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Horizontal projectile motion graph

At the end of this section, you can: Identify and explain the properties of a projectile, such as Z.B. acceleration due to gravity, range, maximum altitude, and trajectory. Determine the position and speed of a projectile at different points in its trajectory. Apply the principle of motion independence to solve problems with projectile movements. Projectile movement is the movement of an object that is thrown into the air or projected, depending only on the acceleration of gravity. The object is called a projectile, and its path is called its trajectory. The movement of falling objects, as described in Problem-Solving Basics for One-Dimensional Kinematics, is a simple one-dimensional type of projectile movement in which there is no horizontal movement. In this section, we look at two-dimensional projectile movements, such as that of a football or other object for which drag is negligible. The most important fact that is remembered here is that movements along vertical axes are independent and can therefore be analyzed separately. This fact was discussed in Kinematics in Two Dimensions: An Introduction, where vertical and horizontal movements were considered independent. The key to analyzing the two-dimensional projectile movement is to divide it into two motions, one along the horizontal axis and the other along the vertical. (This choice of axes is most useful because acceleration is vertical due to gravity, so there will be no acceleration along the horizontal axis if the drag is negligible.) As usual, we call the horizontal axis the x-axis and the vertical axis the y-axis. Figure 1 shows the notation for the displacement, where s is defined as the total displacement and x and y its components are along the horizontal or vertical axis, respectively. The sizes of these vectors are s, x, and y. (Note that in the last section we used notation A to represent a vector with the components Ax and Ay. If we continued this format, we would call shifts s with the components sx and sy. However, to simplify notation, we simply present the component vectors as x and y.) Of course, we need to describe the movement, both with speed and acceleration as well as with displacements. We also need to find their components along the x and y axes. We assume that all forces except gravity (e.B. drag and friction) are negligible. The components of acceleration are then very simple: ay = -g = -9.80 m/s2. (Note that this definition assumes that the defined as a positive direction. Instead, if you arrange the coordinate system so that the downward direction is positive, the acceleration assumes a positive value due to gravity.) Because gravity is vertical, ax=0. Both accelerations are constant, so the kinemamatic equations can be used. [latex]x= x=-x-{0}+-Bar-Bar,--[/latex] x=-x-{0}+-Bar-Bar,-[/latex] [latex]v= v and _{0} {0}+-text-text[/latex] [latex]x=-x-{0}+-v-{0}t+-frac{1}{2}-text-,text-{2}-{2}--[/latex]-{2}=-{0} {2} {0} {2}-Figure 1. The total shift s of a football at a point along its path. The vector s contains the components x and y along the horizontal and vertical axes. Its size is s, and it makes an angle - with the horizontal. Under these assumptions, the following steps are then used to analyze the projectile movement: Step 1. Detach or break the movement into horizontal and vertical components along the x and y axes. These axes are vertical, so that Ax = A cos and Ay = A sin . used. The size of the components of displacement s along these axes are x and y. The sizes of the components of the velocity v are Vx = V cos and Vy = v sin , where v is the size of the speed and the direction, as shown in 2. As usual, the initial values are denoted with a subscription value of 0. Step 2.Treat the motion as two independent one-dimensional movements, one horizontal and the other vertical. The kinematic equations for horizontal and vertical motion take the following forms: Horizontal motion (ax = 0) x = x0 + vxt vx = v0x = vx = velocity is a constant. Vertikale Bewegung (vorausgesetzt, positiv ist nach oben = -g = -9,8 m/s2) [latex]y='y'_{0}+'frac{1}{2}''''''''''''x] [latex]y='y'_{0}+'v'_'0y't-'frac{1}{2}'mathrm'gt'{2}'[/latex] [latex]''''''''{2}''''''''''{0} {2}'''''''''''' Schritt 3. Lösen Sie für die Unbekannten in den beiden getrennten Bewegungen – eine horizontale und eine vertikale. Note that the only common variable between the movements is time t. The problem-solving methods are the same here as in the one-dimensional kinematics and are illustrated in the examples solved below. Step 4. Recombine the two movements to find the total displacement s and speed v. Since the x- and y-movements are permeable, let