Rates of change worksheet

I'm not robot!

Prior to working with rates of change, one should have an understanding of basic algebra, a variety of constants and non-constants ways in which a dependent variable can change with respect to changes in a second independent variable. It is also recommended that one has experience calculating slope and slope intercepts. The rate of change is a measure of how much one variable changes for a given change of a second variable, which is, how much one variable grows (or shrinks) in relation to another variable. The following questions require you to calculate the rate of change. Solutions are provided in the PDF. The speed at which a variable changes over a specific amount of time is considered the rate of change. Real life problems as those presented below require an understanding of calculating the rate of change. Graphs and formulas are used to calculate rates of change. Finding the average rate of change is similar to a slope of the secant line that passes through two points. Here are 10 practice questions below to test your understanding of rates of change. You will find PDF solutions here and at the end of the questions. The distance a race car travels around a track during a race is measured by the equation: s(t)=2t2+5t Where t is the time in seconds and s is the distance in meters. Determine the car's average speed: During the first 5 secondsBetween 10 and 20 seconds.25 m from the start Determine the instantaneous speed of the car: At 1 secondAt 10 secondsAt 75 m The amount of medicine in a milliliter of a patient's blood is given by the equation:M(t)=t-1/3 t2Where M is the amount of medicine in mg, and t is the number of hours passed since administration.Determine the average change in medicine: In the first hour.Between 2 and 3 hours.1 hour after administration.3 hours after administration. Examples of rates of change are used daily in life and include but are not limited to: temperature and time of day, rate of growth over time, rate of decay over time, size and weight, increases and decreases of stock over time, cancer rates of growth, in sports rates of change are calculated about players and their statistics. Learning about rates of change usually begins in high school and the concept is then re-visited in calculus. There are often questions about the rate of change on SATs and other college entry assessments in mathematics. Graphing calculators and online calculators also have the ability to calculate a variety of problems involving the rate of change. This lesson includes 1 additional question and 54 additional question variations for subscribers. Here you will learn about the rate of change including calculating the instantaneous rate of change and the average rate of change. We will also be applying knowledge of rate of change to velocity-time graphs. There are also rate of change worksheets based on Edexcel, AQA and OCR exam questions, along with further guidance on where to go next if you're still stuck. The rate of change is what degree one variable changes in relation to another. For example, A common 'rate of change' is speed. Speed is the rate at which an object's distance changes in relation to the time taken. Step-by-step guide: Speed distance time Gradient 'of a line' If we plot a graph showing how the variables relate to each other, the rate of change is calculated by finding the gradient. For example, Here the gradient is \text{Gradient}=\frac{\text{change in y}}{\text{change in x}}=\frac{3}{2}=1.5 . Rates of change can be both positive (increases) and negative (decreases). Positive rate of change When two variables both increase in relation to each other. Example shown by the graph below. Negative rate of change When one variable increases the other decreases. Example shown by the graph below. Zero rate of change When the input variables increase the output remains constant. Example shown by the graph below. There are several other key terms that are useful to know. Independent variable The 'input' value of the function, usually denoted by x. For example, In the linear function y= 2x +3 , \ x is the independent variable. Dependent variable The 'output' value of the function, usually denoted by y. It is called the dependent because it depends on the value inputted into the function (e.g x). For example, In the linear function y= 2x +3 , \ y is the independent variable. Instantaneous rate of change The rate of change at a specific point. It is found by calculating the gradient of a curve/line at a particular point. Tangent line A line that just touches a curve at a single point, it matches the curve's gradient at that point. Average rate of change The rate of change between two points where the rate of change is not constant. It is found by calculating the gradient of a chord between two points. In order to calculate the instantaneous/average rate of change from a graphed function: Note the point/s on the graph where you are calculating the rate of change.Draw the tangent (straight line) at the point/or the line between the given points.Select another point on the tangent line you have drawn (select integer coordinates' if possible).Calculate the gradient of the line.State the rate of change clearly (with units if given). Get your free rate of change worksheet of 20+ questions and answers. Includes reasoning and applied questions. COMING SOON x Get your free rate of change worksheet of 20+ questions and answers. Includes reasoning and applied questions. COMING SOON Below is a distance-time graph of a journey. What is the speed at 2 \ hours? Note the point/s on the graph where you are calculating the rate of change. We find 2 on the horizontal axis, and go up to the graph. 