**Definitions, Formulas, Tests, and Theorems to Memorize**

1.  exists iff 
2. f(x) is continuous at x=a iff 
3. Intermediate Value Theorem: if f(x) is continuous on [a,b], and k is between f(a) and f(b), f(c) = k for some c in [a,b].
4. Mean Value Theorem: if f(x) is continuous on [a,b] and differentiable on (a,b), a c in (a,b) s.t. 
5. Definition of the Derivative:  or 
6. Average Rate of Change: of f(x) over the interval [a,b] is 
7. Average Value: of f(x) over the interval [a,b] is 
8. If (a,b) is on the graph of f(x) and then 
9. If f’’(x)>0, f(x) is concave up and f’(x) is increasing; if f’’(x)<0, f(x) is concave down and f’(x) is decreasing
10. First Derivative Test: if f’(x) changes from positive to negative at x=c, then f(x) has a local maximum at c
11. First Derivative Test: if f’(x) changes from negative to positive at x=c, then f(x) has a local minimum at c
12. Second Derivative Test: if f’(c)=0 and f’’(c)<0 then f(x) has a local maximum at c
13. Second Derivative Test: if f’(c)=0 and f’’(c)>0 then f(x) has a local minimum at c
14. f(x) has a point of inflection when f’’(x) changes sign
15. Tangent lines and Euler’s Method’s steps are below the curve and are thus an under approximation when f’’(x)>0
16. Tangent lines and Euler’s Method’s steps are above the curve and are thus an over approximation when f’’(x)<0
17. Secant lines are above the curve and thus Trapezoidal Approximations are over approximations when f’’(x)>0
18. Secant lines are below the curve and thus Trapezoidal Approximations are under approximations when f’’(x)<0
19. Area of a trapezoid: 
20. Fundamental Theorem of Calculus: for any constant a,  = 
21. FTC Extension: if the bounds are differentiable functions, then  = 
22. Euler’s Method: the ***change*** in y can be approximated by 
23. Logistic Growth: the carrying capacity C =  occurs when 
24. Logistic Growth: if the carrying capacity is C, then P(t) has an inflection point and grows fastest when P(t)=
25. Arc Length (rectangular): of f(x) over the interval [a,b] is 
26. L’Hôpital’s Rule: if  is of the form  then  =  , if it exists
27. Nth Term Test: for , if , then the series diverges; if  then the test is inconclusive
28. P-series Test: the series  converges when  and diverges when 
29. Geometric Series Test: the series  converges when  and diverges when 
30. Ratio Test: examine ; the series converges when  and diverges when 
31. Direct Comparison Test: compare the series to one that is larger and converges or that is smaller and diverges
32. Slope of Tangent Line (Parametric): 
33. Parametric 2nd Derivative: 
34. Speed (Parametric) : given position vector , speed = 
35. Total Distance = Arc Length (Parametric): for  over [a,b]= 
36. Slope of Tangent Line (Polar): , so first you must write y =  and x = 
37. Area between a polar curve r(θ) and the origin for is 