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Gateways Practice

I. Sans Calcutron

1.) If $x^2 + xy = 10$, then when $x = 2$, $\frac{dy}{dx} =$	**2.)** The slope of the line tangent to the curve $y^2 + (xy+1)^3 = 0$ at $(2,-1)$ is
3.) If f and g are twice differentiable and $h(x) = f(g(x))$, then $h''(x) =$ a. $f''(g(x))$ b. $f''(g(x))g''(x)$ c. $f''(g(x))[g'(x)]^2$ d. $f''(g(x))g'(x) + f'(g(x))g''(x)$ e. $f''(g(x))[g'(x)]^2 + f'(g(x))g''(x)$	**4.)** If $f(x) = \sin(e^{-x})$, then $f'(x) =$ a. $-\cos(e^{-x})$ b. $e^{-x}\cos(e^{-x})$ c. $-e^{-x}\cos(e^{-x})$ d. $\cos(e^{-x}) + e^{-x}$ e. $\cos(e^{-x}) - e^{-x}$
5.) An equation of the line tangent to the graph of $y = x + \cos x$ at the point $(0,1)$ is…	**6.)** What is the instantaneous rate of change at $x = 2$ of the function f given by $f(x) = \frac{x^2-2}{x-1}$
7.) If $f(x) = \tan(2x)$, then $f'\left(\frac{\pi}{6}\right) =$	**8.)** If $y = \cos^{-1}(3x^2 - 7)$ then $g'(x) =$ a. $-6x\sin^{-1}(3x^2-7)$ b. $-\frac{6x}{\sin x}$ c. $\frac{6x}{-3x^2+8}$ d. $-\frac{6x}{\sqrt{1-(3x^2-7)^2}}$ e. $\frac{6x}{\sqrt{1-(3x^2-7)^2}}$

II. Avec Calcutron

9.) The position of an object attached to a spring is given by $y(t) = \frac{1}{6}\cos(5t) - \frac{1}{4}\sin(5t)$ where t is time in seconds. In the first 4 seconds, how many times is the velocity of the object equal to 0?	**10.)** Write the equation of the line tangent to the graph of $f(x) = x^4 + 2x^2$ at the point where $f'(x) = 1$?
11.) The volume of a tank of water at t minutes is given by the function $Q(t) = t^3 + 4t^2 + 2t + 1$. Determine the average rate of change (in gallons/minute) of the volume during the time interval from 0 minutes to 3 minutes.	**12.)** If $\frac{dy}{dx} = \sqrt{1-y^2}$ then $\frac{d^2y}{dx^2} =$ a. $-2y$ b. $-y$ c. $-\frac{y}{\sqrt{1-y^2}}$ d. y e. $\frac{1}{2}$
13.) Let f be the function given by $f(x) = 3e^{2x}$ and let g be the function given by $g(x) = 6x^3$. At what value of x do the graphs of f and g have parallel tangent lines?	**14.)** Given $f(x) = x^2\sin(2x)$, then $f''\left(\frac{\pi}{3}\right) =$?

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III. Sans Calcutron

The functions f and g are twice differentiable and selected values are given below.

x	$f(x)$	$g(x)$	$f'(x)$	$g'(x)$	$f''(x)$	$g''(x)$
-2	3	-1	3	-1	-4	-3
0	2	-5	0	-2	-4	3
1	-1	-4	4	0	4	1
4	1	-1	3	-6	4	6

15.) Given $h(x) = f(x)g(x), h''(1) =?$

16.) Differentiate for $x = 4$

$$\frac{d}{dx}[g(-\sqrt{x})]$$

17.) Differentiate for $x = -2$

$$\frac{d}{dx}\left[\frac{g(x)}{f(x)}\right]$$

18.) Differentiate for $x = 0$

$$\frac{d}{dx}[g(g(x)+3)]$$

19.) Given $j(x) = f(x^2), j''(-2)$

20.) Differentiate for $x = 4$

$$\frac{d}{dx}\left[\frac{f'(x)}{g(x)}\right]$$

21.) Differentiate for $x = \frac{\pi}{6}$

$$\frac{d}{dx}[f(2\sin(x))]$$

22.) Given $k(x) = \sqrt{f(x)}, k''(4) =?$

23.) Determine at what value of x the function f has a turning point and determine if it is a maximum or a minimum.

24.) Determine at what value of x the function g has a turning point and determine if it is a maximum or a minimum.

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IV. Avec Calcutron

t (*minutes*)	0	5	10	15	20	25	30	35	40
$x(t)$ *(miles)*	0	40.9	88.6	132.0	162.3	178.8	189.8	206.7	236.7
$v(t)$ (*miles per minute*)	7.0	9.2	9.5	7.0	4.5	2.4	2.4	4.3	7.3

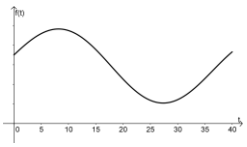
25.) A test plane flies in a straight line with positive velocity $v(t)$, in miles per minute and position given by the function $x(t)$ at time t minutes, where x and v is a differentiable functions of t. Selected values of $x(t)$ and $v(t)$ for $0 \le t \le 40$ are show in the table above.

(a) Write an equation for the line tangent to the graph of position at $t = 20$. Use your equation to estimate the position of the plane at $t = 23$.

(b) Based on the values in the table, what is the smallest number of instances at which the velocity of the plane could equal 8.0 on the open interval $0 < t < 40$? Justify your answer.

(c) The function f, defined by $f(t) = 6 + \cos\left(\frac{t}{10}\right) + 3\sin\left(\frac{7t}{40}\right)$, is used to model the velocity of the plane, in miles per minute for $0 \le t \le 40$. According to this model, what is the acceleration of the plane at t = 23? Indicate units of measure.

(d) The graph of the model provided in part (c) is shown below:



Use the graph provided to describe, in words, the acceleration of the plane during the time interval $t = 0$ to $t = 40$. Justify your conclusions.

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V. Sans Calcutron

26.) Consider the curve given by .

$$x^2 + 4y^2 = 7 + 3xy$$

(a) Show that $\frac{dy}{dx} = \frac{3y - 2x}{8y - 3x}$.

(b) Write an equation for the line normal to the curve at the point (3 , 2)

(c) Show that there is a point P with *x*-coordinate 3 at which the line tangent to the curve at P is horizontal. Find the *y*-coordinate of P.

(d) Find the value of $\frac{d^2y}{dx^2}$ at the point (3,2).

27.) The twice-differentiable function *f* is defined for all real numbers and satisfies the following conditions:

$$f(0) = 2, \quad f'(0) = -4, \quad f''(0) = 3.$$

(a) The function *g* is given by $g(x) = e^{ax} + f(x)$ for all real numbers, where *a* is a constant. Find *g'*(0) and *g"*(0) in terms of *a*. Show the work that leads to your answers.

(b) The function *h* is given by $h(x) = \cos(kx) f(x)$ for all real numbers, where *k* is a constant. Find *h'*(*x*) and write an equation for the line tangent to the graph of *h* at *x* = 0.