1) Evaluate:

$$\lim_{x\to -\frac{\pi}{6}} \frac{\cos(x) - \cos\left(-\frac{\pi}{6}\right)}{x + \frac{\pi}{6}} =$$

A) $-\frac{\sqrt{3}}{2}$ B) $-\frac{1}{2}$ C) $\frac{1}{2}$ D) $\frac{\sqrt{3}}{2}$ E) DNE

---

2) Find the sum of the infinite series below.

$$1 + 3 + \frac{9}{2} + \frac{27}{6} + \frac{81}{24} + \frac{243}{120} + \frac{729}{720} + \cdots$$

A) $\tan^{-1}(3)$ B) e^3 C) $-\frac{1}{2}$ D) 20 E) Diverges

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3) Which integral below is equivalent to the integral:

$$\int_{-2}^{5} \frac{4x-2}{x^2 - x}\, dx$$

A) $\int_{-2}^{5}\left(\frac{du}{u}\right)$ B) $2\int_{-2}^{5}\left(\frac{du}{u}\right)$ C) $\frac{1}{2}\int_{-2}^{5}\left(\frac{du}{u}\right)$ D) $\int_{6}^{20}\left(\frac{du}{u}\right)$ E) $2\int_{6}^{20}\left(\frac{du}{u}\right)$

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4) If $f(x) = 3^{\sin x}$, what is $f'(x)$?

A) $3^{\sin x}$ B) $3^{\cos x}$ C) $\left(3^{\sin x}\right)(\ln 3)$
D) $(3^{\cos x})(\ln 3)$ E) $\left(3^{\sin x}\right)(\ln 3)(\cos x)$

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5) Evaluate:

$$\lim_{x\to 0^+} \frac{2x}{|2x|}$$

A) 1 B) $\frac{1}{2}$ C) $-\frac{1}{2}$ D) -1 E) DNE

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6) Which of these could be a solution to the differential equation below?

$$\frac{dy}{dx} = 3y$$

A) $y = e^x$ B) $y = 3e^x$ C) $y = e^{3x}$ D) $y = e^{x+3}$ E) $y = e^x + 3$

[Use this table on problems 7-9.]

The functions $f(x)$ and $g(x)$ are continuous, twice-differentiable functions. The values of the functions and some of their derivatives are given in the table below.

x	$f(x)$	$g(x)$	$f'(x)$	$g'(x)$
-2	4	1	-1	8
-1	3	2	-2	10
0	8	5	3	4
1	2	7	9	-5
2	1	-2	0	4

7) Find the value of $(fg)'(-2)$.

A) -62 B) -8 C) -4 D) 4 E) 31

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8) Create a new function, $h(x) = g\big(f(x)\big)$. Find the value of $h'(1)$.

A) -45 B) -1 C) 4 D) 5 E) 36

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9) Which of the following statements must be true?

A) For some value of c on the interval $(-1,1)$, $f'(c) = 0$.
B) For some value of c on the interval $(1,2)$, $g'(x) = -8$.
C) For all values of c on the interval $(-2,2)$, $f(c) > 0$.
D) The graph of $y = g(x)$ has exactly two turning points in the interval $(-2,2)$.
E) The graph of $y = f(x)$ is concave up for all x in the interval $(0,1)$.

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10) For the function $f(x)$ defined below, find $f'(x)$.

$$f(x) = \int_{2}^{x^2} \sin t \, dt$$

A) $\cos x$ B) $\sin(x^2)$ C) $\sin^2 x$ D) $2x \sin(x^2)$ E) $\cos(x^2)$

11) Which integral below would give the correct volume of the solid formed by revolving the region in the first quadrant bounded by the graphs of $y = 3x - x^2$, $x = 0$, and $y = 0$ about the y-axis?

A) $\int_0^3 (3x - x^2)dx$ B) $\int_0^3 \pi(3x - x^2)dx$ C) $\int_0^3 \pi(3x - x^2)^2 dx$

D) $\int_0^3 2\pi(3x - x^2)dx$ E) $\int_0^3 2\pi x(3x - x^2)dx$

---

12) If $a \neq 0$, then which of the following is equivalent to the limit below?

$$\lim_{x \to a} \frac{x^2 - a^2}{x^4 - a^4}$$

A) $\frac{1}{a^2}$ B) $\frac{1}{2a^2}$ C) $\frac{1}{6a^2}$ D) 0 E) DNE

---

13) If *f* is the function defined below, for what values of x is f NOT continuous?

$$f(x) = \begin{cases} \dfrac{2\sin x}{x+3} & x < 0 \\ 3x + 1 & 0 \leq x \leq 1 \\ 5 - x & x > 1 \end{cases}$$

A) -3 only B) -3 and 0 C) 0 only D) 0 and 1 E) -3, 0, and 1

---

14) What is the average rate of change of the function $f(x) = 2x^2 - 5x + 1$ over the interval $[-2,3]$?

