AB Calculus Review Sheet

Legend: A – Precalculus, B – Limits, C – Differential Calculus, D – Applications of Differential Calculus, E – Integral Calculus, F – Applications of Integral Calculus, G – Particle Motion and Rates

	When you see the words …	**This is what you think of doing**
1 (B)	Show that $f(x)$ is continuous.	
2 (C)	Find the equation of the tangent line to f at (x_1, y_1).	
3 (A)	If continuous function $f(x)$ has $f(a) < k$ and $f(b) > k$, explain why there must be a value c such that $a < c < b$ and $f(c) = k$.	
4 (D)	Find points of relative extrema of $f(x)$.	
5 (D)	Find range of $f(x)$ on $[a, b]$	
6 (G)	Given the position function $s(t)$, find the average velocity on $[t_1, t_2]$.	
7 (E)	Approximate $\int_a^b f(x)\,dx$ using left Riemann sums with n rectangles.	
8 (D)	Given a graph of $f'(x)$, determine intervals where $f(x)$ is increasing/decreasing.	
9 (C)	Given a piecewise function, show it is differentiable at $x = a$ where the function rule splits.	
10 (D)	Find critical values of $f(x)$.	
11 (A)	Find the zeros of $f(x)$.	

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	When you see the words …	**This is what you think of doing**
12 (B)	Find $\lim_{x\to a} f(x)$.	
13 (C)	Find x-values of horizontal tangents to f.	
14 (D)	Show that Rolle's Theorem holds for $f(x)$ on $[a, b]$.	
15 (D)	Find inflection points of $f(x)$.	
16 (F)	Find the area between $f(x)$ and $g(x)$.	
17 (F)	Given $\frac{dy}{dx}$, draw a slope field.	
18 (G)	Given the velocity function $v(t)$, determine the difference of position of a particle on $[t_1, t_2]$.	
19 (F)	Find the volume when the area under $f(x)$ is rotated about the x-axis on the interval $[a, b]$.	
20 (C)	Find the average rate of change of f on $[a, b]$.	
21 (C)	Find the derivative of $f(g(x))$.	
22 (C)	Find the derivative of a function using the derivative definition.	
23 (A)	Show that $f(x)$ is odd.	
24 (B)	Find $\lim_{x\to\infty} f(x)$ and $\lim_{x\to-\infty} f(x)$.	

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	When you see the words …	This is what you think of doing
25 (G)	Given the position function $s(t)$, find the instantaneous velocity at $t = k$.	
26 (G)	Given the velocity function $v(t)$ and $s(0)$, find $s(t)$.	
27 (F)	Find the average value of $f(x)$ on $[a, b]$.	
28 (E)	Meaning of $\int_a^x f(t)\,dt$.	
29 (E)	Find $\frac{d}{dx}\int_a^x f(t)\,dt$.	
30 (C)	Find x-values of horizontal tangents to f.	
31 (A)	Find domain of $f(x)$.	
32 (C)	Given a chart of x and $f(x)$ and selected values of x between a and b, approximate $f'(c)$ where c is a value between a and b.	
33 (G)	Given the velocity function $v(t)$ and $s(0)$, find the greatest distance of the particle from the starting position on $[0, t_1]$.	
34 (F)	y is increasing proportionally to y.	
35 (E)	Given $\int_a^b f(x)\,dx$, find $\int_a^b \left[f(x)+k\right]dx$.	
36 (C)	Find the equation of the normal line to f at (x_1, y_1).	
37 (D)	Show that the Mean Value Theorem holds for $f(x)$ on $[a, b]$.	