us determine these vectors using the techniques described in vector addition and subtraction: Analytical methods and use of [latex]A= 'sqrt'A'___x'''{2}+'A'_y''{2}'&s/latex] and '=tan'1 (Ay/Ax) in the following form, where the direction of the shift is s and v is the direction of the velocity v: [latex]s= sqrt, {2} + y, {2}. y/x) [latex]v='sqrt'v''''{2} {2}''''''''''''by dividing them into two independent one-dimensional movements along the vertical and horizontal axes. b) The horizontal movement is simple because ax=0 and vx are therefore constant. c) The speed in the vertical direction begins to decrease as the object rises; at its highest point, the vertical velocity is zero. When the object falls to earth the vertical velocity increases again in size, but points in the opposite direction to the initial vertical velocity. (d) The x and y movements are recombined to give the total speed at a certain point in the trajectory. During fireworks, a grenade with an initial speed of 70.0 m/s is fired into the air at an angle of 75.0o above the horizontal, as shown in Figure 3. The fuse is timed to ignite the shell as soon as it reaches its highest point above the ground. a) Calculate the height at which the shell explodes. b) How much time ewent between the launch of the grenade and the explosion? c) What is the horizontal displacement of the shell when it explodes? Strategy Since the drag is negligible for the unexploded shell, the analysis method described above can be used. The motion can be divided into horizontal and vertical movements in which ax = 0 and ay = -g. We can then define x0 and y0 as zero and solve them for the desired quantities. Solution for (a) By height we mean the height or vertical position y above the starting point. The highest point in each trajectory, the so-called vertex, is reached when vy=0. Because we know the start and end speeds and the starting position, we use the following equation to find y: Figure 3. The trajectory of a fireworks grenade. The fuse is set so that the shell explodes at the highest point of its trajectory, which is located horizontally at an altitude of 233 m and 125 m. Since y0 and vy are both zero, the equation simplifies solving for y gives [latex]y='frac''''{2}'''''''''''' the component of the initial velocity in the y-direction. It is given by v0y = v0 sin, where v0y is the initial velocity of 70.0 m/s, and 0 = 75.0o is the initial angle. Thus vOy = v0 sin 0 = (70.0 m/s)(sin 75o) = 67.6 m/s and y is [latex]y='frac'left(67.6'text'm/s'right)'{2}'''left(9.80'text'm/s'{2}'right)'[/latex], so that y = 233 m. Note that, since the top is positive, the initial velocity is positive, as is the maximum height, but the acceleration due to gravity is negative. Also note that the maximum height depends only on the vertical component of the initial velocity, so that each projectile with an initial vertical component of 67.6 m/s reaches a maximum height of 233 m (neglect of drag). The numbers in this example make sense for large fireworks whose shells reach such heights before they explode. In practice, the not to be completely neglected, so that the initial speed would have to be slightly greater than the given one in order to reach the same height. Solution to (b) As with many physics problems, there is more than one way to solve the time to the highest point. In this case, the easiest way to [latex]y='y'_{0}+'frac{1} {2}'left'''''''''''' y0 is zero, this equation is reduced to simple [latex]y='frac{1}{2}'''left(''''''''''''that the final vertical speed, vy, at the highest point is zero. Therefore, it is for [latex]-,begin-array-lll-t& =& 'frac'2y'left('v''''''''''''Text (text, 233 m, right) and text (text) 67.6 m/right) and & Text and text and discussion for (b) This time is also useful for large fireworks. If you are able to see the start of fireworks, you will notice that a few seconds pass before the grenade explodes. (Another way to find the time is to use [latex]y='y'_{0}+'v'_'0y''t-'frac{1}{2}'text'gt'{2}'[/latex], and the square equation for t.) and solve the square equation for t.) Solution for (c) Since the drag is negligible, the ax=0 and the horizontal velocity is constant as described above. The horizontal displacement is the horizontal velocity multiplied by the time specified by x = x0 + vxt, where x0 is zero: x = vxt, where vx is the x component of the velocity, the of vx = v0 cos '0 Now, vx = v0 cos '0 = (70.0 m/s) (cos 75o) = 18.1 m/s The time t for both movements is the same, and so x is x = (18.1 m/s) (6.90 s) = 125 m. Discussion for (c) The horizontal movement is a constant speed in absence of air resistance. The horizontal shift found here could be useful to keep the fireworks fragments from falling on