AP GUIDE

PHYSICS
BIOLOGY
CALCULUS
CHEMISTRY

TIPS AND WALKTHROUGHS TO GET A 5 ON STEM AP TESTS

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HIGH SCHOOL STUDENT EDITION

Introduction:

I'm a rising Senior in high school and will be graduating as part of the class of 2024. I've been taking AP tests throughout my sophomore and junior years, gaining much experience. I struggled a lot in preparing for the test because there are so many websites, books, and information on the internet. It's difficult for me to select which knowledge to process. It got better when I started doing practice tests. Fortunately, through plenty of practice tests, I found patterns and answering methods that simplified my study.

I knew how the concepts were asked, so I learned to precisely answer such questions for each unit. I wish I had known these things before so I could focus on studying them right at the beginning of the year and not spend half a year struggling to understand unnecessary concepts. Any of these STEM subjects has vast concepts, and not knowing what the test expect from you will waste a lot of time and might not allow you to achieve a 5 on these tests. The fact is you could do better on the exam by just doing practice tests and reading answer keys than a person who just studies.

I don't want you guys to fall into the trap of spending too much time studying futile knowledge, so I wrote this book. I don't think anywhere on the internet could point out these key points that will save you a tremendous amount of time. For my junior year AP tests, I got a 5 on AP Calculus BC and a 4 in AP Biology, Chemistry, Physics 1, and Physics C: Mechanics. I didn't take AP Calculus BC, AP Chem, and AP Physics C, and I decided to study by myself. My teachers didn't really teach AP Biology and Physics 1, so they're 98% self-studied. I actually didn't spend much time on these subjects but just scrambled almost around April, so you guys, with my precious tips and walkthroughs, should do much better on these STEM subjects. This book was written by a student who got an AP Scholar with Distinction Award and a 4 and above on his Stem AP tests. Good luck! Let's get that 5!

Acknowledgment:

I want to give a big thanks to Gabi Le for helping me design this book.

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Tip #1:

Screw the textbook. I know every AP class has a textbook for you to gain knowledge and keep track of the curriculum. However, there is no need to use a textbook to study; it's just too abundant and traditional. Most of the time, it's too broad, bland, and, most importantly, TIME-WASTING. Use it only to keep track of the units that you need to cover for the AP test.

Tip #2:

Search the internet for your AP subject's "Exam description." This contains units you must cover before you walk into the testing room. Each unit has test weight percentages; focus on the ones with the highest weight.

Tip #3:

Go on YouTube and look for lectures on those units; there are simple ones to more precise ones; make sure you get the basic concept of any knowledge first before continuing. For example, in Biology, if you forget any content from normal biology, check out "Amoeba sisters," they have straightforward and concise illustrations of the contents. For the AP level, check out "Gabe Poser"; his lessons cover all the basic concepts. For specific skills like Pedigrees, Crossings, Cell cycles, and Metabolism processes, check out "Khan Academy" or "The Organic Chemistry Tutor"; they have precise and college-level explanations about those content. For the AP Biology statistics part, make sure to check out "Bozeman Science."

Tip #4:

For AP Chemistry, analyze and familiarize yourself with the Periodic table before proceeding to Youtube videos. Youtube channels like "Abigail Giordano" cover every single lesson in AP Chemistry. For AP Physics, walkthrough the equation sheet and try to understand the meaning of each equation first before you proceed. Great Youtube channels for AP Physics 1 and 2 content are "Flipping Physics" and "Bozeman Science." For Physics Cs, check out "lasseviren1"; he covers every conceptual knowledge and a lot of practice problems

Tip #5:

For AP Calculus AB and BC, here is the best Youtube channel that covers every single content in the most straightforward way, "The Algebros." You can also access those videos on this website, "https://calculus.flippedmath.com/." They also have version 2, which in my perspective, covers each skill better.

Tip #6:

Check out websites that can assist you with materials, guidelines, and problems. "Fiveable" is known for good cram reviews and quick walkthroughs of all kinds of AP subjects. Quizlet, Chegg, and Brainly can help you with complex problems and keywords. For AP Calc revision, use "https://support.ebsco.com/LEX/AP-Calculus-AB-Study-Guide.pdf." For AP Physics practice problems, use "https://www.learnapphysics.com/apphysics1and2/index.html." For AP Biology practice, use "https://highschooltestprep.com/ap/biology/."

