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HALF-LIFE PROBLEMS

Name

Block

1. An isotope of cesium (cesium-137) has a half-life of 30 years. If 1.0 g of cesium-137 disintegrates over a period of 90 years, how many g of cesium-137 would remain?

$$\frac{1.0}{2^3} = 0.125 \text{ g}$$

2. Actinium-226 has a half-life of 29 hours. If 100 mg of actinium-226 disintegrates over a period of 168 hours, how many mg of actinium-226 will remain?

$$\frac{100}{2^6} = 3.125 \text{ mg}$$

3. Sodium-24 was to be used in an experiment, but it took 3.0 minutes to get the sodium from the reactor to the laboratory. If 0.05 mg of sodium-24 was removed from the reactor, how many mg of sodium-24 were placed in the reaction vessel 0.0 minutes later if the half-life of sodium-24 is 15 minutes?

$$\frac{0.05}{2^2} = 0.0125 \text{ mg}$$

4. The half-life of isotope X is 2.0 years. How many years would it take for a 4.0 mg sample of X to decay and have only 0.50 mg of it remain?

$$3 \times 2.0 \text{ yr} = 6 \text{ yr}$$

5. Selenium-80 has a half-life of 25.0 minutes. How many minutes would it take for a 10.0 mg sample to decay and have only 1.25 mg of it remain?

$$3 \times 25 = 75 \text{ min}$$

6. The half-life of Po-218 is three minutes. How much of a 3.0 gram sample remains after 18 minutes? Suppose you wanted to try some of this isotope, and it required half an hour for it to reach you. How much should you order if you need to use 0.10 gram of Po-218 material?

$$\frac{3.0}{2^6} = 0.0469 \text{ g}$$

EXAMPLE 2 The half-life of radium-226 is 1590 years.

(a) A sample of radium-226 has a mass of 200 mg. Find a formula for the mass of the sample that remains after t years.

(b) Find the mass after 500 years correct to the nearest milligram.

(c) When will the mass be reduced to 30 mg?

SOLUTION

(a) Let $m(t)$ be the mass of radium-226 (in milligrams) that remains after t years. Then $dm/dt = km$ and $m(0) = 200$, so this theorem gives

$$m(t) = m(0)e^{kt} = 200e^{kt}$$

In order to determine the value of k , we use the fact that $m(1590) = \frac{1}{2}200$.

$$200e^{k(1590)} = 100 \quad \text{so} \quad e^{1590k} = 1/2$$

and

$$1590k = \ln\left(\frac{1}{2}\right) = -\ln(2)$$
$$k = \frac{-\ln(2)}{1590}$$

Therefore

$$m(t) = 200e^{-\left(\frac{\ln(2)}{1590}\right)t}$$

We could use the fact that $e^{\ln(2)} = 2$ to write the expression for $m(t)$ in the alternative form

$$m(t) = 200 \cdot 2^{-\left(\frac{t}{1590}\right)}$$

(b) The mass after 500 years is as follows. (Round your final answer to the nearest milligram.)

$m(500) =$

mg

(c) We want to find the value of t such that $m(t) = 30$, that is

$= 30$

or

 $= 0.15.$

We solve this equation for t by taking the natural logarithm of both sides:

$= \ln(0.15).$

Thus, we have the following. (Round your final answer to the nearest year.)

$t =$

yr

Half Life Worksheet - Extra Practice

1) Fluorine-21 has a half life of approximately 5 seconds. What fraction of the original nuclei would remain after 1 minute?

2) Iodine-131 has a half life of 8 days. What fraction of the original sample would remain at the end of 32 days?

3) The half-life of chromium-51 is 28 days. If the sample contained 510 grams, how much chromium would remain after 56 days? How much would remain after 1 year? How much was present 168 days ago?

4) If 20.0 g of a radioactive isotope are present at 1:00 PM and 5.0 g remain at 2:00 PM, what is the half life of the isotope?

5) The half life of Uranium-238 is 4.5 billion years and the age of earth is 4.5×10^9 years. What fraction of Uranium-238 that was present when Earth was formed still remains?