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	When you see the words …	**This is what you think of doing**
38 (D)	Find range of $f(x)$ on $(-\infty,\infty)$.	
39 (C)	Find the instantaneous rate of change of f at $x = a$.	
40 (F)	Find the line $x = c$ that divides the area under $f(x)$ on $[a, b]$ into two equal areas.	
41 (E)	Approximate $\int_a^b f(x)\,dx$ using trapezoidal summation.	
42 (F)	Solve the differential equation $\frac{dy}{dx} = f(x)g(y)$.	
43 (F)	Given a base bounded by $f(x)$ and $g(x)$ on $[a, b]$ the cross sections of the solid perpendicular to the x-axis are squares. Find the volume.	
44 (E)	Approximate $\int_a^b f(x)\,dx$ using midpoint Riemann sums.	
45 (D)	Find the interval(s) where $f(x)$ is increasing/decreasing.	
46 (B)	Find horizontal asymptotes of $f(x)$.	
47 (C)	The line $y = mx + b$ is tangent to the graph of $f(x)$ at (x_1, y_1).	
48 (A)	Find vertical asymptotes of $f(x)$.	
49 (C)	Find x-values of vertical tangents to f.	

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	When you see the words …	**This is what you think of doing**
50 (E)	Given the value of $F(a)$ where the antiderivative of f is F, find $F(b)$.	
51 (F)	Find the area under the curve $f(x)$ on the interval [a, b].	
52 (D)	Find the minimum slope of $f(x)$ on [a, b].	
53 (E)	Find $\int_b^a f(x)\,dx$ where $a < b$.	
54 (G)	Given the position function $s(t)$ of a particle moving along a straight line, find the velocity and acceleration.	
55 (F)	Find the volume when the area between $f(x)$ and $g(x)$ is rotated about the x-axis.	
56 (G)	Given the velocity function $v(t)$, determine the distance a particle travels on $[t_1, t_2]$.	
57 (G)	Given the velocity function $v(t)$, determine if a particle is speeding up or slowing down at $t = k$.	
58 (D)	Find intervals where the slope of $f(x)$ is increasing.	
59 (E)	Approximate $\int_a^b f(x)\,dx$ using right Riemann sums with n rectangles.	

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	When you see the words …	This is what you think of doing
60 (C)	Approximate the value of $f(x_1 + a)$ if you know the function goes through point (x_1, y_1).	
61 (G)	Calculate $\int_{t_1}^{t_2} \lvert v(t) \rvert \, dt$ without a calculator.	
62 (G)	Given the velocity function $v(t)$ on $[t_1, t_2]$, find the minimum acceleration of a particle.	
63 (D)	Find the absolute maximum or minimum of $f(x)$ on $[a, b]$.	
64 (A)	Show that $f(x)$ is even.	
65 (F)	Find the average rate of change of $F'(x)$ on $[t_1, t_2]$.	
66 (G)	The meaning of $\int_a^b R'(t)\, dt$.	
67 (G)	Given the velocity function $v(t)$, find the average velocity on $[t_1, t_2]$.	
68 (A)	Find the intersection of $f(x)$ and $g(x)$.	
69 (G)	The volume of a solid is changing at the rate of …	
70 (G)	Given the acceleration function $a(t)$ of a particle at rest and $s(0)$, find $s(t)$.	
71 (E)	Find $\frac{d}{dx} \int_a^{g(x)} f(t)\, dt$.	

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	When you see the words …	This is what you think of doing
72 (D)	Determine whether the linear approximation for $f(x_1+a)$ over-estimates or under-estimates $f(x_1+a)$.	
73 (B)	Find $\lim_{x\to a} f(x)$ where $f(x)$ is a piecewise function.	
73 (C)	Find the derivative of the inverse to $f(x)$ at $x=a$.	
74 (G)	Given a water tank with *g* gallons initially, filled at the rate of $F(t)$ gallons/min and emptied at the rate of $E(t)$ gallons/min on $[t_1,t_2]$ a) The amount of water in the tank at $t = m$ minutes. b) the rate the water amount is changing at $t = m$ minutes and c) the time *t* when the water in the tank is at a minimum or maximum.	

