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# Displacement time graph for uniform velocity

Card 1: Displacement - Time Graph In a Displacement-Time Graph, the gradient of the graph is equal to the velocity of motion. Card 2: Analysign Displacement - Time Graph Gradient = 0 Hence, velocity = 0 Gradient is constant, hence, velocity is Uniform Gradient is negative and constant, hence velocity is uniform and in opposite direction Gradient is increasing, hence velocity is increasing.  Gradient is decreasing, hence velocity is decreasing.  Card 3: Velocity - Time Graph The gradient of the velocity-time gradient gives a value of the changing rate in velocity, which is the acceleration of the object. The area below the velocity-time graph gives a value of the object's displacement. Card 4: Analysing Velocity - Time graph Uniform velocity Uniform acceleration Uniform deceleration Increasing acceleration  Increasing deceleration  Card 5: Converting a Velocity-Time graph to Acceleration-Time graph In order to convert a velocity-time graph to acceleration time graph, we need to find the gradient of the velocity time graph and plot it in the acceleration-time graph. Card 6: Graph of free falling 1-Dropping an object from high place Velocity - Time Graph Acceleration - Time Graph Card 7: Graph of free falling 2 - Launching obejct upward Velocity-Time Graph Acceleration-Time Graph Card 8: Graph of free falling 3 - Object moving upward and fall back to the ground Velocity-Time Graph Acceleration-Time Graph Card 9: Graph of free falling 4 - Object falling and bounces back Velocity-Time Graph Acceleration-Time Graph Question 1 What is the nature of graph for a uniform speed? Question 2 Name the quantity which is measured by the area occupied under the velocity-time graph? Question 3 What does the slope of speed-time graph indicate? Question 4 What can you say about the motion of a body if its displacement-time graph is a straight line? Question 5 What can you say about the motion of a body if its velocity-time graph is a straight line? Question 6 Name the quantity,the slope of whose graph give Speed? Distance – Time graphs (1) Uniform Speed Straight line graph between distance and time tells us that body is moving with uniform speed. Slope of distance time graph indicates speed.  Slope = PQ/OQ  (2) Non-Uniform speed The distance time graph for a non-uniform motion is a curved line (parabola). If a body moves with a non-uniform speed then its motion is said to be accelerated. It also represents distance time graph with accelerated motion. Speed – Time or velocity – Time Graphs (1) Speed-time graph when speed remains constant (a) Speed time graph for a body moving with constant speed(no acceleration) is a straight line parallel to time axis. We can find the distance travelled by a body in a given time from speed-time graph. Speed = Distance travelled / Time taken OC x BC = Distance travelled OC x OA = Time taken Distance travelled = Area of rectangle OABC The velocity time graph of an object moving with constant velocity is a straight line parallel to time axis. (2) Speed-time graph when speed changes at uniform rate (uniform acceleration) (1) When a body moves with uniform acceleration,its speed changes by equal amount in equal intervals of time. Speed time graph for a uniformly changing speed will be a straight line.  The value of acceleration from speed time graph of moving body can be calculated as: a = Change in speed or velocity / Time taken a = PQ/OQ In a speed time graph the acceleration is given by slope of the graph. The distance travelled by a moving body in a given time can be calculated from speed time graph. Distance travelled = Area of triangle POQ = 1/2 x OQ x OP In a speed time graph of a body a straight line sloping downwards indicates retardation. Speed time graph when the initial speed of the body is not zero. The distance travelled by the body in this case is equal to the area of trapezium OBCA.  Area of Trapezium =  (Sum of parallel sides x Height) / 2  Distance Travelled =  (OB x AC) x OA)/2 (3) Speed – Time graph when speed changes at a non-uniform rate (Non-uniform acceleration) When the speed of a body changes in an irregular manner,then speed-time graph of a body is curved line. Acceleration is the rate at which an object's velocity changes. It is given the symbol (), and is measured in metres per second per second, or metres per second squared (m/). In other words, it is how the velocity (measured in m/s) changes per second. Note that because acceleration is based on change in velocity, which is a vector quantity, acceleration is a vector quantity as well. Direction must always be included when discussing acceleration. Uniform motion is motion in which the velocity does not change. Non-uniform motion occurs when the velocity of an object is not constant: the object speeds up or slows down during its motion, or changes direction. The motion we'll be looking at in this activity will all be non-uniform, however, we will only be looking at examples where the magnitude of the velocity changes -- we will keep everything in one dimension. How can we tell these two types of motion apart?  