spectators. As soon as the grenade explodes, the drag has a big effect, and many fragments will land directly below it. When solving part (a) of the preceding example, the expression we found for y applies to any projectile movement where the drag is negligible. Call the maximum height y=h; then [latex]h='frac''v'_''''{2}'''''''''''' When analyzing the projectile movement, it is important to set up a coordinate system. Part of the definition of the coordinate system is to define an origin for the x and y positions. It is often convenient to select the starting position of the object as the origin so that x0 = 0 and y0 = 0. It is also important to define the positive and negative directions in the x and y directions. As a rule, we define the vertical direction as upwards, and the positive horizontal direction is usually the direction of the object's movement. If this is the case, the vertical acceleration, g, assumes a negative value (because it is directed downwards to the Earth). Occasionally, however, it makes sense to define the coordinates differently. For example, if you analyze the movement of a ball that is thrown down from the top of a cliff, it may be useful to define the positive direction downwards, since the movement of the ball occurs only in the downward direction. If this is the case, g assumes a positive value. Kilauea in Hawaii is the the most continuous active volcano. Very active volcanoes characteristically eject red-hot rocks and lava, rather than smoke and ash. Suppose a large rock is ejected from the volcano at a speed of 25.0 m/s and at an angle of 35.0o above the horizontal, as shown in Figure 4. The rock hits the side of the volcano at an altitude of 20.0 m lower than its starting point. (a) Calculate the time it takes the rock to follow this path. b) How large and trend-setting is the speed of the rock when impacting? Figure 4. The trajectory of a rock ejected from the Kilauea volcano. Strategy Again, it will allow us to solve this two-dimensional movement into two independent one-dimensional movements. The time in which a projectile is in the air is determined solely by its vertical movement. We will solve first for t. While the rock falls vertically up and down, the horizontal movement continues at a constant speed. This example asks for the final speed. This recombines the vertical and horizontal results to get v and v at the last time determined in the first part of the example. Solution for (a) While the rock is in the air, it rises and then drops to a final position 20.0 m lower than its starting height. We can find the time for it by going [latex]y={2}{1}{2} {0}'''''''''''' If we take the starting position y0 as zero, then the final position is y = 20.0 m. Now the initial vertical velocity is the vertical component of the initial velocity found from vOy = v0 sin 0 = (25.0 m/s) (Sin 35.0o) = 14.3 m/s. The substitution of known values gives 20.0 m = (14.3 m/s)t (4.90 m/s2)t2. The rearrangement of terms results in a square equation in t: (4.90 m/s2)t2 (14.3 m/s)t (20.0 m) = 0. This expression is a square equation of the shape at2 + bt + c = 0, where the constants are a = 4.90 , b = -14,3, and c = -20.0. The solutions are indicated by the square formula: [latex]t='frac'-bpm 'sqrt'b'{2}-4'text'text{2}'text''text'a'[/latex] This equation results in two solutions: t = 3.96 and t = -1.03. (It is left to the reader as an exercise to verify these solutions.) The time is t = 3.96 s or -1.03 s. The negative value of time implies an event before the beginning of movement, and so we discard it. Thus t = 3.96 s. The time for the projectile movement is completely determined by the vertical movement. Thus, each projectile that has an initial vertical speed of 14.3 m/s and 20.0 m below its starting height is 3.96 s in the air. Solution for (b) From the information now available, we can find and combine the final horizontal and vertical velocities vx and vy to find the total velocity v and the angle it makes with the horizontal. Of course, vx is constant, so we can solve it at any horizontal position. In this case, we have chosen the starting point, as we have both Initial speed and initial angle. Therefore: vx = v0 cos 0 = (25.0 m/s)(cos 35o) = 20.5 m/s The final vertical velocity is specified by the following equation: [latex]-v-__y'____''''text''''''[/latex], where v0y was found in part (a) to be 14.3 m/s. Thus vy = 14 . 