2Draw the tangent (straight line) at the point/or the line between the given points. To find the speed we need to calculate the gradient of the line segment. We can use the whole of the line segment as the tangent. 3Select another point on the tangent line you have drawn (select integer coordinates' if possible). We can use the points (0,0) and (3,30). 4Calculate the gradient of the line. Coordinate one, (0,0) . Coordinate two, (3,30) . \text {Gradient }=\frac{\text{change in y}}{\text{change in x}}=\frac{y_{2}-y_{1}}{x_{2}-x_{1}}=\frac{30-0}{3-0}=\frac{30}{1}=10 5State the rate of change clearly (with units if given). The speed at 2 \ hours is 10 \ km \ per \ hour. Below is a distance-time graph of a journey. What is the speed at 7 \ hours? Note the point/s on the graph where you are calculating the rate of change. We find 7 on the horizontal axis, and go up to the graph. Draw the tangent (straight line) at the point/or the line between the given points. To find the speed we need to calculate the gradient of the line segment. We can use the whole of the line segment as the tangent. Select another point on the tangent line you have drawn (select integer coordinates' if possible). We can use the points (6,50) and (8,0). Calculate the gradient of the line. Coordinate one, (6,50) . Coordinate two, (8,0) . \text {Gradient }=\frac{\text{change in y}}{\text{change in x}} =\frac{y_{2}-y_{1}}{x_{2}-x_{1}}=\frac{50-0}{6-8}=\frac{50}{-2}=-25 State the rate of change clearly (with units if given). The gradient is -25. For speed we can ignore the negative sign. The speed at 7 \ hours is 25 \ km \ per \ hour. Note: if we were asked for the velocity, speed in a given direction, the answer would be -25 \ km \ per \ hour. What is the rate of change of the graphed function below at the point where x=1? Note the point/s on the graph where you are calculating the rate of change. Draw the tangent (straight line) at the point/or the line between the given points. Select another point on the tangent line you have drawn (select integer coordinates' if possible). Calculate the gradient of the line. Coordinate one, (0.5,1) . Coordinate two, (1,3) . \text {Gradient }=\frac{\text{change in y}}{\text{change in x}} =\frac{y_{2}-y_{1}}{x_{2}-x_{1}}=\frac{3-1}{1-0.5}=\frac{2}{0.5}=6 State the rate of change clearly (with units if given). The rate of change at the point x=1 is 6. Note: this is the instantaneous rate of change because you calculated it from a specific point. What is the rate of change of the graphed function below at the point where x=0.5? Note the point/s on the graph where you are calculating the rate of change. Draw the tangent (straight line) at the point/or the line between the given points. Select another point on the tangent line you have drawn (select integer coordinates' if possible). Calculate the gradient of the line. Coordinate one, (0,0.5) . Coordinate two, (1.5,0.5) . \text { Gradient }=\frac{\text{change in y}}{\text{change in x}}=\frac{y_{1}-y_{1}}{x_{2}-x_{1}}=\frac{1.5-0.5}{0.5-0}=\frac{1}{0.5}=2 State the rate of change clearly (with units if given). The rate of change at the point x=0.5 is 2. Note: this is the instantaneous rate of change because you calculated it from a specific point. What is the average rate of change of the graphed function between the points x=0.5 and x=1? Note the point/s on the graph where you are calculating the rate of change. Draw the tangent (straight line) at the point/or the line between the given points. Select another point on the tangent line you have drawn (select integer coordinates' if possible). You already have two points so you do not need to find another point on the straight line. The line you draw is a chord. Calculate the gradient of the line. Coordinate one, (0.5,1.5) . Coordinate two, (1,3) . \text { Gradient }=\frac{\text{change in y}}{\text{change in x}}=\frac{y_{-} y_{1}}{x_{2}-x_{1}}=\frac{3-1.5}{1-0.5}=\frac{1.5}{0.5}=3 State the rate of change clearly (with units if given). The average rate of change between the points x = 0.5 and x = 1.5 is 3. Note: this is the average rate of change because you calculated it from two points. Below is a graph representing the velocity of a cyclist in m/s in relation to the period of time they had been travelling. Calculate an estimate for the cyclist average rate of change in m/s^2 after they had been travelling for 3 seconds. Give your answer to 2 decimal places. Note the point/s on the graph where you are calculating the rate of change. Draw the tangent (straight line) at the point/or the line between the given points. Select another point on the tangent line you have drawn (select integer coordinates' if possible). Calculate the gradient of the line. Coordinate one, (3,0.8) . Coordinate two, (4,1.4) . \text { Gradient }=\frac{\text{change in y}}{\text{change in x}}=\frac{y_{2}-y_{1}}{x_{2}-x_{1}}=\frac{4-3}{1.4-0.8}=\frac{1}{0.6}=1.67 \ (2dp) State the rate of change clearly (with units if given). The rate of change of the cyclist after 3 seconds is 1.67 \ (2dp) \ ms^{-2}. Note: this is the instantaneous rate of change because you calculated it from a specific point or moment in time. For a velocity-time graph this is the acceleration. The graph of y = f(x) is drawn below. At what coordinates does the graph have a rate of change of zero? The example is asking to find the points where the rate of change is 0. This