AB Calculus Review Sheet Solutions

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	When you see the words …	**This is what you think of doing**
1 (B)	Show that $f(x)$ is continuous.	Show that 1) $\lim\limits_{x\to a} f(x)$ exists 2) $f(a)$ exists 3) $\lim\limits_{x\to a} f(x) = f(a)$
2 (C)	Find the equation of the tangent line to *f* at (x_1, y_1).	Find slope $m = f'(x_i)$. Then use point slope equation: $y - y_1 = m(x - x_1)$
3 (A)	If continuous function $f(x)$ has $f(a) < k$ and $f(b) > k$, explain why there must be a value *c* such that $a < c < b$ and $f(c) = k$.	This is the Intermediate Value Theorem.
4 (D)	Find points of relative extrema of $f(x)$.	Make a sign chart of $f'(x)$. At $x = c$ where the derivative switches from negative to positive, there is a relative minimum. When the derivative switches from positive to negative, there is a relative maximum. To actually find the point, evaluate $f(c)$. OR if $f'(c) = 0$, then if $f''(c) > 0$, there is a relative minimum at $x = c$. If $f''(c) < 0$, there is a relative maximum at $x = c$. (2nd Derivative test).
5 (D)	Find range of $f(x)$ on [*a*, *b*]	Use relative extrema techniques to find relative max/mins. Evaluate *f* at these values. Then examine $f(a)$ and $f(b)$. Then examine $f(a)$ and $f(b)$.
6 (G)	Given the position function $s(t)$, find the average velocity on $[t_1, t_2]$.	Avg. vel. $= \dfrac{s(t_2) - s(t_1)}{t_2 - t_1}$
7 (E)	Approximate $\int_a^b f(x)\,dx$ using left Riemann sums with *n* rectangles.	$A = \left(\dfrac{b-a}{n}\right)\left[f(x_0) + f(x_1) + f(x_2) + \ldots + f(x_{n-1})\right]$
8 (D)	Given a graph of $f'(x)$, determine intervals where $f(x)$ is increasing/decreasing.	Make a sign chart of $f'(x)$ and determine the intervals where $f'(x)$ is positive and negative.
9 (C)	Given a piecewise function, show it is differentiable at $x = a$ where the function rule splits.	First, be sure that $f(x)$ is continuous at $x = a$. Then take the derivative of each piece and show that $\lim\limits_{x\to a^-} f'(x) = \lim\limits_{x\to a^+} f'(x)$.
10 (D)	Find critical values of $f(x)$.	Find and express $f'(x)$ as a fraction. Set both numerator and denominator equal to zero and solve.
11 (A)	Find the zeros of $f(x)$.	Set function equal to 0. Factor or use quadratic equation if quadratic. Graph to find zeros on calculator.

