Constant velocity model worksheet 5 answer key

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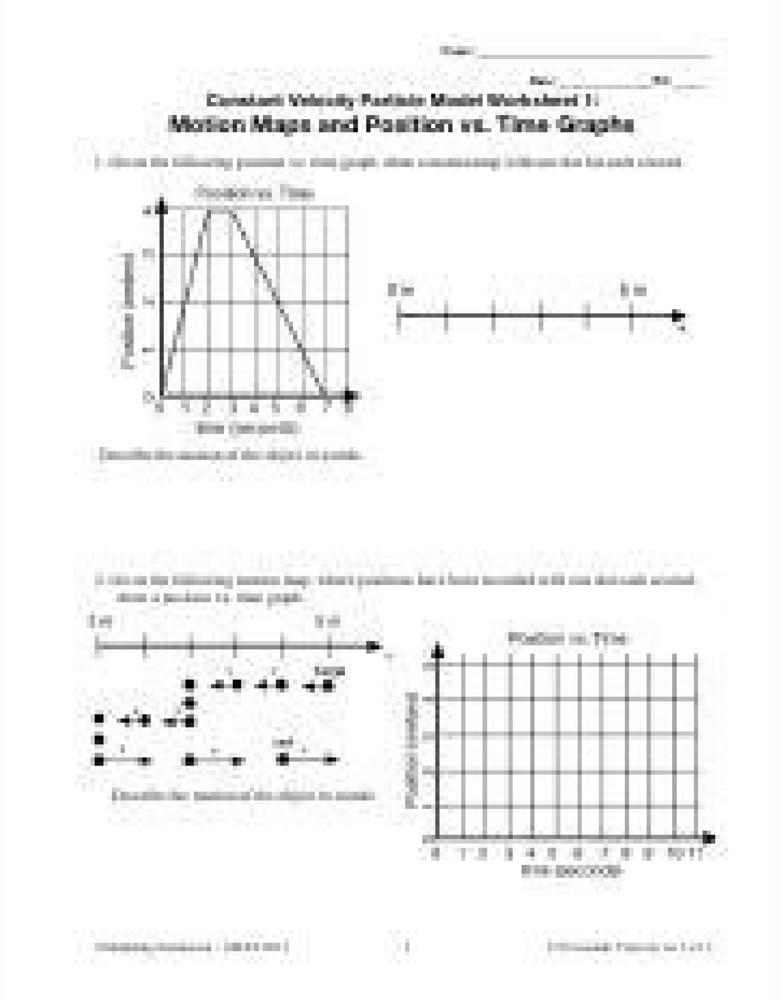

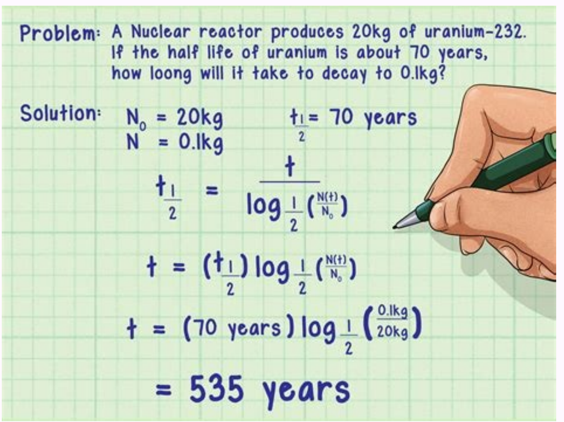

Constant velocity particle model worksheet 5 answer key.