A) -4 B) -3 C) -1 D) 4 E) 15

---

15) If $e^{f(x)} = 1 + x^2$, then $f'(x) =$

A) $\frac{1}{1+x^2}$ B) $\frac{2x}{1+x^2}$ C) $2x(1 + x^2)$ D) $2x\left(e^{1+x^2}\right)$ E) $2x\ln(1 + x^2)$

---

16) If $\frac{dy}{dx} = x^2y^2$, then find $\frac{d^2y}{dx^2}$.

A) $2xy^2$ B) $2xy^2 + C$ C) $2xy^2 + 2x^2y$

D) $4xy$ E) $2xy^2(1 + x^3y)$

17) Which of these would correctly give the n^{th} derivative of $f(x) = e^{kx}$?

A) 0 B) e^{kx} C) ke^{kx} D) nke^{kx} E) $k^n e^{kx}$

---

18) Which of these statements is TRUE?

A) If f is differentiable and increasing on (a, b), then $f'(c) > 0$ for every c in (a, b).

B) If $f''(c) = 0$, then $\big(c, f(c)\big)$ is a point of inflection.

C) If $f'(c) = 0$ and $f''(c) < 0$, then $f(c)$ is a local maximum.

D) If $f'(c) = 0$ and $f(c)$ is not a local maximum, then $f(c)$ is a local minimum.

E) If $f(c)$ is a local maximum of a continuous function f on an open interval (a, b), then $f'(c) = 0$.

---

19) If an MRAM sum with four equal subintervals is used to approximate the integral below, what is that approximation?

$$\int_0^4 (4x - x^2)dx$$

A) 10 B) 10.5 C) $10\frac{2}{3}$ D) 10.75 E) 11

---

20) Evaluate:

$$\int_{-1}^{2} \frac{|x|}{x} dx$$

A) -3 B) -1 C) 0 D) 1 E) 3

---

21) If $f(a) = g(a) = 0$, $f'(a) = 14$, and $g'(a) = 7$, which of these is the correct value of the limit below?

$$\lim_{H \to a} \left(\frac{f(H)}{g(H)} + \frac{g(H)}{f(H)} \right)$$

A) 0 B) 1 C) 2 D) 2.5 E) DNE

22) Evaluate

$$\int \frac{dx}{x^2\sqrt{9-x^2}}$$

A) $-\frac{\sqrt{9-x^2}}{9x}+C$

B) $\ln\left|x^2\sqrt{9-x^2}\right|+C$

C) $2x\ln\left|x^2\sqrt{9-x^2}\right|+C$

D) $\frac{\sqrt{9-x^2}}{x^2}+C$

E) $\frac{\sqrt{9-x^2}}{9x}+C$

---

23) Find $\boldsymbol{r}'(t)$ for the vector-valued function $\boldsymbol{r}(t)$ given below.

$$\boldsymbol{r}(t)=(\cos 2t)\boldsymbol{i}-(\tan 3t)\boldsymbol{j}+(\sin(\ln t))\boldsymbol{k}$$

A) $(\sin 2t)\boldsymbol{i}-(\sec^2 3t)\boldsymbol{j}+\cos(ln\,t)\,\boldsymbol{k}$

B) $(-\sin 2t)\boldsymbol{i}-(\sec^2 3t)\boldsymbol{j}+\cos(\ln t)\,\boldsymbol{k}$

C) $(-2\sin 2t)\boldsymbol{i}-(3\sec^2 3t)\boldsymbol{j}+\ln t\,(\cos(\ln t))\boldsymbol{k}$

D) $(-2\sin 2t)\boldsymbol{i}-(3\sec^2 3t)\boldsymbol{j}+\frac{\cos(\ln t)}{t}\boldsymbol{k}$

E) $(2\sin 2t)\boldsymbol{i}-(3\sec^2 3t)\boldsymbol{j}+\frac{\cos(\ln t)}{t}\boldsymbol{k}$

---

24) How many distinct lines are tangent to the graph of $r(\theta)=2\cos 3\theta$ (in polar coordinates)?