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	When you see the words …	**This is what you think of doing**
12 (B)	Find $\lim_{x \to a} f(x)$.	Step 1: Find $f(a)$. If you get a zero in the denominator, Step 2: Factor numerator and denominator of $f(x)$. Do any cancellations and go back to Step 1. If you still get a zero in the denominator, the answer is either ∞, -∞, or does not exist. Check the signs of $\lim_{x \to a^-} f(x)$ and $\lim_{x \to a^+} f(x)$ for equality.
13 (C)	Find *x*-values of horizontal tangents to *f*.	Write $f'(x)$ as a fraction. Set numerator of $f'(x) = 0$.
14 (D)	Show that Rolle's Theorem holds for $f(x)$ on [*a*, *b*].	Show that *f* is continuous and differentiable on [*a*, *b*]. If $f(a) = f(b)$, then find some *c* on [*a*, *b*] such that $f'(c) = 0$.
15 (D)	Find inflection points of $f(x)$.	Find and express $f''(x)$ as a fraction. Set both numerator and denominator equal to zero and solve. Make a sign chart of $f''(x)$. Inflection points occur when $f''(x)$ witches from positive to negative or negative to positive.
16 (F)	Find the area between $f(x)$ and $g(x)$.	Find the intersections, *a* and *b* of $f(x)$ and $g(x)$. If $f(x) \geq g(x)$ on $[a,b]$, then area $A = \int_a^b [f(x) - g(x)]\,dx$.
17 (F)	Given $\frac{dy}{dx}$, draw a slope field.	Use the given points and plug them into $\frac{dy}{dx}$, drawing little lines with the calculated slopes at the point.
18 (G)	Given the velocity function $v(t)$, determine the difference of position of a particle on $[t_1, t_2]$.	Displacement $= \int_{t_1}^{t_2} v(t)\,dt$
19 (F)	Find the volume when the area under $f(x)$ is rotated about the *x*-axis on the interval [*a*, *b*].	Disks: Radius = $f(x)$: $V = \pi \int_a^b [f(x)]^2\,dx$
20 (C)	Find the average rate of change of *f* on [*a*, *b*].	Find $\frac{f(b) - f(a)}{b - a}$
21 (C)	Find the derivative of $f(g(x))$.	This is the chain rule. You are finding $f'(g(x)) \cdot g'(x)$.
22 (C)	Find the derivative of a function using the derivative definition.	Find $\lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$ or $\lim_{x \to a} \frac{f(x) - f(a)}{x - a}$
23 (A)	Show that $f(x)$ is odd.	Show that $f(-x) = -f(x)$. This shows that the graph of *f* is symmetric to the origin.
24 (B)	Find $\lim_{x \to \infty} f(x)$ and $\lim_{x \to -\infty} f(x)$.	Express $f(x)$ as a fraction. Determine location of the highest power: Denominator: $\lim_{x \to \infty} f(x) = \lim_{x \to -\infty} f(x) = 0$ Both Num and Denom: ratio of the highest power coefficients Numerator: $\lim_{x \to \infty} f(x) = \pm\infty$ (plug in large number)

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	When you see the words …	**This is what you think of doing**
25 (G)	Given the position function $s(t)$, find the instantaneous velocity at $t = k$.	Inst. vel. $= s'(k)$.
26 (G)	Given the velocity function $v(t)$ and $s(0)$, find $s(t)$.	$s(t) = \int v(t)\, dt + C$. Plug in $s(0)$ to find C.
27 (F)	Find the average value of $f(x)$ on $[a, b]$.	$F_{avg} = \dfrac{\int_a^b f(x)\, dx}{b-a}$
28 (E)	Meaning of $\int_a^x f(t)\, dt$.	The accumulation function – accumulated area under function *f* starting at some constant *a* and ending at some variable *x*.
29 (E)	Find $\dfrac{d}{dx}\int_a^x f(t)\, dt$.	$\dfrac{d}{dx}\int_a^x f(t)\, dt = f(x)$. The 2nd Fundamental Theorem.
30 (C)	Find *x*-values of horizontal tangents to *f*.	Write $f'(x)$ as a fraction. Set numerator of $f'(x) = 0$.
31 (A)	Find domain of $f(x)$.	Assume domain is $(-\infty,\infty)$. Restrict domains: denominators $\neq$ 0, square roots of only non-negative numbers, logarithm or natural log of only positive numbers.
32 (C)	Given a chart of *x* and $f(x)$ and selected values of *x* between *a* and *b*, approximate $f'(c)$ where *c* is a value between *a* and *b*.	Straddle *c*, using a value of $k \geq c$ and a value of $h \leq c$. $f'(c) \approx \dfrac{f(k)-f(h)}{k-h}$
33 (G)	Given the velocity function $v(t)$ and $s(0)$, find the greatest distance of the particle from the starting position on $[0,t_1]$.	Generate a sign chart of $v(t)$ to find turning points. $s(t) = \int v(t)\, dt + C$. Plug in $s(0)$ to find C. Evaluate $s(t)$ at all turning points and find which one gives the maximum distance from $s(0)$.
34 (F)	*y* is increasing proportionally to *y*.	$\dfrac{dy}{dt} = ky$ which translates to $y = Ce^{kt}$
35 (E)	Given $\int_a^b f(x)\, dx$, find $\int_a^b [f(x)+k]\, dx$.	$\int_a^b [f(x)+k]\, dx = \int_a^b f(x)\, dx + \int_a^b k\, dx$
36 (C)	Find the equation of the normal line to *f* at (x_1,y_1).	Find slope $m\perp = \dfrac{-1}{f'(x_i)}$. Then use point slope equation: $y - y_1 = m(x - x_1)$
37 (D)	Show that the Mean Value Theorem holds for $f(x)$ on [*a*, *b*].	Show that *f* is continuous and differentiable on [*a*, *b*]. If $f(a) = f(b)$, then find some *c* on [*a*, *b*] such that $f'(c) = \dfrac{f(b)-f(a)}{b-a}$