6) Chromium-48 decays. After 6 half-lives, what fraction of the original nuclei would remain?

7) The half life of iodine-125 is 60 days. What fraction of iodine-125 nuclides would be left after 360 days?

8) Titanium-51 decays with a half life of 6 minutes. What fraction of titanium would remain after one hour?

9) A medical institution requests 1 g of bismuth-214, which has a half life of 20 min. How many grams of bismuth-214 must be prepared if the shipping time is 2 h?

10) The half life of radium 226 is 1602 years. If you have 500 grams of radium today how many grams would have been present 9612 years ago?

Practice Problems

3) Ash from an early fire pit was found to have 12.5 percent as much carbon-14 as would be found in a similar sample of ash today. How long ago was the ash formed?

Convert 12.5% to a decimal --- 0.125

$$0.5 \times 0.5 \times 0.5 = 0.125$$

3 half-lives have gone by.

$$5730 \times 3 = 17,190 \text{ years ago}$$

The mechanism by which the heart reliably pumps blood to the body can be understood by looking solely at the mechanics of the right ventricle, the thickest chamber of the heart. From a fluid motion perspective, the right ventricle can be modelled as a single-chamber pump (Figure 1) attached in series to two pressure-activated, one-way valves. Using radiometric techniques, the volume and shape of the heart can be imaged in real time, as can the volume of blood that passes through the heart during each part of the cardiac cycle. This data can be combined to generate a pressure-volume diagram for the left-ventricle, corresponding to a single, full cardiac cycle (Figure 2).

During the diastolic phase (segment AB in the Figures), the heart refills with blood from its contracted state at the end of the previous cycle. Thus, this phase is essentially a return stroke, in which blood slowly fills the heart, increasing its volume without changing the pressure due to the flexibility of the walls. The mitral valve closes at B, at which point the heart begins to contract around the trapped blood. The aortic valve opens at C, but the heart continues to contract---resulting in a rapid efflux of blood at a constant pressure. The aortic valve closes at D, and the heart tissue expands, relieving pressure, until the mitral valve re-opens at A, blood rushes back in, and the cycle repeats.