3 m/s at (9.80 m/s 2) (3.96 s) so that vy = 24.5 m/s. To determine the size of the final speed, we combine their vertical components, with the following equation: [latex]v='sqrt'v''''''''{2} {2}''''''''''''{2} {2}'''''''''''' the direction 'v' can be found from the equation: 'v = tan ' 1 (vy / vx), so that 'v = tan'1('24.5/20.5) = tan'1('1.19''). So the rating of v = 50.1o. The negative angle means that the speed is 50.1o below the horizontal. This result is consistent with the fact that the final vertical velocity is negative and therefore downwards – as you would expect, since the final height is 20.0 m lower than the initial height. (See Figure 4.) One of the most important things illustrated by projectile movement is that vertical and horizontal movements are independent of each other. Galileo was the first person to fully understand this property. He used it to predict the range of a projectile. On a flat ground, we define the area as the horizontal distance R that is traveled by a projectile. Galileo and many others were interested in the range of projectiles that were mainly intended for military purposes , such as.B target guns. However, studying the range of projectiles can shed light on other interesting phenomena, such as the orbits of satellites around the Earth. Let's look further at the projectile range. Figure 5. Trajectories of projectiles on flat ground. (a) The greater the initial velocity v0, the greater the range for a given initial angle. (b) The effect of the initial angle 0 on the area of a projectile at a certain initial speed. Note that the range is the same for 15o and 75o, although the maximum heights of these paths are different. How does the initial speed of a projectile affect its range? Obviously, the greater the initial velocity v0, the larger the range, as shown in Figure 5(a). The initial angle 0 also has a dramatic effect on the area, as shown in Figure 5 letter b. At a fixed initial speed, such as that generated by a cannon maximum range is reached with 0 = 45o. This applies only to conditions that neglect air resistance. When air resistance is taken into account, the maximum angle is about 38o. Interestingly, for each initial angle, except 45o, there are two angles that give the same range – the sum of these angles is 90o. The range also depends on the value of the acceleration of gravity g. Moon astronaut Alan Shepherd was able to ride a golf ball far on the moon because gravity there is weaker. The R area of a projectile on The soil for which the drag is negligible is determined by [latex]R='frac'v'_{0}'{2}'sin'2'theta'_{0}'g'[/latex], where v0 is the initial velocity and '0' is the initial angle relative to the horizontal. The proof for this equation is left as the end of the chapter problem (notes are given), but it fits the main features of the projectile area as described. When we talk about the range of a projectile on flat ground, we assume that R is very small compared to the circumference of the Earth. However, if the area is large, the earth bends below the projectile, and the acceleration of gravity changes the direction along the path. The range is larger than predicted by the range equation above because the projectile must fall further than it would be on flat ground. (See Figure 6.) If the initial velocity is large enough, the projectile goes into orbit. This is called escape velocity. This possibility was recognized centuries before it was possible. When an object is in orbit, the Earth bends under the object at the same speed as it falls. The object therefore falls continuously, but never hits the surface. These and other aspects of orbital motion, such as earth's rotation, will be treated analytically and deeper later in this text. Once again, we see that thinking about one topic, such as the reach of a projectile, can lead us to others, such as Earth's orbits. In addition to the speeds, we will study the addition of velocities, which is another important aspect of two-dimensional kinematics and will also provide insights beyond the immediate topic. Figure 6.

Projectile to satellite. In each case shown here, a projectile is launched from a very high tower to avoid drag. As the initial speed increases, the range increases and becomes longer than it would be on flat ground, as the Earth bends beneath its path. The orbit is reached at a sufficiently large initial speed. Blast a Buick from a cannon! Learn more about projectile movements by firing different objects. Set the angle, initial velocity, and mass. Add drag. Make a game out of this simulation by trying to hit a target. Click here to run the simulation. Projectile movement is the movement of an object through the air, which is subject only to the acceleration of gravity. To solve projectile movement problems, follow these steps: 1. Determine a coordinate system. then loosen the position and/or speed of the object in the horizontal and vertical components The components of position s are indicated by the sizes x and y, and the components of the velocity v are indicated by vx = v cos and vy = v sin - where v is the size of the speed and the direction of - . 