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	When you see the words …	**This is what you think of doing**
38 (D)	Find range of $f(x)$ on $(-\infty,\infty)$.	Use relative extrema techniques to find relative max/mins. Evaluate f at these values. Then examine $f(a)$ and $f(b)$. Then examine $\lim_{x\to\infty} f(x)$ and $\lim_{x\to-\infty} f(x)$.
39 (C)	Find the instantaneous rate of change of f at $x = a$.	Find $f'(a)$
40 (F)	Find the line $x = c$ that divides the area under $f(x)$ on $[a, b]$ into two equal areas.	$\int_a^c f(x)\,dx = \int_c^b f(x)\,dx$ or $\int_a^b f(x)\,dx = 2\int_a^c f(x)\,dx$
41 (E)	Approximate $\int_a^b f(x)\,dx$ using trapezoidal summation.	$A = \left(\frac{b-a}{2n}\right)\left[f(x_0) + 2f(x_1) + 2f(x_2) + \ldots + 2f(x_{n-1}) + f(x_n)\right]$ This formula only works when the base of each trapezoid is the same. If not, calculate the areas of individual trapezoids.
42 (F)	Solve the differential equation $\frac{dy}{dx} = f(x)g(y)$.	Separate the variables: x on one side, y on the other with the dx and dy in the numerators. Then integrate both sides, remembering the $+C$, usually on the x-side.
43 (F)	Given a base bounded by $f(x)$ and $g(x)$ on $[a, b]$ the cross sections of the solid perpendicular to the x-axis are squares. Find the volume.	Base = $f(x) - g(x)$. Area = base^2 = $\left[f(x) - g(x)\right]^2$. Volume = $\int_a^b \left[f(x) - g(x)\right]^2 dx$
44 (E)	Approximate $\int_a^b f(x)\,dx$ using midpoint Riemann sums.	Typically done with a table of points. Be sure to use only values that are given. If you are given 7 points, you can only calculate 3 midpoint rectangles.
45 (D)	Find the interval(s) where $f(x)$ is increasing/decreasing.	Find critical values of $f'(x)$. Make a sign chart to find sign of $f'(x)$ in the intervals bounded by critical values. Positive means increasing, negative means decreasing.
46 (B)	Find horizontal asymptotes of $f(x)$.	$\lim_{x\to\infty} f(x)$ and $\lim_{x\to-\infty} f(x)$
47 (C)	The line $y = mx + b$ is tangent to the graph of $f(x)$ at (x_1, y_1).	Two relationships are true: 1) The function f and the line share the same slope at x_1: $m = f'(x_1)$ 2) The function f and the line share the same y-value at x_1.
48 (A)	Find vertical asymptotes of $f(x)$.	Express $f(x)$ as a fraction, express numerator and denominator in factored form, and do any cancellations. Set denominator equal to 0.
49 (C)	Find x-values of vertical tangents to f.	Write $f'(x)$ as a fraction. Set denominator of $f'(x) = 0$.

