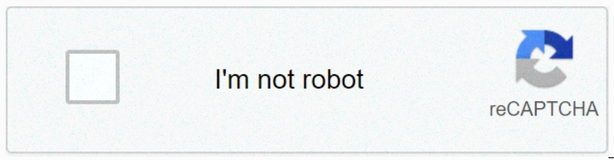

Continue

Average velocity and displacement worksheet answers

By the end of this section, you'll be able to set the location, offset, and distance traveled. Calculate the total offset given the position as a time function. Determine the total distance travelled. Calculate the average speed given the displacement and time spent. When you're on the move, the key questions you need to ask are: Where are you? Where are you going? How fast are you going to get there? The answers to these questions require you to specify your location, shift, and average speed—the terms we set in this section. To describe the animation of an object, you must first be able to describe its position (x): where it is at any particular time. More specifically, we need to determine its position in relation to a convenient reference framework. A reference box is an arbitrary set of axes that describe the position and movement of an object. The Earth is often used as a reference frame and we often describe the position of an object as it relates to fixed objects on Earth. For example, a rocket launch could be described based on the position of the rocket relative to Earth as a whole, while the position of a cyclist could be described based on where it is located in relation to the buildings it passes through (Figure). In other cases, we use reference frames that are not stationary but are moving relative to Earth. To describe a person's position on a plane, for example, we use the plane, not Earth, as a reference frame. To describe the location of an object subjected to one-dimensional motion, we often use the variable x. Later in the chapter, during the discussion of free fall, we use the variable y. Figure 3.2 These cyclists in Vietnam can be described by their position in relation to buildings or a canal. Their movement can be described by changing their position, or shifting, in a reference frame. (credit: Suzan Black) This change in position is called a offset. Word offset means that an object has been moved or displaced. Although the position is the numeric value of x along a straight line where an object can be located, the offset gives the change in position along that line. Since the shift indicates direction, it is a vector and can be either positive or negative, depending on the choice of positive direction. Also, a motion resolution can have multiple shifts embedded in it. If the right is positive an object moves 2 m to the right, then 4 m to the left, the individual shifts are 2 m and [latex] -4 [/latex] m, respectively. Figure 3.3 A teacher walks left and right while giving lectures. His position in relation to the Earth is given by x. The +2.0 m displacement of the relative to Earth is represented by an arrow pointing to the right. Offset [latex] \text{D}x [/latex] is the change in the position of an object: [latex] \text{D}x={x}_{\text{f}}-{x}_{0}, [/latex] where [latex] \text{D}x [/latex] is offset, [latex] {x}_{\text{f}} [/latex] is the final position and [latex] {x}_{0} [/latex] is the original position. We use the capital Greek letter delta (D) to mean change in any quantity that follows it. Thus, [latex] \text{D}x [/latex] means change in position (final position minus original position). Always solve for offset by subtracting the original [latex] position {x}_{0} [/latex] from the final [latex] position {x}_{\text{f}} [/latex]. Note that the SI unit for displacement is the meter, but sometimes we use kilometers or other units of length. Note that when units other than counters are used in a problem, you may need to convert them to counters to complete the calculation (see Conversion factors). Objects in motion can also have a number of shifts. In the previous example of the pacing teacher, the individual shifts are 2 m and [latex] -4 [/latex] m, giving an overall displacement of −2 m. We define the total offset [latex] \text{D}{\text{Total}} [/latex], as the sum of the individual shifts, and express this mathematically with the equation [latex] \text{D}{x}_{\text{Total}}=\sum \text{D}{\text{i}}, [/latex] where [latex] \text{D}_{i} [/latex] are the individual shifts. In the previous example, [latex] \text{D}{x}_{1}={x}_{1}-{x}_{0}=2-0=2\,\text{m.} [/latex] Similarly, [latex] \text{D}{x}_{2}={x}_{2}-{x}_{1}=-2-(2)=-4\,\text{m.} [/latex] Therefore, [text latex] \text{D}{x}_{\text{Total}}=\text{D}{x}_{1}+\text{D}{x}_{2}=2-4=-2\,\text {m}\text text{ .