is a 'reverse' of examples 1-6 where you were finding the rate of change at a specific point. Here you are being asked to find the points where the rate of change is 0. Hint: Notice how the questions says points not point. This indicates to you that there is more than one point where the rate of change is 0. Earlier on this page you were told a rate of change is zero when the tangent is a horizontal line. This is because at a point where the rate of change is zero the output remains a constant (no change in y). Therefore you are looking for points on the graph where the tangent to the curve is a horizontal line. Consider the below diagram to help you before looking at the graph. A curve has a horizontal line as a tangent at its 'maximum point' and 'minimum point'. See below. Therefore the points on the curve from the graph where the rate of change is zero is at the points \bf{(-1,4)} and \bf{(1,0).} Not drawing an accurate tangent line If you do not draw an accurate tangent line on a curve you will not be finding an accurate rate of change. However the mark schemes for assessment do give you a bit of 'lee-way' each side of your answer. Incorrect reading of coordinates Remember the first coordinate refers to the x-axis and the second to the y -axis. Not using a ruler to draw the tangent line Always use a ruler to draw the tangent line. Incorrect formula for calculate the gradient of a line This is something you need to be super confident about for this topic. It is worth recapping beforehand. \text {Gradient}=\frac{\text{change in y}}{\text{change in x}}=\frac{y_{2}-y_{1}}{x_{2}-x_{1}} Gradients may be positive or negative Remember gradients can be positive or negative. If you are finding speed from a distance-time graph, we can ignore any negative gradients. However, if we are calculating the velocity, then it is important if the gradient is positive or negative. Practice rate of change questions Coordinate one, (0,10) . Coordinate two, (2,40) . \text { Gradient }=\frac{\text{change in y}}{\text{change in x}}=\frac{40-10}{2-0}=\frac{30}{2}=15 Therefore the speed is 15 \ m/s. Note: you may have picked different coordinates but you should still get the same gradient. Coordinate one, (7,50) . Coordinate two, (10,0) . \text { Gradient }=\frac{\text{change in y}}{\text{change in x}}=\frac{50-0}{7-10}=\frac{50}{-3}=-16.666... Therefore the speed is 16.7 \ m/s (to 3 sf). Since we have been asked for the speed we can ignore the negative sign. Note: you may have picked different coordinates but you should still get the same gradient. Coordinate one, (5,50) . Coordinate two, (7,50) . \text { Gradient }=\frac{\text{change in y}}{\text{change in x}}=\frac{50-50}{7-5}=\frac{0}{2}=0 Therefore the speed is 0 \ m/s. Note: since the line is horizontal when t=2.5 we can just write down that the speed is 0 \ m/s. Two coordinates on the tangent are coordinate one, (1,6) , and coordinate two, (6,12) . \text {Gradient}=\frac{\text{change in y}}{\text{change in x}}=\frac{12-6}{6-1}=\frac{6}{5}=1.2 Therefore the gradient is 1.2. Note: you may have picked different coordinates but you should still get the same or similar gradient. When x=0, \ y=0 . When x=2, \ y=6 . Therefore the two coordinates are given to you as coordinate one, (0,0) , and coordinate two, (2,6) . \text {Gradient}=\frac{\text{change in y}}{\text{change in x}}=\frac{6-0}{2-0}=\frac{6}{2}=3 Therefore the gradient is 3. The graph has a horizontal tangent, with gradient 0 , when x=6. Rate of change GCSE questions 1. Look at the graph below. a) What is the instantaneous rate of change when x=1? b) What is the instantaneous rate of change when x=2? c) What is the average rate of change between x=1 and x=2? (6 marks) a) Drawing tangent line at x = 1 (1) Gradient of 2 (allow \pm \ 0.2) (1) b) Drawing tangent line at x = 2 (1) Gradient of 4 (allow \pm \ 0.2) (1) c) \frac{4-1}{2-1} (1) 3 (1) 2. The graph below gives information about the changing temperature of a hot drink (C) as it cools down over a period of time in seconds (t). a) What was the initial temperature of the drink? b) What was the temperature of the drink after 4 seconds? c) What was the instantaneous rate of change of the drink after 3 seconds? d) What was the average rate of change of the drink between 2 and 5 seconds? (6 marks) a) 7.5 (1) b) 4.4 (1) c) Drawing of a straight line tangent at x=3 (1) -1 (1) d) \frac{3.1-6.4}{5-2} (1) -1.1 (allow \pm \ 0.2) (1) 3. The graph below gives information about the distance (km) covered by a person walking in relation to a period of time in hours (t). a) How long was it until the person moved? b) How far had the person travelled after 1 hour? c) What was the speed of the person walking at 3 hours? d) What was the average speed of the person walking between 1 and 2 hours? e) When was the person stationary during the walk? (7 marks) a) 0.4 hours (allow \pm \ 0.05) (1) b) 3 \ km (1) c) Drawing of a straight line tangent at x=3 (1) 3 (allow \pm \ 0.2) (1) d) \frac{4-3}{2-1} (1) 1 (1) e) At 2 hours (1) Allow t=2 (1) You have now learned how to: Draw a tangent to a graphCalculate the gradient between two pointsCalculate the rate of change of a function from a graphCalculate the average rate of change of a function from a graph Exchange ratesConversion graphsFlow rate Prepare your KS4 students for maths GCSEs success with Third Space Learning. Weekly online one to one GCSE maths revision lessons delivered by expert maths tutors. Find out more about our GCSE maths revision programme.

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