Figure 1: A simple diagram of the four phases of the cardiac cycle

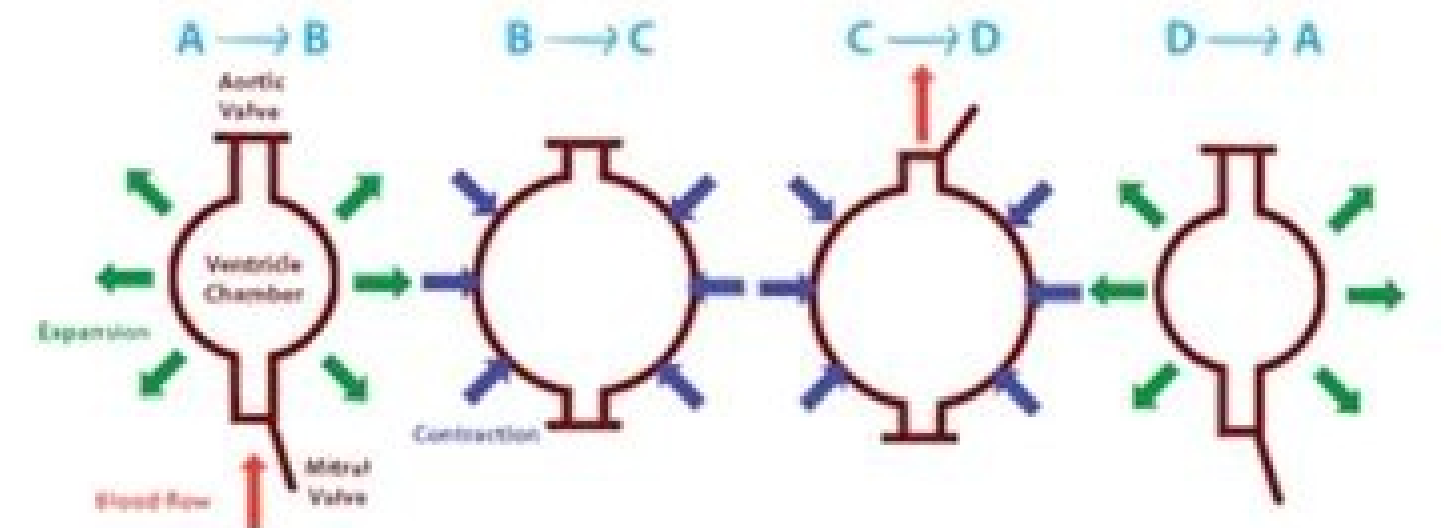


Figure 2: A pressure-volume diagram for the four phases of the cardiac cycle

Sometimes I don't understand what my problem is; I always just want something more from life. I don't know what I want and I don't know why I want it, but I'm never really satisfied, not for long anyway. It's like I'm frantically rushing to catch life's flight, afraid that I'll miss it, but I don't really know what flight is it that I need to catch and I don't know which airport it takes off from! This need for more starts pretty early. In school it's the marks -should be higher than the next guy, in college it's the looks - should be better than the next guy, at work it's the compensation package - should be fatter than the next guy. Life as a whole, well, has to be fuller than the next guy. Has to be at that maximum level of everything, but somehow, even when you reach that maximum, you start worrying about a new maximum, it doesn't end. - Scroll down to continue reading article - - Scroll down to continue reading article - Sure, wanting more is a good thing, ambition makes the world progress, but why is there always this feeling of discontentment? Striving for the best is great, but why does it come with a constant restlessness and fear of missing out? Why is life always so full, but never fully complete? You know who is complete? A 5 year old child, just take a look at one - raucous screaming, clothes in disarray, dirt on the face, running about stepping on people's toes and making them jump (my toes still hurt from the one who stepped on mine today). So effortlessly complete. Doesn't need to get anything, doesn't need to be anyone. We were all there at a point in time, and then somewhere between 5 and 15, we became incomplete. - Scroll down to continue reading article - - Scroll down to continue reading article - We were taught that we need to do extra, to achieve extra, to stay ahead - but even as we learnt ambition, no one seems to have noticed that we also learnt that 'we are not enough'. The more we learnt about all the things we needed to do and be, we also unlearned how to love ourselves as we are. Even as we learnt to be at the top of everything, we forgot how to accept ourselves when we are not at the top. We all learnt social etiquette, but we never learnt how to treat our own selves I wonder, among all the math lessons we were taught, why didn't they knock off one of those barely survivable trigonometry lessons and teach us how to love ourselves. Honestly, we need to spend some time on this one - 'How to love the person you will spend the rest of your life with' - guess who - YOU! - Scroll down to continue reading article - - Scroll down to continue reading article - People write a hundred odes to unconditional undying love for partners, for parents, for children, for animals - why not an ode to unconditional self love. We celebrate the fact that we can love the people in our lives irrespective of their flaws but we cannot even bring ourselves to accept our own flaws...leave alone love ourselves despite them. Of the hours and hours we spend obsessing over whether 'XYZ' likes us, we don't even dedicate a minute to asking whether we like ourselves. If we were to take all the adults on earth and give them a test on self acceptance and love - more than half the world would be sitting in detention trying to make up credit for the subject they just flunked! - Scroll down to continue reading article - - Scroll down to continue reading article - As long as we are failing at that subject, no matter how much we stuff our life and make it overflow with success and social recognition, our discontentment and need for more will not go. We will keep looking for that external validation - something out there that will help us feel like we have done everything we need to do, proven everything that we need to prove. Well, there is nothing out there and we know it. If in our heads we are not good enough, we will never feel good enough. One could win the Nobel Prize and feel great for a few days until that voice in the head starts whining again - do extra, achieve extra, stay ahead - you are not good enough! The fact is simple enough - all we need, to be complete, is a little bit of love, to give to ourselves. A little acceptance for being average, even as we strive for the best. A little kindness towards our own failures even as we pursue success. All it needs really, is to look in the mirror every once in a while and say "Well lousy fellow, you need to stop lazing around, you need to stop messing up, you really need to stop skipping gym and eating those donuts - and - I love