2. Analyze the movement of the projectile in horizontal direction with the following equations: Horizontal motion (ax = 0) x = x0 + vxt vx = v0x = vx = = = = is a constant. 3. Analysieren Sie die Bewegung des Projektils in vertikaler Richtung mit den folgenden Gleichungen: Vertikale Bewegung (vorausgesetzt, positiv ist nach oben = -g = -9,8 m/s2) [latex]y= y_{0}+-frac{1}{2}-links [latex]y='y='y {0} {2} {2} {2}{1}{2}"{0}"""""""""""""""""""""""""""""""" 4. Kombinieren Sie die horizontalen und vertikalen Komponenten der Position und/oder Geschwindigkeit mit den folgenden Gleichungen neu: [latex]s=sqrt, {2} + , {2}, [/latex] x) [latex]v='sqrt'v'_'x'{2}+""""{2}"""""""""""""""""""""""""""""" Die maximale Höhe h eines Projektils, das mit der anfänglichen vertikalen Geschwindigkeit v0y gestartet wird, wird von [latex]h='frac'"{2}""""""""""""""""""""""""""""""" Die maximale horizontale Entfernung, die von einem Projektil zurückgelegt wird, wird als Bereich bezeichnet. The rarea R of a flat-bottomed projectile that starts at an angle of 0 above the horizontal mitning speed v0 is specified by [latex]R='frac'v'_{0}'{2}'sin'"2'theta''_{0}'"[/latex]. 1. Answer the following questions about projectile movement on flat ground assuming a negligible drag (the initial angle is neither 0o nor 90o): (a) Is the speed ever zero? b) When is the speed a minimum? A maximum? c) Can the speed ever be the same at the initial speed at a time other than t = 0? d) Can the speed ever be the same at the initial speed at a time other than t = 0? 2. Answer the following questions about projectile movement on flat ground assuming a negligible drag (the initial angle is neither 0o nor 90o): (a) Is the acceleration ever zero? b) Is the acceleration ever in the same direction as a part of the speed? c) Is the acceleration ever in the direction of a component facing the speed? 3. At a fixed initial speed, the area of a projectile is determined by the angle at which it is fired. For all but the maximum, there are two angles that result in the same range. Considering factors that might affect an archer's ability to hit a target, such as .B wind, explain why the smaller angle (closer to the horizontal) is preferable. When the archer use the larger angle? Why does the player use the higher trajectory in a football match? 4. During a lecture demonstration, a professor places two coins on the edge of a table. Then she strokes one of the coins horizontally from the table and nudging the other over the edge at the same time. Describe the subsequent movement of the two coins, in particular the discussion of whether they are hit on the ground at the same time. 1. A projectile is launched on the ground at an initial speed of 50.0 m/s at an angle of 30.0o above the horizontal. He hits a target over the ground 3.00 seconds later. What are the x and y distances from the place where the projectile is projectile it lands? 2. A ball is kicked at an initial speed of 16 m/s in horizontal direction and 12 m/s in vertical direction. a) At what speed does the ball hit the ground? b) How long does the ball stay in the air? c) What is the maximum height of the ball? 3. A ball is thrown horizontally from the top of a 60.0 m building and lands 100.0 m from the base of the building. Ignore the drag. a) How long is the ball in the air? b) What must have been the original horizontal component of speed? c) What is the vertical component of speed just before the ball hits the ground? d) What is the speed (including the horizontal and vertical components) of the ball just before impact on the ground? 4. (a) A daredevil tries to jump his motorcycle over a series of parked buses by driving up a 32o ramp at a speed of 40.0 m/s (144 km/h). How many buses can it delete if the top of the launch pad is at the same height as the bus tops and the buses are 20.0 m long? (b) Discuss what your answer means about the margin of error in this act – that is, consider how much greater the range is than the horizontal distance it must travel to miss the end of the last bus. (Neglect of air resistance.) 5. An archer shoots an arrow at a target 75.0 m away; the target's porthole is at the same height as the trigger height of the arrow. a) At what angle must the arrow be released to hit the bull's eye when its initial velocity is 35.0 m/s? In this part of the problem, explicitly show you how to follow the steps to resolve projectile movement problems. (b) Between the archer and the target is a large tree with an overhanging horizontal branch 3.50 m above the trigger height of the arrow. Does the arrow go over or under the branch? 