General Word ProblemsMax/Min Problems Calculus involves lots of finding maximums, minimums, and zeroes. You will get a taste of that with quadratic word problems. In fact, if/when you reach calculus, you will discover that some of the homework exercises will be identical to those you're doing now; it's just that you'll have new tools for finding the answers. A major category of quadratic-equation word problems relates to what is called projectile motion. For our purposes, a projectile is any object that is thrown, shot, or dropped. Almost always, in this context, the object is initially moving directly up or straight down. (If it starts by going up then, naturally, it will later be coming back down.) This initial movement speed is the velocity. In projectile-motion exercises, the object being released (shot, dropped, or whatever has What does the velocity's sign say about the object? The initial velocity of the object, in these exercises, tells us how the object was released. The initial value of the velocity will be either zero (so the object was just dropped), positive (so it was thrown or shot upward), or negative (so the object was thrown downward). What does "g" stand for? In projectile-motion exercises, the coefficient on the squared term is −½ g. The g stands for the constant of gravity (on Earth), which is −9.8 meters per second square (that is meters per second per second) in metric terms, or −32 feet per second squared in Imperial terms. The "minus" signs reflect the fact that Earth's gravity pulls us, and the object in question, downward. What does "per second squared" mean? Acceleration (being the change in speed, rather than the speed itself) is measured in terms of how much the velocity changes per unit time. So, if the velocity of an object is measured in feet per second, then that object's acceleration says how much that velocity changes per unit time; that is, acceleration measures how much the feet per second changes per second. And this duplicate "per second" is how we get "second squared". It's from the physics of the situation. Which value should I use for gravity? If a projectile-motion exercise is stated in terms of feet, miles, or some other Imperial unit, then use −32 for gravity; if the units are meters, centimeters, or some other metric unit, then use −9.8 for gravity. What is the projectile-motion equation? The projectile-motion equation is s(t) = −½ gx2 + v0x + h0, where g is the constant of gravity, v0 is the initial velocity (that is, the velocity at time t = 0), and h0 is the initial height of the object (that is, the height at of the object at t = 0, the time of release). Yes, you'll need to keep track of all of this stuff when working with projectile motion. An object is launched at 19.6 meters per second (m/s) from a 58.8-meter tall platform. The equation for the object's height s at time t seconds after launch is s(t) = −4.9t2 + 19.6t + 58.8, where s is in meters. When does the object strike the ground? What is the height (above ground level) when the object smacks into the ground? Well, zero, obviously. So I'm looking for the time when the height is s = 0. I'll set s equal to zero, and solve: 0 = −4.9t2 + 19.6t + 58.8 0 = t2 − 4t − 12 0 = (t − 6)(t + 2) Then t = 6 or t = −2. The second solution is from two seconds before launch, which doesn't make sense in this context. (It makes sense on the graph, because the line crosses the x-axis at −2, but negative time won't work in this word problem.) So "t = −2" is an extraneous solution, and I'll ignore it. Instead, my answer to this exercise (that is, the correct answer in context) is the other solution value. They asked me for the time, and time here is measured in seconds, so my answer is: The object strikes the ground six seconds after launch. Note the construction of the height equation in the problem above. (Yes, we went over this at the beginning, but you're really gonna need this info, so we're revisiting.) The initial launch height was 58.8 meters, and the constant term was "58.8". The initial velocity (or launch speed) was 19.6 m/s, and the coefficient on the linear term was "19.6". This is always true for these up/down projectile motion problems. (If you have an exercise with sideways motion, the equation will have a different form, but they'll always give you that equation.) The initial velocity is the coefficient for the middle term, and the initial height is the constant term. And the coefficient on the leading term comes from the force of gravity. This coefficient is negative, since gravity pulls downward, and the value will either be "−4.9" (if your units are "meters") or "−16" (if your units are "feet"). Yes, these values are half of the values listed for the gravity constant at the beginning of this page; they've had the ½ multiplied through. In general, the projectile-motion equation's format is: ...where "g" here is the "4.9" or the "16" derived from the value of the force of gravity (technically, it's the force of gravity on Earth), "v0" ("vee-naught", or "vee-sub-zero") is the initial velocity, and "h0" ("aitch-naught", or "aitch-sub-zero") is the initial height. Memorize this equation (or at least its meaning), because you may need to know this on the test. An object in launched directly upward at 64 feet per second (ft/s) from a platform 80 feet high. What will be the object's maximum height? When will it attain this height? Hmm... They didn't give me the equation this time. But that's okay, because I can create the equation from the information that they did give me. The initial height is 80 feet above ground and the initial speed is 64 ft/s upward. Since my units are feet, then the number for gravity will be −16, and my equation is: They want me to find the maximum height. For a negative quadratic like this, the maximum will be at the vertex of the upside-down parabola. So they really want me to find the vertex. From graphing, I know how to find the vertex; in this case, the vertex is at (h, k) = (2, 144): But what do the coordinates of this vertex tell