you." - Scroll down to continue reading article - - Scroll down to continue reading article - Featured photo credit: www.consciouslifestylemag.com via consciouslifestylemag.com It's 7:30, you're picking her up at 8, and your shirt looks like an old cowboy's face. But you have to wear this shirt. It's your lucky shirt, the one that makes you look as if you have pecs. Who's going to save your butt? We are. Just follow our guide to the most efficient, embarrassment-free ways to deal with annoying things and other junk that life throws at you.Survive a Long Car RideIf you're with a person you can't stand get the jerk off the subjects that drive you around the bend. Hit "scan" on the radio and see who can name the artist first. Keep score. Loser buys lunch.Or you could follow the advice of Jim Gaffigan, a stand-up comedian who appeared on That '70s Show and does mandatory comedy-club road trips with less-than-enjoyable folks. He'll ask about family-rituals, how they spent holidays, what the bar mitzvahs were like. Magically, the person becomes, well, a person. "You understand why they are how they are," Gaffigan says. "It takes the edge off." Make Small Talk with the BossYour goal, Little Cog, is to become one of the 10 names the Big Wheel remembers from this social event. So shake his hand and introduce yourself. "You have the chutzpah to go up to him and leave an impression," says Scott. Fisher, regional president of Wachovia's Atlanta Metro Region and a boss man who's been fielding these kinds of underlying approaches for years.When you chat, stay light on details, because the Wheel will not share your excitement about the newly installed software program. Customer feedback, though, will always get his ear: The executive suite is remote, so your street-level position is your advantage.To close, tell him you've got some ideas that could improve some slack-ass part of the business, and ask if he can recommend a candidate who'd be good to develop them with. He'll drop the name of a promising crony, and you'll get a chance to show off for somebody who has the boss's ear. He drives home thinking, That boy has some chutzpah.Plunge a ToiletOne of life's classic annoying things . . . You, with the rolled shirtsleeves and purged colon, need to know only this: Success is in the pulling up, not the pushing down, which just further packs the clog.You should be using a force-cup plunger, the one with the funnel on the end. Fit the rubber head over the hole at the bottom of the bowl and slowly push down to create a good seal of rubber against porcelain. (You'll feel the suction grab when you've positioned it right.) Then yank up, says Ed Del Grande, a master plumber and host of Ed the Plumber on the DIY Network.If you've been yanking for 30 minutes and the dam hasn't burst, call a pro. And, however tempting it is, stop trying to dispose of cats in the toilet.Console a FriendIf your friend's father just passed away, ask him what two words he would put under a photo of his dad in the paper. He'll start talking, and that's all he really wants or needs to do. You get to listen, and that's all you need to do, says Rabbi Harold Kushner, author of Living a Life That Matters.Just avoid comforting him with "He lived a long life" or "He's not suffering anymore." You're basically telling him to shut up and stop whining, and there's a reason that's not a section at the greeting-card shop.As far as a condolence note, just say you're sorry, and if you've got a good anecdote involving his dad, spill it. He's hoarding memories; give him another one.Wrap Her GiftBuy colored tissue paper and matching cellophane at a gift shop. Lay down the cellophane, then the tissue, bring them up over the gift, and lasso that dogie at the top with a twist tie or a piece of ribbon. "It looks big and shiny, and that will make any gift appear impressive," says Marie Browning, author of Wonderful Wraps. (Stop thinking about using the same method on your other "package." If it's too late to buy the wraps, be creative with the container. Use a big pot, suitcase, toolbox—anything different that will grab attention. Then turn on your paper shredder, act like you're avoiding an audit, and bury the gift in wood-pulp spaghetti. It turns the event into a treasure hunt, which adds drama. She might not notice that you're giving her \$8 earrings wrapped in a garbage can.Drive in a DownpourPut on your headlights so others can see you. Keep your wipers off until the windshield gets fully wet, so the glass doesn't smudge. (Spraying the windshield with Rain-X will make for faster beading.) Shift a foot and a half to the right or left on the road, out of the puddling ruts.And slow down. You lose 25 percent of your stopping