Tip #7:

Doing practice tests, especially official ones, is crucial. One mistake most test-takers make is they spend too little time doing practice tests. I recommend to start doing practice tests at least 3 months before the exam; you can learn more from reading the answer key from those practice tests than any other methods. There is a lot of official practice on College Board Past Exam Questions. Make sure you read both the Scoring Guideline and Student Response. If you haven't covered all the content, the test is in 1 month, and you haven't done any practice tests, you need to start doing practice tests immediately. I recommend doing the latest practice before you begin studying to see what the test expects from you.

Tip #8:

If you really want to make sure you get a five or you want to self-study the whole process, I recommend registering at Ardent Academy; they have detailed and quality notes and lessons. I aced AP Chem without a lot of studies through this academy. I recommend just joining the Spring section since their summarization of everything is precise enough for you to get a 5. They also have research classes if you want to do a quality research paper to impress colleges or just for the experience.

AP CALCULUS

Ap Calculus:

Walkthrough #1:
From now on, I will give specific tips about the content of each subject. We will start with AP Calc AB. For Calc, you first need to know about the limit; it's easiest to interpret the limit using the graph. When the limit has a negative exponent, it means that the limit is approaching from the left, which means you have to look for the value of that point coming from the left of the graph; it's the same thing for a positive exponent where you have to go from the right. The limit won't exist if the value of that limit is infinite or undefined. For some problems, at first glance, it seems like the limit doesn't exist because when you plug the limit value into the denominator of a fraction, it is 0. However, you must remember to factor and eliminate first before evaluating the limit; you can also use L'Hospital Rule to take the function's derivative. You will also learn about the holes, discontinuity, and asymptotes when you evaluate the limit at a specific point, not from the left or right.

Walkthrough #2:
The next part of AP Calc AB is derivative. You need to know how to take the normal power derivative, product rule, quotient rule ("ho-di-hi-minus-hi-di-ho-over- hoho"), chain rule, trig rule, e rule, ln rule. It will be quick and intuitive when you grasp it; this can only be achieved through doing a lot of practice problems. You have to understand that derivative means rate; for example, the derivative of distance is velocity, and the derivative of velocity is acceleration. You need to acknowledge that speed is different from velocity because it's not a vector; speed is positive when the signs of velocity and acceleration are the same and negative when the signs are other. You need to know how to calculate the average rate of "something"; note that the unit for the average rate is the unit of that "something."

Walkthrough #3:
You need to know how to use derivatives to evaluate a graph. The first derivative means to take the derivative one time, and the Second derivative means to take another derivative from that one. You can know if the graph is increasing or decreasing, having a relative max or min if you know the first derivative of that function. You can know if the graph has a point of inflection, concave up, or concave down if you take the second derivative of that graph. Remember to look at the change in signs before you conclude if the graph has a max or min at an x-value.

Walkthrough #4:
You must know the Theorems, IVT, Rolle's, MVT, and EVT to evaluate intervals. Ensure the condition is met before applying the theorem (continuous or differentiable). Each theorem has

different purposes, and the only way to identify which theorem to use is to do practice problems with these theorems mixed. Remember, for trigonometry, $\text{limit}_{\theta\to 0}\ \sin\theta/\theta=1$, and $\text{limit}_{\theta\to 0}\ (1-\cos\theta)/\theta=0$. To find the tangent line equation, just use this equation $y-y_1=m(x-x_1)$. You can be asked to use a tangent line to approximate a value of another point.

Walkthrough #5:

To identify the area under the curve of a function, you can use either the approximation method if you only have the graph and the integral method if you know the function. For area approximation, there is a left-hand, right-hand, midpoint, and trapezoidal Riemann sum, which includes you dividing the graph into many sections and finding the approximated area of each section. The right-hand Riemann sum is always an over-approximation if the graph is increasing and underestimated if the graph is decreasing; it's vice versa for the left-hand Riemann sum.

Walkthrough #6:

Integral is the opposite of derivative, where you find the area under the curve instead of finding the rate. There is only the power, opposite-trig rule, and $\int 1/x = \ln|x|$. There is u-substitution and u-v substitution (integration by part) for Calc BC. Calc BC also has improper integral where you must use the limit to evaluate that integral. Calc BC also has linear parietal fraction integral when your denominator has more than 1 x term. Make sure you know $\sin^2+\cos^2=1$ and sin/cos=tan. Remember, you must add a C constant at the end of your answer for indefinite integral. Using integral, you can find the area under the graph of any function and the position from velocity and number of people from the rate of people.

