**To justify the following for f(x):**

**Increasing:** The derivative is positive. Generally **f ‘ (x)>0.**

**Decreasing**: The derivative is negative. Generally **f ‘ (x) <0**

**Maximum**: By the first derivative test**, x is a max since** **f’(x) changes from positive to negative** (check when f’(x)= 0 or Und). Or By the second derivative test, f’(x) = 0 or undefined and f”(x)<0 (concave down).

**Minimum:** By the first derivative test, **x is a min since f’(x) changes from negative to positive.**  Or By the second derivative test, f’(x) = 0 or undefined and f”(x)>0 (concave up).

**Concave up**: The second derivative is positive or the first derivative is increasing. Generally, **f”(x)>0 or f’(x) is increasing**.

**Concave Down**: The second derivative is negative or the first derivative is decreasing. Generally, **f”(x)< 0 or f’(x) is decreasing**.

**Point of Inflection (POI):** **f”(x) changes sign** (usually f”(x)=0 or undefined.)

**YOU MUST STATE A SIGN CHANGE TO JUSTIFY A MAX,MIN OR POI!**

**Position, Velocity and Acceleration.** These are vectors. Speed is the magnitude of velocity, |v| and has no direction.

**Positive velocity (moving right or up)**: The derivative of position is positive.

Generally **s ‘ (t)>0, or v(t) >0**.

**Negative velocity (moving left or down)**: The derivative of position is negative. Generally **s ‘ (t)<0 or v(t)<0**.

**Direction change**: When the derivative, **S’(t) changes sign or v(t) changes sign**.

**Positive Acceleration**: The second derivative of position or first derivative of velocity is positive. **S”(t)>0 or v’(t)>0**.

**Negative Acceleration**: The second derivative of position or first derivative of velocity is negative. **S”(t)<0 or v’(t)<0**.

**Speeding up**: **v(t) and a(t) have the same sign**.

**Slowing down**: **v(t) and a(t) have opposite signs**.

**Velocity Increasing**: a(t)>0 **Velocity Decreasing**: a(t)<0

**Continuous:** (limit exists), f(a) exists**,** 

Limit exists, point exists, limit =point. You **must** talk about limits to justify continuity!

**Differentiable**: everywhere except: corner, cusp, discontinuity, vertical tangent

In piecewise: must be continuous and left slope must = right slope , write



**Extreme value Theorem**: All closed intervals must have an absolute max and min if continuous. **YOU MUST CHECK ENDPOINTS** to justify an absolute max or min!

**IVT**: If continuous (you must state this), can justify the existence of a value between two y values. Good to use when you know two values of a function. f(2)=4 and f(4)=-2, therefore it must be y=0 in between. If differentiable then can also use to justify the existence of a max or min. f’(2)=4 and f’(4)=-2, therefore f’(x) must be zero in between and have a max by the first derivative test.

**MVT**: must be Continuous and Differentiable. Used to justify when the average rate of change must equal the instantaneous. Rolle’ theorem is a specific case where the average rate of change is 0. Look for y values that are the same! Then av slope =0 so there must be a relative min or max in the interval.

**Tangent line under or over approximates**: uses CONCAVITY. If concave up, the tangent lines are below the curve so it is an underestimate. If concave down, the tangent line is above the curve so it is an overestimate.

**Riemann Sums under or over**: depends on if function is increasing or decreasing! Do not talk about concavity.

Average value of a function is an integral! Average rate of change is slope!!