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50 (E)	Given the value of $F(a)$ where the antiderivative of f is F, find $F(b)$.	Use the fact that $\int_a^b f(x)\,dx = F(b) - F(a)$ so $F(b) = F(a) + \int_a^b f(x)\,dx$. Use the calculator to find the definite integral.
51 (F)	Find the area under the curve $f(x)$ on the interval $[a, b]$.	$\int_a^b f(x)\,dx$
52 (D)	Find the minimum slope of $f(x)$ on $[a, b]$.	Find the derivative of $f'(x)$ which is $f''(x)$. Find critical values of $f''(x)$ and make a sign chart of $f''(x)$. Values of x where $f''(x)$ switches from negative to positive are potential locations for the minimum slope. Evaluate $f'(x)$ at those values and also $f'(a)$ and $f'(b)$ and choose the least of these values.
53 (E)	Find $\int_b^a f(x)\,dx$ where $a < b$.	$\int_b^a f(x)\,dx = -\int_a^b f(x)\,dx$
54 (G)	Given the position function $s(t)$ of a particle moving along a straight line, find the velocity and acceleration.	$v(t) = s'(t) \qquad a(t) = v'(t) = s''(t)$
55 (F)	Find the volume when the area between $f(x)$ and $g(x)$ is rotated about the x-axis.	Washers: Outside radius = $f(x)$. Inside radius = $g(x)$. Establish the interval where $f(x) \geq g(x)$ and the values of a and b, where $f(x) = g(x)$. $V = \pi\int_a^b \left([f(x)]^2 - [g(x)]^2\right) dx$
56 (G)	Given the velocity function $v(t)$, determine the distance a particle travels on $[t_1, t_2]$.	Distance $= \int_{t_1}^{t_2} \lvert v(t)\rvert\, dt$
57 (G)	Given the velocity function $v(t)$, determine if a particle is speeding up or slowing down at $t = k$.	Find $v(k)$ and $a(k)$. If both have the same sign, the particle is speeding up. If they have different signs, the particle is slowing down.
58 (D)	Find intervals where the slope of $f(x)$ is increasing.	Find the derivative of $f'(x)$ which is $f''(x)$. Find critical values of $f''(x)$ and make a sign chart of $f''(x)$ looking for positive intervals.
59 (E)	Approximate $\int_a^b f(x)\,dx$ using right Riemann sums with n rectangles.	$A = \left(\frac{b-a}{n}\right)\left[f(x_1) + f(x_2) + f(x_3) + \ldots + f(x_n)\right]$

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	When you see the words …	**This is what you think of doing**
60 (C)	Approximate the value of $f(x_1 + a)$ if you know the function goes through point (x_1, y_1).	Find slope $m = f'(x_i)$. Then use point slope equation: $y - y_1 = m(x - x_1)$. Evaluate this line for y at $x = x_1 + a$. Note: The closer a is to 0, the better the approximation will be. Also note that using concavity, it can be determine if this value is an over or under-approximation for $f(x_1 + a)$.
61 (G)	Calculate $\int_{t_1}^{t_2} \lvert v(t) \rvert \, dt$ without a calculator.	Set $v(t) = 0$ and make a sign charge of $v(t) = 0$ on $[t_1, t_2]$. On intervals [a, b] where $v(t) > 0$, $\int_a^b \lvert v(t) \rvert \, dt = \int_a^b v(t) \, dt$ On intervals [a, b] where $v(t) < 0$, $\int_a^b \lvert v(t) \rvert \, dt = \int_b^a v(t) \, dt$
62 (G)	Given the velocity function $v(t)$ on $[t_1, t_2]$, find the minimum acceleration of a particle.	Find $a(t)$ and set $a'(t) = 0$. Set up a sign chart and find critical values. Evaluate the acceleration at critical values and also t_1 and t_2 to find the minimum.
63 (D)	Find the absolute maximum or minimum of $f(x)$ on [a, b].	Use relative extrema techniques to find relative max/mins. Evaluate f at these values. Then examine $f(a)$ and $f(b)$. The largest of these is the absolute maximum and the smallest of these is the absolute minimum.
64 (A)	Show that $f(x)$ is even.	Show that $f(-x) = f(x)$. This shows that the graph of f is symmetric to the y-axis.
65 (F)	Find the average rate of change of $F'(x)$ on $[t_1, t_2]$.	$\dfrac{\frac{d}{dt}\int_{t_1}^{t_2} F'(x)\, dx}{t_2 - t_1} = \dfrac{F'(t_2) - F'(t_1)}{t_2 - t_1}$
66 (G)	The meaning of $\int_a^b R'(t) \, dt$.	This gives the accumulated change of $R(t)$ on [a, b]. $\int_a^b R'(t) \, dt = R(b) - R(a)$ or $R(b) = R(a) + \int_a^b R'(t) \, dt$
67 (G)	Given the velocity function $v(t)$, find the average velocity on $[t_1, t_2]$.	Avg. vel. $= \dfrac{\int_{t_1}^{t_2} v(t) \, dt}{t_2 - t_1}$
68 (A)	Find the intersection of $f(x)$ and $g(x)$.	Set the two functions equal to each other. Find intersection on calculator.
69 (G)	The volume of a solid is changing at the rate of …	$\dfrac{dV}{dt} = \ldots$
70 (G)	Given the acceleration function $a(t)$ of a particle at rest and $s(0)$, find $s(t)$.	$v(t) = \int a(t) \, dt + C_1$. Plug in $v(0) = 0$ to find C_1. $s(t) = \int v(t) \, dt + C_2$. Plug in $s(0)$ to find C_2.
71 (E)	Find $\dfrac{d}{dx} \int_a^{g(x)} f(t) \, dt$.	$\dfrac{d}{dx} \int_a^{g(x)} f(t) \, dt = f(g(x)) \cdot g'(x)$. The 2nd Fundamental Theorem.