Walkthrough #7:

The Second Theorem of Calculus is when your integral has a non-constant value like x. Just plug that non-constant value into the x in f(x) and time the derivative of that non-constant value. You need to know how to draw a slope field; they will give you the slope dy/dx. Just plug the x and y-value at the point you want to find the slope into dy/dx. The slope field is often combined with Euler's Rule approximation method for Calc BC.

Walkthrough #8:

The logistic model seems complicated but is actually really simple. A logistic growth, because it is "logistic," will increase but eventually approach a value, an asymptote. Just use the standard form $dp/dt=kP(L-P)$, where L is the asymptote of logistic growth, the maximum value. You can rewrite it in the form $kP(1-P/L)$. When you find the Area under the curve, you could be asked to find the volume made by squares, right triangles, isosceles triangles, and semi-circles; the answer is just the integral of the area. If there are two curves, you could also be asked to find the volume of their revolution about the line. Just study the formula; remember, outer means further from the axis, and inner means closer to the axis.

Walkthrough #9:

BC topics could be really tedious if you only have more than one month left before the test and you just start on them, so I recommend leaving yourself two months to finish these two units since it takes up most of the BC test. Unit 9 is about a polar curve; it's not too bad; just remember, the area of a polar curve is $A = \int_a^b (\rho (\theta))^2 \, d\theta$. Remember, it's polar, so you are doing in radiant, and when you graph, use the polar mode. Remember, the a and b integrand is not the x value but the θ value, so you are going around the curve. Remember to square the function first before you integrate, or it is wrong. When there are two polar curves enclosing an area, just subtract the areas of those two curves.

Walkthrough #10:

Another vital part of BC is parametric; it means instead of dy/dx, we have dy/dt and dx/dt. You can find dy/dx from these two separate functions. Remember, speed differs from velocity; when they ask about speed, use √x'(t)+y'(t). This is just the method to find the hypotenuse of a triangle when you have the x and the y sides. The position is just the integral of speed. Acceleration is √x''(t)+y''(t). They will also tell you to write in vector form just put x and y separately in <> like <x,y>.

Walkthrough #11:

The final unit is the most challenging from my point of view. You will deal with series, which is the total sigma sign combined with a function. You must evaluate those series if they converge or diverge; converge means the sum approaches a number; diverge means the sum approaches infinity. You will need to use series testing methods including nth term, geometric (ar^{n-1}), p-series ($1/n^p$), integral (using limits), ratio (work most of the time), and alternating ($(-1)^n a_n$ with $a_n>0$). Remember, if the integral of a series converges, then the series itself also converges. Geometric series converges at a/(1-r). You should learn by heart the five basic Maclaurin expansions (1/1-x; e^x; sin x; cos x; ln(1+x)); it saves a lot of your time.

Walkthrough #12:

You need to know how to write the Taylor series and Maclaurin series. Notice that when they ask for the power degree, it doesn't mean the term but rather the power degree of the function. Sometimes a third-degree polynomial could be the fourth term in the Taylor series. Maclaurin is just a Taylor series where the real or complex number part of the Taylor equation $(((f^n a)/n!)(x-a)^n)$ equals 0. You also have to deal with error bound; there are Lagrange error bound and Alternating series errors. For alternating series errors, they might not tell you explicitly, but they might ask you to prove if the series is convergent and usually ask if it's less than a specific number. You could write the error bound as |f(x)-p(x)|< (the following degree term). You use alternating series error bound when it's an alternating series.

AP PHYSICS

AP Physics 1:

Walkthrough #13:

Next is AP Physics 1. This AP is more about familiarizing yourself with the kinds of problems that could be asked; there is not much content. Unlike AP Calc, which has no equation sheet, you're provided with an equation sheet with all the equations, unit conversions, and trigonometry angle values, which is really handy. I recommend looking into those equations and trying to understand the meaning of each variable before dealing with problems. You can probably notice many similarities between Linear motion equations and Rotational motion equations (e.g., $F=ma$ and $\tau=I\alpha$); they're the same format with different variables. Another handy knowledge is that force is the derivative of energy (e.g., $U_s=\frac{1}{2}kx^2$, $F_s=-kx$).