} [/latex] The total displacement is 2 − 4 = −2 m to the left or in the negative direction. It is also useful to calculate the size of the offset, or its size. The size of the shift is always positive. This is the absolute value of the offset because the offset is a vector and cannot have a negative size value. In our example, the size of the total displacement is 2 m, while the sizes of the individual shifts are 2 m and 4 m. The size of the total displacement should not be confused with the distance travelled. The distance travelled [latex] {x}_{\text{Total}} [/latex] is the total length of the path traveled between two positions. In the previous problem, the distance travelled is the sum of the sizes of the individual shifts: [latex] {x}_{\text{Total}}=|\text{D}{x}_{1}|\|| text{D}{x}_{2}|=2+4=6\,\text{m}\text{} [/latex] To calculate the other physical quantities in the kinematic we must enter the variable The time variable allows us not only to indicate where the object (its position) is during its movement, also how fast it moves. The speed of movement of an object is given by the rate at which the position changes over time. For each [latex] location {x}_{\text{i}} [/latex], we assign a specific time [latex] {t}_{\text{i}} [/latex]. If the details of the animation at each moment are not important, the rate is usually expressed as the average speed [latex] \exceed{\text{–}}{v} [/latex]. This vector quantity is simply the total displacement between two points divided by the time it took to travel between them. The time it took to move between two points is called elapsed [latex] \text{D}t [/latex]. Average speed If [latex] {x}_{1} [/latex] and [latex] {x}_{2} [/latex] are the positions of an object from time to time [latex] {t}_{1} [/latex] and [latex] {t}_{2} [/latex], respectively, then [latex] \begin{array}{cc} \text{Average velocity}=\overset{\text{–}}{v}=\frac{\text{Shift between two points}}{\text{Time elapsed between two points}}}\\ \surplus{\text{-}}{v}=\frac{\text{D}x}{\text{D}t}=fra c{{x}_{2}-{x}_{1}}{t}_{2}-{t}_{1}}.\end{array} [/latex] It is important to note that the average speed is vector and can be negative, depending on [latex] {x}_{1} [/latex] and [latex] {x}_{2} [/latex] positions. Jill sets out from her home to deliver flyers for her yard sale, traveling east along her street lined with houses. In the [latex] 0.5 [/ latex] kilometers and 9 minutes later she runs out of flyers and has to reminisce about her steps back to her house to get more. This takes an additional 9 minutes. After taking more leaflets, she starts again on the same path, continuing from where she left off, and ends up 1.0 km from her house. This third leg of her journey takes [latex] 15 [/ latex] minutes. At this point she turns back towards her house, heading west. After [latex] 1.75 [/latex] kilometers and [latex] 25 [/ latex] minutes stops to rest. What's Jill's total shift to the point where she stops to rest? What is the size of the final shift? What's the average speed throughout her trip? What is the total distance travelled? Make a chart of the location relative to time. A sketch of Jill's movements appears in (Figure). Figure 3.4 Timeline of Jill's movements. Strategy The problem contains data on the different strands of Jill's journey, so it would be helpful to make a table of physical quantities. We are given a place and time to formulate the problem so that we can calculate the shifts and the time that has passed. We're going east to be the positive direction. From this information we can find the overall displacement and the average Jill's house is the starting point [latex] {x}_{0} [/latex]. The following table gives Jill time and position in the first two columns, and the shifts are calculated in the third column. Time ti (min) Location [latex] {x}_{i} [/latex] (km) Offset [latex] \text{D}{x}_{\text{i}} [/latex] [/latex] [latex] {t}_{0}=0 [/latex] [latex] {x}_{0}=0 [/latex] [latex] \text{Δ}{x}_{0}=0 [/latex] [latex] {t}_{1}=9 [/latex] [latex] {x}_{1}=0.5 [/latex] [latex] \text{Δ}{x}_{1}={x}_{1}-{x}_{0}=0.5 [/latex] [latex] {t}_{2}=18 [/latex] [latex] {x}_{2}=0 [/latex] [latex] \text{Δ}{x}_{2}={x}_{2}-{x}_{1}=-0.5 [/latex] [latex] {t}_{3}=33 [/latex] [latex] {x}_{3}=1.0 [/latex] [latex] \text{Δ}{x}_{3}={x}_{3}-{x}_{2}=1.0 [/latex] [latex] {t}_{4}=58 [/latex] [latex] {x}_{4}=-0.75 [/latex] [latex] \text{Δ}{x}_{4}={x}_{4}-{x}_{3}=-1.75 [/latex] Solution Significance Jill's total displacement is −0.75 km, which means at the end of her trip she ends up [latex] 0.75\ ,\text{km} [/latex] west of her house. The average speed means that if someone were to walk west on the [latex] 0.013 [/latex] km/min starting at the same time as Jill left her house, they would both get to the final stop