and 50 percent of your cornering abilities when the deluge gets biblical, says Terry Earwood, chief instructor at the Skip Barber Racing School.Pay attention to your following distance. When the bumper of the guy in front of you clears a stationary object, start counting off seconds. You shouldn't reach the object until you hit 5. Otherwise, you just might hit him.Clean the Gas GrillRemember what our ancestors said: "Ug. Fire good." Preheat the grill to high-that'll soften up all the gunk. Take a long-handled, stiff wire brush and start scraping, says Steven Raichlen, author of BBQ USA and host of the syndicated TV show BBQ University.Once the grate is clean, fold a paper towel into a thick pad, hold it with tongs, dip it in vegetable oil, and rub it across the bars. This will prevent the food from sticking.If you want to use nonstick spray, lift the grate away from the grill with your tongs, spray it, and place it back on the grill. (Don't spray directly at the grill, or you'll get a dangerous flare-up.)After you've done your cooking and while the grill's still hot, give it a once-over with the brush to remove any debris. If you have no brush, crumpled aluminum foil works.End a Conversation with a BoreGet that "I just thought of the best use for peanut butter!" look on your face. Then lightly touch the snooze's arm. This will halt the ramble. Now, reinforce what the person said, say it was nice to talk with him, shake hands, then exit gracefully, says Jacqueline Whitmore, founder of the Protocol School of Palm Beach.If you can introduce him to someone else—possibly someone you hate—it's a good move.Side benefit: When someone does the arm-touch brush-off to you, you'll make that pitching wedge are not good party banter.Go to Couples TherapyIs the therapist argument bait or a divorce-proofer? Look for three indicators in the first session.1. A sense of relief and trust—for you. The therapist should give you a clear understanding of how she works, and the three of you should agree on therapy goals early in the process, says John C. Friel, Ph.D., a licensed psychologist in St. Paul, Minnesota, and Reno, Nevada, and coauthor of The Seven Best Things (Happy) Couples Do. You should have confidence in your therapist after a couple of sessions.2. A sense of control—for the therapist. If your mate is accusing you of stuff, the counselor needs to take control and steer the conversation to higher ground, says Susan Heitler, Ph.D., a psychologist and author of From Conflict to Resolution. If the therapist doesn't, it's a deal breaker.3. Selfishness—for both of you. You gain, and give, insight by talking about how you feel and listening to her do the same; complaining about each other just builds resentment. So if you spend the session bickering, get a new therapist.Explain Kinky TV to Your KidYou're relaxing on the couch, bonding with your 8-year-old, when you accidentally surf over to spring break special on MTV. Just say that those people are sinners and if he ever mentions it again, all puppies will explode.Alternatively, you can ask him what he was thinking about when he saw the dirty dealing, says Kalman Heller, Ph.D., a psychologist in Needham, Massachusetts. You'll find out what he needs by way of explanation, which is probably not much. Those little heads are low to the ground, so a lot goes blessedly right over them.Keep answers short and simple. No diagrams. Have him repeat what you said, and ask if he wants to know more. If he does, he'll ask. If he doesn't, don't harp on it. Just set the precedent that even troubling things are talked about in an easy, open way.Attend a Party SoloWalk in, stand beside the door, and scope the room. It'll let you focus on whom you want to approach, says Whitmore. Large groups are a good destination, since you have the best odds of finding people who aren't captivated by the pitching-wedge discussion and don't know the arm-touch trick. Stand just outside the circle; eventually, someone will give you a nonverbal welcome.When talking, lean forward a bit, says Mary Mitchell, an etiquette consultant and author of Class Acts. You'll seem inviting, which is good, instead of creepy, which is bad, unless that's the theme of the party; then, by all means, stare, lean backward, and rave about the devil.Put Your Dog to SleepAsk yourself two questions: (1) If you woke up and found that he'd died in his sleep, would you feel relieved? and (2) Are his bad days outweighing his good ones? If you answer yes to both, it's probably time, says David Brunner, D.V.M., a veterinarian in Indianapolis and author of The Dog Owner's Manual.Still not sure he's ready to chase (and catch!) cats for all eternity? Remember that no matter what the breed, all dogs