Walkthrough #14:

For Kinematics, remember to analyze a system with the x and y components; it makes it easier to visualize. For example, an object in free fall has no velocity or acceleration in the horizontal direction but instead a 9.8m/s^2 acceleration in the y-direction downward. The questions are usually friction and air resistance negligible, so sometimes, imagining what it would be in real life wouldn't help you answer the question. Remember a non-listed equation $v_{average} = (v_i+v_f)/2$; it is convenient when they ask you for the final velocity because, most of the time, $v_i=0$.

Walkthrough #15:

Another example is the projectile problem; you will need to use the equation $\Delta x=v_it+\frac{1}{2}at^2$, which can also be in the y-direction. When the object is launched at 0 degrees, there is only the velocity in the x-direction; there is always a downward acceleration due to gravity in the y-direction. You can use the equation above to find the time it takes for the object to land since there is no initial velocity, so if you know the height, you can find the time. Then, plug this time into the equation in the x-direction to find the horizontal distance it travels since acceleration in the x-direction is 0. If the object is launched at an angle, find the y and x components of the velocity, then plug them into these two equations.

Walkthrough #16:

You must also identify and convert position vs. time, velocity vs. time, and acceleration vs. time graph. If you know calculus, this could be really simple. When position increases, velocity is constant; when position increases exponentially, velocity increases, and acceleration is constant. When they give you a velocity graph and ask for the total distance traveled, just look for the area under the graph. Speed is positive when the signs of velocity and acceleration are the same and negative when those signs are different.

Walkthrough #17:

You then need to know about forces; there are many forces (gravitational force, normal force, friction, spring force, tension force). The normal force is the force generated by the surface, usually to counter gravitation force. For forces, you need to learn different scenarios which they can ask (incline, sliding across a table, attached to a spring, sliding down a hill, pulley, strings, etc.) It will be intuitive when you do enough problems about a scenario; you can identify all the forces in that scenario. You need to know how to use trigonometry to find the component forces of a force vector (e.g., $Fg_x = mg\sin\theta$); make sure you can use similar triangles to derive different θ angles; it's different for different problems.

Walkthrough #18:

Note that in a system where there are many objects, $F_{net} = m_{total}a$. Acceleration is always the same for connected objects, so if you know the mass of individual objects, you can find the force applied specifically to that object. You could be asked about momentum, work, impulse, and torque when dealing with forces, so make sure that whenever a force is not horizontal or vertical, figure out the component forces; everything depends on the directions. For problems with different strings attached to an object, you have to correctly use the angle θ to find component forces; use SOH CAH TOA.

Walkthrough #19:

Momentum is mass times velocity ($p=mv$), and impulse is the change in momentum ($\Delta p = Ft$), which depends on the time the force is exerted on an object. Remember that when there is no EXTERNAL force exerted on the system, momentum is conserved. Which means the momentum before the action is equal to the momentum after. They usually ask about momentum when there are collisions (between 2 blocks), which could result in both blocks sticking together (inelastic) or bouncing off (elastic). Note that when they stick together, there is only one term for the final momentum, and the masses are combined; you can then find the final velocity if you know both masses and the momentum before the collision.

Walkthrough #20:

The center of mass problems is a little bit similar to the conservation of momentum problems where instead of velocity, it's position ($m_1x_1+m_2x_2=(m_1+m_2)x_{cm}$). Note that x here is not the distance from any point but the position relative to a point. Center of mass problems include planets, seesaws, and even rectangle problems. For rectangle problems, when it's 2-D, make sure you look at both the x-direction center of mass and the y-direction center of mass.

Walkthrough #21:

Most of the time, friction is negligible, but when the prompt says there is friction, make sure you consider that all the friction can possibly be in the system. Most of the time, friction and air resistance occurs on the surface (even vertical surface). Friction is only dependent upon the normal force of the surface, so the heavier the object, the more friction exerts on the object. Due to Newton's Third Law, the surface would feel the same friction force it exerts on the object. The velocity vs. time graph for the presence of air resistance in free fall is always a logistic growth graph since the force of gravitational would eventually be equal to the force of air resistance; the acceleration vs. time graph would be decreasing concave up. Friction is a non-conservative force, which means the distance friction acts on the object affects the net force.