at the same time. Note that if Jill ended her journey home, her overall shift would be zero, as would her average speed. The total distance travelled during the 58 minutes of the time spent on her journey is 3.75 km. A cyclist rides 3 km west and then turns around and rides 2km east. (a) What is its displacement? (b) What is the distance travelled? c) What is the size of its displacement? Summary Kinematic is the description of the movement without taking into account its causes. In this chapter, it is limited to moving along a straight line, called one-dimensional motion. Offset is the change in the position of an object. The SI unit for displacement is the counter. The displacement has direction as well as size. The distance travelled is the total length of the journey between two positions. Time is measured in terms of change. The time between two [latex] position points {x}_{1} [/latex] and [latex] {x}_{2} [/latex] is [latex] \text{D}t={t}_{2}-{t}_{1} [/latex]. The elapsed time for an event is [latex] \text{D}t={t}_{\text{f}}-{t}_{0} [/latex], where [latex] {t}_{\text{f}} [/latex] is the last hour and [latex] {t}_{0} [/latex] is the original time. The initial time is often considered zero. The average [latex] speed \overset{\text{–}}{v} [/latex] is defined as a offset divided by the time passed. If [latex] {x}_{1}, {t}_{1} [/latex] and [latex] {x}_{2},{t}_{2} [/latex] are two location times, the average speed between these points is [latex] \overset{-}{v}=\frac{\text{D}{\text{D}t}=\frac{x}_{2}-{x}_{1}}{{t}_{2}-{t}_{1}}. [/latex] Specify each quantity specifically in your example. Under what conditions does the distance equal offset size? What is the only case in which the size of the offset and displacement is exactly the same? Bacteria move back and forth using their flag which look like short queues). Speeds of up to 50 μm/s (50 × 10−6 m/s) have been observed. The total distance travelled by a bacterium is large for its size, while its displacement is small. Why are you doing this? Give an example of a device used to measure time and determine which change on that device indicates a change in time. Does a car's mileage meter measure the distance travelled or the displacement? During a given period of time, the average speed of an object is zero. What can you say about its displacement during the interval? Examine a coordinate system in which the positive x-axis is directed up vertically. What are the positions of a particle (a) 5.0 m just above the origin and (b) 2.0 m below the origin? A car is located 2.0 km west of a traffic light at t = 0 and 5.0 km east of light in t = 6.0 minutes. Assume that the origin of the coordinate system is light and the positive direction x is to the east. a) What are the car's position vectors in these two times? b) What is the displacement of the car between 0 min and 6.0 min? The Shanghai maglev train connects Longyang Road to Pudong International Airport, a distance of 30 km. The journey takes an average of 8 minutes. What is the average speed of the Maglev train? The position of a particle moving along the x-axis is given by [latex] x(t)=4.0-2.0t [/latex] m. (a) At what time does the particle cross the origin? (b) What is the particle offset between [latex] \text{t}=3.0\,\text{s} [/latex] and [latex] \text{t}=6.0\,\text{s}? [/latex] A cyclist drives 8.0 km east for 20 minutes, then turns and heads west for 8 minutes and 3.2 km. Finally, it leads east for 16 km, which takes 40 minutes. a) What is the final displacement of the cyclist? (b) What is its average speed? On February 15, 2013, a hyperbole meteor (brighter than the Sun) entered the Earth's atmosphere above Chelyabinsk, Russia, and exploded at an altitude of 23.5 kilometers. Witnesses could feel the intense heat from the fireball, and the explosion wave from the explosion blew up the windows in the buildings. The blast wave took about 2 minutes and 30 seconds to reach ground level. (a) What was the average speed of the explosion wave? b) Compare this to the speed of sound, which is 343 m/s at sea level. mean speed the displacement divided by the time at which the change shifts to the position of the object distance travelled the total length of the path travelled between positions where the difference between the end time and the start time has elapsed movingly the description of movement through properties such as position, time, speed and acceleration position the position of an object in a specific temporal total offset the sum of individual shifts over a given period of time

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