Here is the data of an object that is undergoing uniform motion. Time (t) in s Position () in m [S] 0 0 10 20 20 40 30 60 40 80 50 100 60 120 70 140 The amount of distance covered is the same for each 20 second interval. If we were to graph this, the slope of each line segment would be the same: And the graph would look like this: What does the position-time graph look like for an object that's accelerating? Let's create a scenario with non-uniform motion. We'll start with the same time data as above, but this time, you will create the position data. In the original set of data, the object increased its distance by 20 metres every 10 seconds. In this case, the object will need to cover greater and greater amounts of distance in each 10-second interval. Time (t) in s Position () in m [S] 0 0 10  20  30  40  50  60  70  Now, graph your data. Compare what you see in your graph with the graph of uniform motion earlier in this activity. Create a reflection, and record your answers to the following questions: How does the shape of your non-uniform motion graph differ from the uniform motion graph? What do you think the position-time graph of an object that was slowing down might look like? Take a look at the following position-time graph -- it might resemble the one you created. Can you see a difference between the rate of change (slope) in the first segment and the rate of change (slope) in the last segment? In each segment, actually, the rate of change is getting a little larger each time, and the slope is getting a little steeper. And, if rate of change of a position-time graph is the object's velocity, that means that the object is going a little faster in each segment. An object that is slowing down might have a graph that looks like this: In the above case, the greatest rate of change (greatest velocity) is the first segment, and then the slope decreases (the velocity decreases) throughout the rest of the object's motion. In general, a curved position-time graph indicates non-uniform motion. When the velocity is constant, you are aware of what a position-time graph looks like -- a straight line, slanted up. When it comes to non-uniform motion, if we want a visual representation of how that velocity is changing, we may want to change what we graph. Instead of a position-time graph, we can create a velocity-time graph. In both cases, time is our independent variable, and is on the horizontal axis. With a velocity-time graph, though, the instantaneous velocity is on the vertical axis. Let's take a look at what this looks like. For our original object moving in uniform motion, this is what the velocity-time graph would be: This graph may seem strange, as it represents a horizontal line at the value of 2 m/s [S]. But remember that the object is moving in a uniform way, at 2 m/s the whole time, in the same direction. If there is no change in velocity (i.e., the velocity is constant), then it makes sense that the object's velocity-time graph always indicates a velocity of 2 m/s [S]. An object that isn't moving in uniform motion will have different velocities indicated on its velocity-time graph. Here is a graph that matches the motion of our unknown object moving with non-uniform motion. By reading points off the graph, we can see that the object is accelerating: at 20 seconds, the object is moving at 2 m/s [S], but then at 40 seconds, the object is moving faster, at 4 m/s [S]. At 60 seconds, the object is travelling at 6 m/s [S]. Can we find the rate of this acceleration? Of course! Any time we have a linear graph, we can find the rate of change, just like we did in Activity 2. Let's find the rate of change between the points (20, 2) and (40, 4). For every second that passes, the object is going 0.1 m/s[S] faster than it was the second before. We could also write this answer as 0.1 m/  [S]. Even though it's commonly used in everyday life, physicists rarely use the term "deceleration." Instead, they say that an object that is slowing down undergoes "negative acceleration." Can you guess why? Let's repeat our rate of change calculation for an object that is slowing down. Here's the position-time graph we saw earlier for an object getting slower and slower… If we take the slope of each segment, and plot those values in a velocity-time graph, we get the following: Question Using the graph above, choose two points, and determine the rate of change, then check your answer. Let's use the points (0, 30) and (40, 10): Because the object is slowing down, when we calculate the rate at which its velocity is changing, we see it is experiencing a negative acceleration. Every second, the object is moving at a speed 0.5 m/s [S] slower than it was the previous second. Negative acceleration indicates an object is slowing down. Think back to the Minds On task at the beginning of this activity -- you were asked to guess when the