love three things: walking, eating, and seeing their master. If he can't take pleasure in these things, he's not happy. Do him a favor and end it.Sit Through a Long MeetingAsk the question that's on everyone's mind. You'll get pumped up in anticipation, which will help you stay awake, and you'll show that you're engaged. It'll also help focus the meeting and make it end sooner, says Lisa Yaffe, deputy director of Pennsylvania's Office of Housing and Community Revitalization.If you can preface your question with a smidgen of humor—as long as it doesn't sound too forced or involve a bar, a priest, a monkey, and a hooker—even better. "Humor takes guts, and if you have guts, you likely have confidence," explains Debra A. Benton, author of Executive Charisma.Run into the Ex at a WeddingThe real problem: You still have strong feelings—warm, resentful, confused. So, to help you remember why you were together and, more important, why you're not, make three lists: what attracted you to her, what you never liked, and the deal breakers. Print them out and keep them in your pocket for the day.At the ceremony, go up and shake her hand. It's gracious but sets a distance. You've also taken the initiative—especially good if she pulled the plug, Heitler says. Keep the meeting short, then scoot over to some friends.And if you need something else to keep in mind: It's someone's wedding. The only person who has a right to be difficult is wearing a white dress and veil. If that still describes you, there are other issues that need to be addressed.From a ShirtIroning is simple, and it's easier on your shirts than the chemical bath and mechanical pressing they'll get from the pros. Just find the heat gauge on the iron and spin it to match the shirt's fabric. (Check the label, dude.)Make sure the iron's water reservoir is full so there's plenty of steam. "It cuts your time in half," says Laura Dellutri, of healthhousekeeper.com. Let the iron heat up a bit while you arrange the unbuttoned shirt on the tip of the ironing board.Flatten the collar and shoulders first, applying some pressure against the board. Next, do the sleeves and cuffs, lining up the seams and pressing flat. Then, using big strokes, work over the body, starting with the button placket, then doing half of the front. Keep rotating the shirt over the board as you work around the back and over to the buttonholes. Total time: 2 minutes.Hang Out with Her Annoying FriendFirst off, figure out what you can't stomach and tell your lady, but—and this is the important part—make it your problem. "I seem to be allergic to her." "I have a hard time with her voice." "I try, but I don't have anything to say to her."You're open, but you're owning the problem, Heitler says. It doesn't trash her friend, or their friendship.Now, the two of you can figure out a solution. Ideas? If it's the friend's voice that bothers you, go to the movies. If you have nothing to say to her, go out with a group and sit at opposite ends of the table, or have a party and man the grill.Work with Someone You MistrustControl information about your project. Commit it to paper and group e-mails, recruit witnesses, and save everything. If you fear he'll badmouth you, have regular joint meetings with the big boss man to give updates, and then ask the weasel for his take. He's on record now, says Hyler Bracey, Ph.D., author of Building Trust: How to Get It! How to Keep It! If there's a dispute, set up a meeting with the boss and have it out.Promote Yourself to the BossThe best way to make yourself look good to everybody is to talk up your team. They get recognition, which motivates them more, and you shine as a leader, Fisher says. And by having such a great team, you've groomed your successor, which will help you expand your own horizons. (Or leave early on Friday—your choice.)If you haven't built a team, you're going no place: If the brass thinks no one else can do your job but you, guess what? No one else will do your job but you.Escape a Friend Who's BlitzedA lubed-up businessman wants to chat hard. Tell him one of two things: You're an IRS auditor (instant buzz kill). Or you're coming from a funeral. "It puts fear into him that you'll burst into tears," says Chris McGinnis, travel advisor for CNN Headline News. Answer your cell, whether it rings or not, then rush out.Sit Through a Chick FlickHeed Men's Health's Girl Next Door, Nicole Beland, and pick the right subgenre. Girl-power movies involve honeys kicking ass. (Ashley Judd thrillers have Ashley Judd going for them.) Foreign films tend to have hot, aloof women getting naked on buses, at cafés, everywhere. "She'll just think it's artsy," says Beland.

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