6. A rugby player passes the ball 7.00 m across the field, where he is caught at the same height as he has left his hand. a) At what angle was the ball thrown when its initial speed was 12.0 m/s, provided that the smaller of the two possible angles was used? b) What other angle indicates the same range and why should it not be used? c) How long did this passport take? 7. Check the areas for the projectiles in Figure 5 a) for - = 45o and the specified initial speeds. 8. Check the areas shown in Figure 5 (b) for the projectiles to an initial speed of 50 m/s at the specified initial angles. 9. The cannon on a battleship can be a grenade with a maximum distance of 32.0 km (a) Calculate the initial speed of the grenade. b) What is the maximum height? (The shell is at its highest than 60% of the atmosphere – but the drag is not really negligible, as is assumed to facilitate this problem.) c) The ocean is not flat because the earth is curved. Suppose the Earth's radius is 6.37 × 103. How many meters lower its surface is 32.0 km from the ship along a Parallel to the surface of the ship? Does your answer mean that the error caused by the assumption of a flat earth in projectile motion is significant here? 10. An arrow is shot from a height of 1.5 m towards a cliff of height H. It is shot at a speed of 30 m/s at an angle of 60o above the horizontal. It lands on the top of the cliff 4.0 s later. a) What is the height of the cliff? b) What is the maximum altitude the arrow reaches along its trajectory? (c) What is the impact speed of the arrow shortly before hitting the cliff? 11. In the standing long jump you squat and then push yourself off with your legs to see how far you can jump. Suppose that the extension of the legs from the stool position is 0.600 m and the acceleration achieved from this position is 1.25 times the acceleration due to gravity, g. How far can they jump? Enter your assumptions. (Increased range can be achieved by swinging your arms toward the jump.) 12. The long jump world record is 8.95 m (Mike Powell, USA, 1991). As a projectile is treated, what is the maximum range a person receives when they have a start speed of 9.5 m/s? Enter your assumptions. 13. At a speed of 170 km/h, a tennis player hits the ball at a height of 2.5 m and an angle below the horizontal. The service line is 11.9 m from the network, which is 0.91 m high. What is the angle so that the ball only crosses the net? Does the ball land in the service box, whose outside line is 6.40 m from the net? 14. A football quarterback moves straight backwards at a speed of 2.00 m/s when he throws a pass at a player 18.0 m straight down. a) If the ball is thrown at an angle of 25o relative to the ground and is caught at the same height as it is released, what is its initial speed relative to the ground? b) How long does it take to reach the recipient? c) What is its maximum height above its release point? 15. Rifle sights are adjusted to aim high to offset the effect of gravity, effectively making the weapon accurate only for a specific area. (a) If a weapon is spotted to hit targets at the same height as the gun and 100.0 m away, how low will the bullet hit if it targets a target 150.0 m away? The muzzle velocity of the sphere is 275 m/s. (b) Discuss qualitatively how a higher muzzle speed would affect this problem and what effects the air resistance would have. 16. An eagle flies horizontally at a speed of 3.00 m/s when the wobbles in its talons and falls 5.00 m deeper into the lake. Calculate the speed of the fish relative to the water when it hits the water. 17. An owl carries a mouse to the chicks in their nest. Its position at this time is 4.00 m west and 12.0 m above the center of the 30.0 cm diameter nest. The owl flies east at 3.50 m/s at an angle of 30.0o below the horizontal if it accidentally drops the mouse. Is the owl owl enough to make the mouse hit the nest? To answer this question, calculate the horizontal position of the mouse if it has fallen 12.0 m. 18. Suppose a footballer kicks the ball towards goal from 30 yards. Find the initial speed of the ball when it only goes over the goal, 2.4 m above the ground, given the initial direction 40o above the horizontal. 19. Can a goalkeeper shoot a football into the opponent's goal at his goal without the ball touching the ground? The distance will be about 95 m. A goalkeeper can give the ball a speed of 30 m/s. 20. The free-throw line in basketball is 4.57 m (15 ft) from the basket, which is 3.05 m above the ground. A player standing on the free-throw line throws the ball at an initial speed of 7.15 m/s and releases it at a height of 2.44 m above the ground. At what angle above the horizontal does the ball have to be thrown to hit the basket exactly? Note that most players use a large initial angle instead of a flat shot, as this allows for a larger margin of error. Explicitly indicate how to follow the steps to solve projectile movement problems. 