SPH3U UNIVERSITY PHYSICS

KINEMATICS

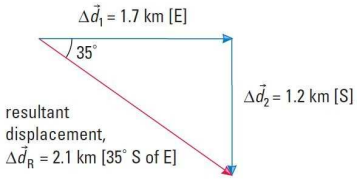
- Motion in Two-Dimensions (P.60-75)

Motion in Two-Dimensions

Although uniform motion, as discussed earlier, is the simplest motion to analyze, it is not as common as non-uniform motion. A simple change of direction renders a motion non-uniform, even if the speed remains constant.

Resultant Displacement in Two Dimensions

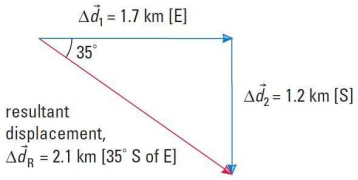
For example, on a rainy day a boy walks from his home 1.7 km[E], and then 1.2 km[S] to get to a community skating arena. On a clear day, however, he can walk straight across a vacant field to get to the same arena. As shown, the ***total*** *or* ***resultant displacement*** *is the same in either case. (Recall vectors are added tip to tail.)*



Resultant Displacement in Two Dimensions

NOTE!

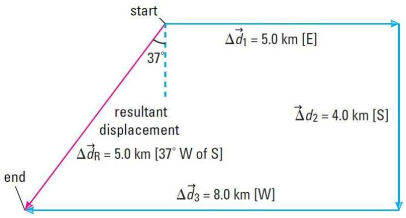
*As was mentioned earlier, we will **not** use a scale diagram (too time consuming). Instead, we will sketch the vector diagram that represents the motion and then use that to help determine the displacement. In the case of motion in two dimensions, we will need to use **Pythagoras** and **trigonometry** to determine the vector length and direction.*



Resultant Displacement in Two Dimensions

PRACTICE

1. A cyclist travels 5.0 km[E], then 4.0 km[S], and then 8.0 km[W]. Use a vector diagram to help determine the total displacement.



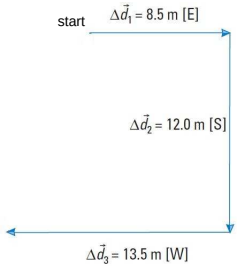
Average Velocity in Two Dimensions

Just as for one-dimensional motion, the average velocity for two-dimensional motion is the ratio of the displacement to the elapsed time. Since more than one displacement may be involved, the average velocity is described using the resultant displacement.

Average Velocity in Two Dimensions

PRACTICE

2. After leaving the huddle, a receiver on a football team runs 8.5 m[E] waiting for the ball to be snapped, then he turns abruptly and runs 12.0 m[S], suddenly changes direction, catches a pass, and runs 13.5 m[W] before being tackled.
   (a) Draw a vector diagram of the situation.



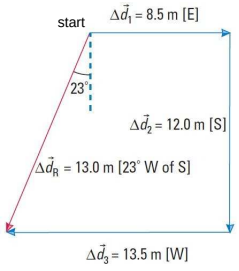
Average Velocity in Two Dimensions

PRACTICE

2. (b) If the entire motion takes 7.0 s, determine the receiver's average velocity. (Hint: you will need to find the resultant or total displacement first.)

   (b) v_{avg} = 1.9 m/s[S23°W]

   (13.0 m[S23°W] ÷ 7.0 s)



Motion in Two-Dimensions

PRACTICE

3. A student starts at the westernmost position of a circular track of circumference 200 m and runs all the way around the track in 26 s. Assuming two significant digits, determine the student's:
   (a) average speed.

   (a) v_{avg} = 7.7 m/s (200 m ÷ 26 s)

Motion in Two-Dimensions

PRACTICE

3. A student starts at the westernmost position of a circular track of circumference 200 m and runs all the way around the track in 26 s. Assuming two significant digits, determine the student's:
   (b) average velocity.

   (b) $v_{avg} = 0$ (because $\Delta d_T = 0$)

Motion in Two-Dimensions

PRACTICE

4. A ball rolling with an initial velocity of 40 m/s[W] undergoes an acceleration of 5.0 m/s²[N] for a period of 6.0 seconds.
   (a) What is the velocity of the ball after 6.0 s?

   (a) $v_2 = 50$ m/s[W37°N]

Motion in Two-Dimensions

PRACTICE

4. A ball rolling with an initial velocity of 40 m/s[W] undergoes an acceleration of 5.0 m/s²[N] for a period of 6.0 seconds.
   (b) What is the displacement of the ball after 6.0 s?

   (b) d = 256 m[W21°N]

Motion in Two-Dimensions

PRACTICE

5. A car travelling at 15 m/s[N] enters a gradual curve. When it exits the curve it is travelling at 18 m/s[E]. What is the car's change in velocity? (Hint: $\Delta v = v_2 - v_1$)

   $\Delta v = 23$ m/s[E40°S]

✔ Check Your Learning

TEXTBOOK

P.75 Q.2