me? According to my equation, I'm plugging in time values and extracting height values, so the input 2 was the time and the output 144 is the height. It takes two seconds to reach the maximum height of 144 feet. As long as you label clearly, you don't need a complete sentence (like I used above) for your hand-in answer. So you could also give you answer as, "time: 2 secs; height: 144 ft". An object is launched from ground level directly upward at 39.2 m/s. For how long is the object at or above a height of 34.3 meters? My units this time are "meters", so the gravity number will be −4.9. Since the object started at ground level, the initial height was 0. Then my equation is: Since this is a negative quadratic, the graph is an upside-down parabola. I can find the two times when the object is exactly 34.3 meters high, and I know that the object will be above 34.3 meters the whole time in between. Why "two times", and how do I know that the time period is between those two times? Because the first time will be when the object passes a height of 34.3 meters on its way up to its maximum height, and the second time when be when it passes 34.3 meters as it is falling back down to the ground. So I have to solve the following: −4.9t2 + 39.2t = 34.3 t2 − 8t + 7 = 0 (t − 7)(t − 1) = 0 The two solutions are at times t = 1 and t = 7. So the object is at 34.3 meters at one second after launch (going up) and againt at seven seconds after launch (coming back down). Subtracting to find the difference, I find that: The object is at or above 34.3 meters for six seconds. Again, you don't technically need a complete sentence for your hand-in answer; saying "6 secs" is probably good enough. But definitely do include the unit "seconds" on your answer. Don't be surprised if many of your exercises work out as "neatly" as the above examples have. Many textbooks still engineer their exercises carefully, so that you can solve by factoring (that is, by quickly doing the algebra). However (fair warning!), heavy dependence on calculators is leading more texts to create "interesting" (that is to say, needlessly complicated) exercises, so some (or all) of your exercises may involve much more messy computations than have been displayed here. If so, study these "neat" examples carefully, until you are quite sure you follow the reasoning. After the semester is over, you discover that the math department has changed textbooks (again) so the bookstore won't buy back your nearly-new book. You and your friend Herman decide to get creative. You go to the roof of a twelve-story building and look over the edge to the reflecting pool 160 feet below. You drop your book over the edge at the same instant that Herman chucks his book straight down at 48 feet per second. By how many seconds does his book beat yours into the water? (Round your answer to two decimal places.) Our initial launch heights will be the same: we're both launching from 160 feet above ground. And the gravity number, since we're working in feet, will be −16. My initial velocity is zero, since I just dropped my book, but my buddy Herman's velocity is a negative 48, the negative coming from the fact that he chucked his book down rather than up. So our "height" equations are: mine: s(t) = −16t2 + 160 his: s(t) = −16t2 − 48t + 160 In each case, I need to find the time for the books to reach a height of zero (a height of zero being "ground level"), so: mine: 0 = −16t2 + 160 t2 − 10 = 0 t = his: 0 = −16t2 − 48t + 160 t2 + 3t − 10 = 0 (t + 5)(t − 2) = 0 t = −5, +2 I will ignore the negative time values as being irrelevant in this context. (There may be a case, at some point, in some exercise, where a negative value does happen to be useful within a given context, so I do need to remember to think about the values and the context, rather than reflexively discarding any and all negative solutions.) Herman's book hits the water after two seconds, and mine hits after seconds, or after about 3.16 seconds. That is: Herman's book hits the water about 1.16 seconds sooner than mine does. Every once in a while, they'll get clever and put a "projectile" problem into a different environment. The equation will remain the same in structure, but you may have to account for a different value for gravity. The International Space Agency has finally landed a robotic explorer on an extra-solar planet. Some probes are extended from the lander's body to conduct various tests. To demonstrate the crushing weight of gravity on this planet, the lander's camera is aimed at a probe's ground-level ejection port, and the port launches a baseball directly upwards at 147 feet per second (ft/s), about the top speed of a professional pitcher. The force due to gravity on this planet is 98 ft/s2. Assuming no winds and that the probe can scurry out of the way in time, how long will it take for the ball to smack back into the surface? To set up my equation for this exercise, I need to keep in mind that the value of the coefficient g from the projectile-motion equation above is one-half of the value of the force due to gravity in a given locale. In physics, there is the "universal gravitational constant" G, being the gravitational pull inherent to our universe (or at least our region of it). Every object exerts its own gravitational force, which is related to its own mass and the universal constant G. In the "projectile motion" formula, the "g" is half of the value of the gravitational force for that particular body. For instance, the gravitational force on Earth is a downward 32 ft/s2, but we used 16 in the equation. So g for my equation this time will by 98 ÷ 2 = 49 feet per second squared. Then: s = −49t2 + 147t 0 = −49t2 + 147t 0 = t2 − 3t 0 = t (t − 3) Then t = 0 or t = 3. The first solution represents when the ball was launched, so the second solution is the one I want. It takes three seconds for the ball to hit the ground. Note: On Earth, it would take a little over nine seconds for the ball to fall back to the ground. URL:

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