilot of an airplane traveling $180\,\text{km/h}$ wants to drop supplies to flood victims isolated on a patch of land 160 m below. The supplies should be dropped how many seconds before the plane is directly overhead?

9. (II) A projectile is fired with an initial speed of $65.2\,\text{m/s}$ at an angle of 34.5º above the horizontal on a long flat firing range. Determine (*a*) the maximum height reached by the projectile, (*b*) the total time in the air, (*c*) the total horizontal distance covered (that is, the range), and (*d*) the velocity of the projectile 1.50 s after firing.

***3–8 Relative Velocity**

***10.** (II) A boat can travel $2.30\,\text{m/s}$ in still water. (*a*) If the boat points its prow directly across a stream whose current is $1.20\,\text{m/s}$, what is the velocity (magnitude and direction) of the boat relative to the shore? (*b*) What will be the position of the boat, relative to its point of origin, after 3.00 s?

***11.** (II) Two planes approach each other head-on. Each has a speed of $785\ \text{km/h}$, and they spot each other when they are initially 11.0 km apart. How much time do the pilots have to take evasive action?

***12.** (II) An airplane is heading due south at a speed of $600\ \text{km/h}$. If a wind begins blowing from the southwest at a speed of $100\ \text{km/h}$ (average), calculate: (*a*) the velocity (magnitude and direction) of the plane relative to the ground, and (*b*) how far from its intended position will it be after 10 min if the pilot takes no corrective action. [*Hint*: First draw a diagram.]

***13.** (III) An unmarked police car, traveling a constant $95\ \text{km/h}$, is passed by a speeder traveling $145\ \text{km/h}$. Precisely 1.00 s after the speeder passes, the policeman steps on the accelerator. If the police car's acceleration is $2.00\ \text{m/s}^2$, how much time elapses after the police car is passed until it overtakes the speeder (assumed moving at constant speed)?