Walkthrough #22:

Work is "parallel" forced done at a distance, and the change in Kinetic energy ($\Delta KE=W=Fd\cos\theta$.) Theta is the angle made by the force vector and the ground. Note that no work is done when the force is perpendicular to the motion, no matter how large that force is. You can derive $KE=\frac{1}{2}mv^2$ or mgh if the object fell to the ground. Energy is also essential in deriving mass, velocity, height, spring constant, etc. Whenever the object is above the ground, it has gravitational potential energy (mgh); when it travels down an inline or falls, mgh turns to kinetic energy ($\frac{1}{2}mv^2$, sometimes combined with rotational kinetic energy when the object rolls down $\frac{1}{2}I\omega^2$).

Walkthrough #23:

Note that the velocity of an object falling down a ramp is not dependent on mass since it is canceled in $mgh=\frac{1}{2}mv^2$. When dealing with springs, energy switches back and forth between kinetic and elastic potential energy ($\frac{1}{2}kx^2$, when the spring stretches). Note that x is the spring's displacement from the equilibrium point, not the length of the spring. Remember that energy is also conserved when there are no external forces acting on the system. Friction can be a factor causing energy to dissipate into the form of heat and sound; that's why the final total energy is less.

Walkthrough #24:

Rotational motion problems are the most challenging problems from my point of view: planets rotating each other, a Ferris wheel, Merry go around, a ball rotating about a center by a string. Every kind of rotational motion has a centripetal acceleration $a_c=v^2/r$. You will use this acceleration in $F_{net}=ma_c$ instead of angular acceleration. Every equation in rotational motion is in the same format as linear motion with different variables (I corresponds to m, ω corresponds to v, α corresponds to a, θ

corresponds to x, τ corresponds to F.) You can find the maximum velocity v_{max} that the object will not fall off when rotating using $a_c=v^2/r$.

Walkthrough #25:

For rotational problems where a string is tied to a ball, and the ball is rotating around an axis vertically, consider the moment when the ball is at its highest and lowest. When the ball is at its highest position, both mg, and F_T are in the same direction, and vice versa for the lowest position. You could be asked about 2 moons rotating a planet at different distances. You will have to use $F_g=Gm_1m_2/r^2$. Note that it will depend on the situations in which one will feel a greater net force because the moons can also attract each other. Note that linear velocity is always constant. You can be asked to derive equations, usually when r is doubled; this makes the denominator $4r^2$.

Walkthrough #26:

The difficult part about torque is inertia. The equations for torque are easy to remember since it's in the same format as linear motion. You can connect linear motion and rotational motion by timing r to the rotational constants to get linear constants (e.g., $v=r\omega$, $a=r\alpha$, etc.) Always consider only the horizontal component of the force applied to the radius to find torque. Inertia corresponds to mass, so the denser the object, the higher its inertia. Rotational momentum is either $\tau\Delta t$, $I\omega$, or rp, which is the same as 'mvr.' It's extremely useful with problems with an object flying towards a lever arm.

Walkthrough #27:

You have to learn by heart the inertia for the common shapes; it is in the format of MR^2 or ML^2. One crucial aspect of inertia is the inertia of the center of mass. When the density is constant throughout the object, $I=I_{cm}+Md^2$, where d is the distance from the center of mass to the point you find the inertia of, and M is the mass of that object. When dealing with Atwood's Machine problems with a fixed core, you only consider tension forces in opposite directions. Energy would only be from mgh to $\frac{1}{2}mv^2$. However, when the core can be rotated, rotational kinetic energy is considered, and inertia is a big part of seeing how far the object can go (the h in mgh).

Walkthrough #28:

For vertical spring problems, mgh is turned into $\frac{1}{2}kx^2$; x is now the same as h. You will have to consider period and frequency where $1/f=T=2\pi/\omega=2\pi\sqrt{(m/k)}$. The period is the time it takes to complete a full complete revolution (up and down). For harmonic motion (no friction, same magnitude of swinging every time), it is similar to spring's motion in which the period $T=2\pi\sqrt{(l/g)}$. As you can see, the period is only dependent on the length of the string, so the mass of the object tied to the string and the height the string is dropped don't matter.

Walkthrough #29:

Physics 1 has many multiple-choice questions, but they are pretty straightforward; most of the time, the long or calculation questions are pretty easy to do, so don't try to read them first before you skip them. In the free response, deriving equations might seem tedious, but there are only a few equations you can derive from each kind of problem; don't memorize the derivation because it can be different every time; instead, do a lot of practice problems; especially on past exams. Make sure you draw a free-body diagram and consider all forces; one missing force or energy can cause all your hard derivation work or prediction to be wrong.

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