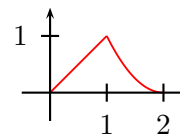


Name: _____

Please show all work and justify your statements. Make and label sketches, draw conclusions (using complete sentences and including units), and box the final answers as appropriate.

1. The diameter of a tumor is given as a function of time by the graph on the right. Sketch the rate of growth of the tumor's diameter as a function of time. Discuss the continuity of both functions.



2. Find the derivatives of the following functions with respect to x . In part (a) use the definition of the derivative — using shortcuts (rules) alone is not sufficient there. Show all steps.

(a) \sqrt{x} (b) $2^{\cos x}$ (c) $x \tan(x)$

3. On what intervals is the graph of $y = \arctan(x^2)$ concave down?
4. Suppose $g(x)$ is differentiable at $x = 0$, $g(0) = 2$, and $g'(0) = 0$. Find an equation for the tangent line at $x = 0$ to the graph of $y = xg(x)$.
5. The tick population on a deer is given in thousands as a function of time by $p(t) = 15 + t \sin(1/t)$. Describe the tick population in the long term by computing the limit of $p(t)$ as $t \rightarrow \infty$ (hint: let $u = 1/t$). Repeat the problem with $p(t) = 15 + \sin(t)/t$.

6. Find dy/dx if $y e^{\cosh x} = x \ln y$.
7. Find the point closest to the origin on the line $y = 2 - 2x$.

8. A hemispherical pimple grows at the rate of $1 \text{ cm}^3/\text{year}$. How fast is the diameter of the pimple growing when it is 5 mm?

(Note: the volume of a sphere of radius r is $\frac{4}{3}\pi r^3$)

9. A drug is administered to a patient in the following manner. The rate of delivery starts at 30 mg/min and during the first 5 minutes is increased linearly to 40 mg/min. Then the delivery is discontinued for 5 minutes. During the last 5 minutes the rate is started at 20 mg/min and is increased to 30 mg/min. Then the treatment is discontinued and the drug is allowed to clear from the body.

Assuming that the drug is cleared from the body at the constant rate of 5 mg/min, what is the accumulation of the drug at the end of treatment? When will the patient be drug free? When is the concentration of the drug the highest? Sketch the amount of the drug in the body as a function of time during the course of treatment.

10. Evaluate the following integrals analytically. Show all steps.

(a) $\int_1^4 \frac{(1 + \sqrt{t})^2}{t} dt$ (b) $\int_0^1 \cos\left(\frac{\pi t}{4}\right) dt$

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | total (100) |
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