A) 0 B) 1 C) 2 D) 3 E) 4

---

25) What is the area enclosed by the graph of $r=6\sin\theta$ (in polar coordinates)?

A) 3π B) 6π C) 9π D) 18π E) 36π

26) Which of the following describes the domain of the function below?

$$z(x,y) = \frac{x^2 - y^2}{x^2 + y^2 + 1}$$

A) $x \neq y$ B) $x \neq \pm y$ C) $x^2 - y^2 \leq 0$

D) $(x,y) \neq (0,0)$ E) $\{x,y\} \in \mathbb{R}$

---

27) Which of the following statements is true?

I. The infinite sum $1 + \frac{1}{n} + \frac{1}{n^2} + \frac{1}{n^3} + \frac{1}{n^4} + \cdots$ converges for all $n < 1$.

II. For any sequence $\{a_n\}$, if $\lim_{n\to\infty} \frac{|a_{n+1}|}{|a_n|} = 0$, then $\sum_{i=1}^{\infty} a_i$ converges.

III. The infinite sum $1 + \frac{1}{2^p} + \frac{1}{3^p} + \frac{1}{4^p} + \cdots$ converges for all $p \leq 1$.

A) II only B) III only C) I and II D) II and III E) I, II, and III

---

28) Evaluate:

$$\frac{d^{1000}}{dx^{1000}}(100x^{100} + 50x^{50} + 10x^{10} + x + e^x - 17)$$

A) 0 B) e^x C) $100!\,(100x^{100}) + 50!\,(50x^{50}) + 10!\,(10x^{10}) + 1!\,(x) + e^x$

D) $100 + e^x$ E) $-900x^{900}$

---

29) If $f(x)$ is a continuous, differentiable function for all real numbers x, and $f(x)$ has a local maximum at $x = c$, then which of the following statements must be true?

A) $f(x) \leq c$ for any real value of x.

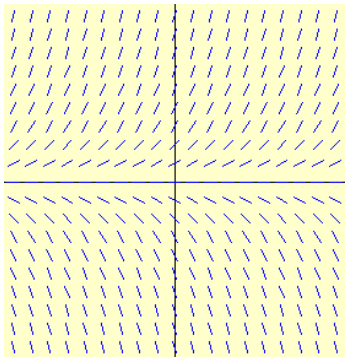
B) The line $y = c$ is tangent to the graph of $y = f(x)$.

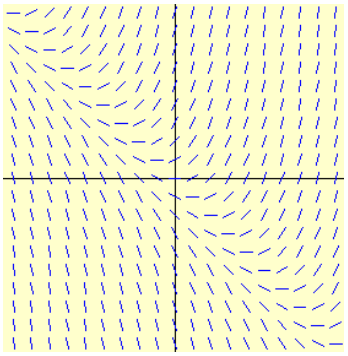
C) The line $x = c$ is normal to the graph of $y = f(x)$.

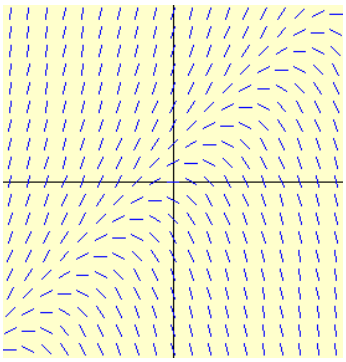
D) The graph of $y = f(x)$ has a corner or cusp at $x = c$.

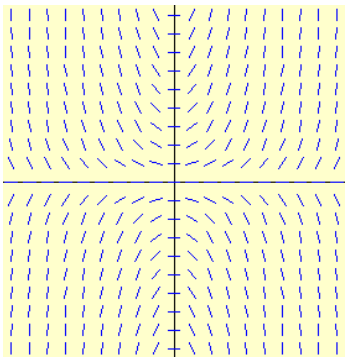
E) The graph of $y = f(x)$ is concave up on an open interval (a,b) containing $x = c$.

30) Which slope field below corresponds to the differential equation $\frac{dy}{dx} = y - x$?

A) 

B) 

C) 

D) 

E)