21, 2007, Michael Carter (USA) set a world record in shot put with 24.77 m. What was the initial speed of the shot when he let it go at a height of 2.10 m and threw it over the horizontal at an angle of 38.0o? (Although the maximum distance for a projectile on a flat ground is reached at 45o when the drag is neglected, the actual angle to reach the maximum range is smaller; 38o gives a greater range than 45o in shot put.) 22. A basketball player runs directly towards the basket at 5.00 m/s as he jumps into the air to sink the ball. It maintains its horizontal speed. a) What vertical speed does it need to rise 0.750 m above the ground? b) How far from the basket (measured horizontally) does it have to start its jump to reach its maximum height at the same time as reaching the basket? 23. A footballer punts the ball at a 45o angle. Without acting windy, the ball would move 60.0 m horizontally. a) What is the initial speed of the ball? (b) When the ball is near its maximum height, it experiences a short wind gust, which reduces its horizontal velocity by 1.50 m/s. What distance does the ball travel horizontally? 24. Prove that the trajectory of a projectile is parabolic, with the form [latex]y='text'ax'+'text'bx'{2}'[/latex]. To get this expression, solve the equation (These equations describe the x and y positions of a projectile that begins at the origin.) You should get an equation of the form [latex]y='text'ax'"'text'bx'{2}'[/latex], where a and b are constants. 25. Derive derives {0} For the area of a projectile at the ground level, the time t is found to which y becomes null, and replace this value from t in the expression for x -x0 by noting that R = x - x0. 26. Unreasonable results (a) Find the maximum range of a supercannon with an estuary speed of 4.0 km/s. (b) What is unreasonable about the range found? (c) Is the premise unreasonable or is the available equation not applicable? Explain your answer. d) If such an estuary speed could be reached, discuss the effects of air resistance, the thinning of the air with the height, and the curvature of the earth on the area of the supercannon. 27. Construct your own problem Consider to topple a ball over a fence. Construct a problem where you calculate the required initial speed of the ball to clear only the fence. Among the things to be determined; The height of the fence, the distance to the fence from the point of release of the ball and the height at which the ball is released. You should also consider whether it is possible to choose the initial speed for the ball and simply calculate the angle at which it is thrown. Also check the possibility of multiple solutions given the distances and heights you have chosen. Air resistance: a frictional force that slows the movement of objects as they travel through the air; In solving basic physical problems, it is assumed that the drag is zero kinematics: the study of motion regardless of mass or force movement: displacement of an object as a function of the time projectile: an object that travels through the air and experiences only acceleration through gravitational projectile movement: the movement of an object that is subject only to the acceleration of the gravitational range: the maximum horizontal distance, moving a projectile: the path of a projectile through the air 1. x = 1.30 m × 102, y = 30.9 m 3. a) 3.50 s (b) 28.6 m/s (c) 34.3 m/s (d) 44.7 m/s, 50.2o horizontally 5. (a) 18.4o (b) The arrow passes over the branch. 7. [latex]R='frac'v'_{0}'"{2} {0} {0}""R = 163 m for v0; R = 255 m for v0 = 50 m/s 9. a) 560 m/s (b) 800 × 103 m (c) 80.0 m. This error is not significant because it is only 1% of the partial (b) response. 11. 1.50 m assuming the starting angle of 45o 13. • =6.1o. Yes, the ball lands at 5.3 m from the net 15. (a) 0.486 m (b) The greater the muzzle speed, the smaller the deviation in vertical because the flight time would be smaller. The effect of air resistance would be to reduce flight time, increasing the vertical deviation. 17. 4.23 m. No, the owl is not lucky; he misses the nest. 19. No, the maximum range (neglect of drag) is approx. 92 m. 21. 15.0 m/s 23. a) 24.2 m/s b) The ball moves in total m with the short gust of wind. 25. [latex]y-y-y-y-{0}=0='v'_"""""{1}{2} {0} {2}{1}{2}""""""""""""""""""""{2}""""""""""""""""""""c-2-links("""""{0}""""""""""""""""""""{0} {0}""""""""""""""""""""und ersetzen durch t gibt: [latex]R = 'v'_{0}'cos'theta'left('frac'2v'_{0}'sin'theta'g'right)='frac'2v'_________. {0} {2} since [latex]2'sin'theta''theta""'theta""the range is: [latex]R='frac'_{0}'{2}'sin 2'theta'"[/latex]. [/latex].