Legend: A – Precalculus, B – Limits, C – Differential Calculus, D – Applications of Differential Calculus, E – Integral Calculus, F – Applications of Integral Calculus, G – Particle Motion and Rates

	When you see the words …	This is what you think of doing
72 (D)	Determine whether the linear approximation for $f(x_1+a)$ over-estimates or under-estimates $f(x_1+a)$.	Find slope $m = f'(x_i)$. Then use point slope equation: $y - y_1 = m(x - x_1)$. Evaluate this line for *y* at $x = x_1 + a$. If $f''(x_1) > 0$, *f* is concave up at x_1 and the linear approximation is an underestimation for $f(x_1+a)$. $f''(x_1) < 0$, *f* is concave down at x_1 and the linear approximation is an overestimation for $f(x_1+a)$.
73 (B)	Find $\lim_{x \to a} f(x)$ where $f(x)$ is a piecewise function.	Determine if $\lim_{x \to a^-} f(x) = \lim_{x \to a^+} f(x)$ by plugging in *a* to $f(x), x < a$ and $f(x), x > a$ for equality. If they are not equal, the limit doesn't exist.
73 (C)	Find the derivative of the inverse to $f(x)$ at $x = a$.	Follow this procedure: 1) Interchange *x* and *y* in $f(x)$. 2) Plug the *x*-value into this equation and solve for *y* (you may need a calculator to solve graphically) 3) Using the equation in 1) find $\frac{dy}{dx}$ implicitly. 4) Plug the *y*-value you found in 2) to $\frac{dy}{dx}$
74 (G)	Given a water tank with *g* gallons initially, filled at the rate of $F(t)$ gallons/min and emptied at the rate of $E(t)$ gallons/min on $[t_1, t_2]$ a) The amount of water in the tank at *t* = *m* minutes. b) the rate the water amount is changing at *t* = *m* minutes and c) the time *t* when the water in the tank is at a minimum or maximum.	a) $g + \int_0^m [F(t) - E(t)]\, dt$ b) $\frac{d}{dt}\int_0^m [F(t) - E(t)]\, dt = F(m) - E(m)$ c) set $F(m) - E(m) = 0$, solve for *m*, and evaluate $g + \int_0^m [F(t) - E(t)]\, dt$ at values of *m* and also the endpoints.