parachutist would experience the greatest acceleration. Go back to your initial reflection on the parachutist and remind yourself of what you guessed. After what we've learned about acceleration, would you like to change your mind? If so, indicate this in your reflection with your reasoning for having a different answer now. Were you right? Watch the video below to see! After watching the video, add to your reflection by recording the answers to the following questions: Did you correctly guess the greatest acceleration? If not, what did you not take into consideration when making your guess? In the video, they look at an acceleration-time graph. In our examples in this activity, our objects were all undergoing uniform acceleration (accelerating at the same rate the entire time). What do you think the acceleration-time graph would look like for our objects? If acceleration is the rate of change of an object's velocity, we can derive a formula for acceleration from a velocity-time graph: Because velocity () was on the y-axis, and time (t) was on the x-axis, we can write: Let's try to solve an acceleration problem. Don't forget to use the GRASP method! A car accelerates from a velocity of 17 m/s [W] to a speed of 25 m/s [W] in 22 seconds. What is the car's acceleration? Answer Given: We are given the following measurements: We chose  because the question gives us the total time during which the change in speed occurs. We could have also used (), with the values of  and , assuming the time started when the car started changing its velocity from 17 m/s [W] to 22 m/s [W]. Required: We are asked to determine the acceleration: Analysis: We know that acceleration is the change in velocity over time. In other words, it is the change in velocity divided by the change in time. Solution: Paraphrase: The car accelerated at 0.36 metres per second per second westward. We could also say that the car's speed increased by 0.36 m/s [W] every second. Try another one. This time, we will have to rearrange the formula in order to get what we need. A ball starts rolling down a ramp at 2.1 m/s [down], and accelerates at 1.5 m/ [down]. It gets to the bottom of the ramp 3.5 seconds later. What was its velocity at the bottom of the ramp? Answer Given: We are given the following measurements: Required: We are asked to determine the final velocity: Analysis: We know that acceleration is the change in velocity over time. In other words, it is the change in velocity divided by the change in time. If we are given the acceleration, the initial velocity, and the time, we can determine the final velocity. Solution: We have all the variables necessary for this calculation already, but will need to rearrange the formula in order to solve for final velocity. Multiplying both sides by : Adding () to both sides: We can now solve for final velocity: *Note that when we multiply acceleration and time, the resulting units are m/s, which allows us to add the 5.25 m/s [down] and the 2.1 m/s [down] since they have the same units and direction. Paraphrase: The ball's velocity at the end of the ramp was 7.35 m/s [down]. Try the following questions to see if you've got it! Alouette I was Canada's first satellite. Launched in 1962, it made Canada the third nation in the world to launch a satellite into space. It was launched with the help of NASA on a two-stage Thor-Agena rocket. Answer the following questions related to this space milestone. A rocket blasts off from the surface of Earth at an acceleration of 21 m/s/s [up]. If its motion is graphed on a speed-time graph, the line it would produce would be a flat horizontal line. a straight line with a positive slope. a straight line with a negative slope. a bent line curving up. Answer Answer:  b. a straight line with a positive slope. The speed of the rocket is increasing at 21 m/s/s [up]. This means it increases by 21 m/s [up] each second (eg: 0 m/s [up], 21 m/s [up], 42 m/s [up], 63 m/s [up], ...). Thus, on a velocity-time graph, the points would be equally spaced going up, causing a constant positive slope. Its initial acceleration was not actually 21 m/s/s [up]. If it went from rest to 660m/s [up] in a time of 12 seconds, its acceleration would be: 42 m/s/s [up] 27.5 m/s/s [up] 110 m/s/s [up] 55 m/s/s [up] Answer Answer:  d. 55 m/s/s [up] Once the first stage burns out, it separates and fall back to Earth. Before the second stage starts burning, the rocket slows down for a short time. If the rocket slows from 1200 m/s [up] to 1140 m/s [up] over a period of 5.0 seconds, what is the acceleration of the rocket for this time between stages? 36 m/s/s [up] 12 m/s/s [up] -12 m/s/s [up] -36 m/s/s [up] Answer Answer:  c. -12 m/s/s [up] The first stage separates from the rocket and begins to fall back to Earth. As it leaves, the rocket is travelling at 1200 m/s [up]. If it is slowing down at an acceleration of -5.5 m/s/s [up], how long will it take to slow down to a velocity of 0 m/s? Answer Answer:  c. 220 s


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