**MA123 — Elem. Calculus** Spring 2017
Exam 3 2017-04-13

**Name:** _____ **Sec.:** _____

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**(a)** (b) (c) (d) (e)

You have two hours to do this exam. Please write your name on this page, and at the top of page three.

**GOOD LUCK!**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **3.** | a | b | c | d | e | **12.** | a | b | c | d | e |
| **4.** | a | b | c | d | e | **13.** | a | b | c | d | e |
| **5.** | a | b | c | d | e | **14.** | a | b | c | d | e |
| **6.** | a | b | c | d | e | **15.** | a | b | c | d | e |
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| **10.** | a | b | c | d | e | **19.** | a | b | c | d | e |
| **11.** | a | b | c | d | e | **20.** | a | b | c | d | e |

**For grading use:**

| Multiple Choice | | Short Answer |
|---|---|---|
| (number right) | (5 points each) | (out of 10 points) |

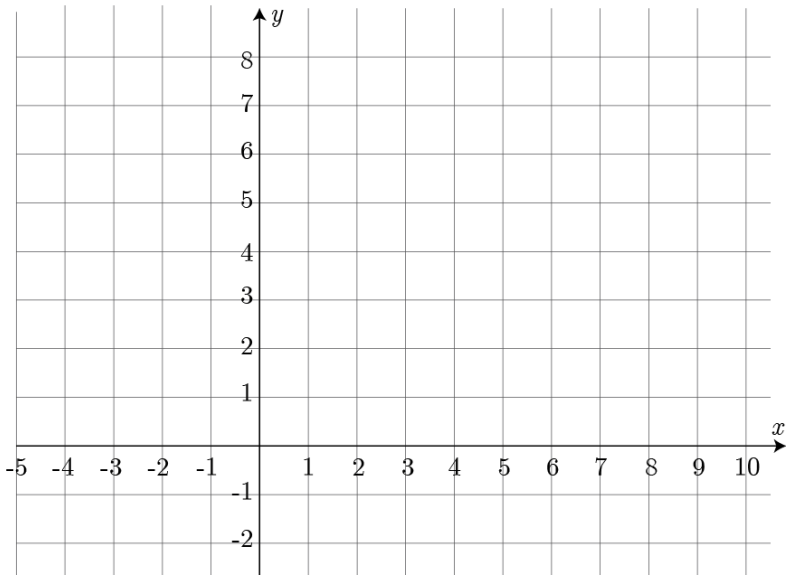
| Total | |
|---|---|
| | (total 100 points) |

**Name:** **Last 4 digits of Student ID:**

**Spring 2017 Exam 3 Short Answer Questions**

*Write answers on this page. Your work must be clear and legible to be sure you will get full credit.*

1. Sketch the graph of a **continuous** function $y = f(x)$ for which $f$ is increasing on $(-\infty, 4)$, decreasing on $(4, \infty)$, $f''(x) > 0$ on $(-\infty, 2)$ and $(7, \infty)$; $f''(x) < 0$ on $(2, 7)$.




2. Suppose we know two nonnegative numbers $x$ and $y$ satisfying $2x + y = 13$. Find the maximum possible value of their product $xy$. *You must **clearly use calculus** to find **and justify** your answer. Your final answer does **not** need to be simplified.*

Maximum possible product: _____

**Name:** _____

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**Multiple Choice Questions**

*Show all your work on the page where the question appears.*
*Clearly mark your answer both on the cover page on this exam*
*and in the corresponding questions that follow.*

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3. Where is the function $f(t) = t^3 + 6t^2 - 36t + 8$ decreasing?

**Possibilities:**

(a) $t < -2$

(b) $f(t)$ is always decreasing

(c) $-6 < t < 2$

(d) $t > -2$

(e) $t < -6$ and $t > 2$

---

4. Where is the function $f(t) = \dfrac{1}{t - 51}$ concave up?

**Possibilities:**

(a) $f(t)$ is never concave up

(b) $-1 < t < 51$

(c) $t < 51$

(d) $t > 51$

(e) $f(t)$ is always concave up except at t = 51

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5. Suppose the derivative of $g(t)$ is $g'(t) = 11(t-3)^2(t-7)$. For $t$ in which interval(s) is $g$ increasing?

**Possibilities:**

(a) $(-\infty, 3) \cup (7, \infty)$

(b) $(-\infty, 7)$

(c) $(3, 7)$

(d) $(3, 7) \cup (11, \infty)$

(e) $(7, \infty)$

6. Suppose the derivative of $g(t)$ is $g'(t) = 81 - t^2$. Where is the function $g(t)$ concave up?

**Possibilities:**

(a) $f(t)$ is always concave up

(b) $t < -9$ and $t > 9$

(c) $t < 0$

(d) $-9 < t < 9$

(e) $t > 0$

7. The following is the graph of the derivative, $f'(x)$, of the function $f(x)$.
Where is the original function $f(x)$ decreasing?

**Possibilities:**

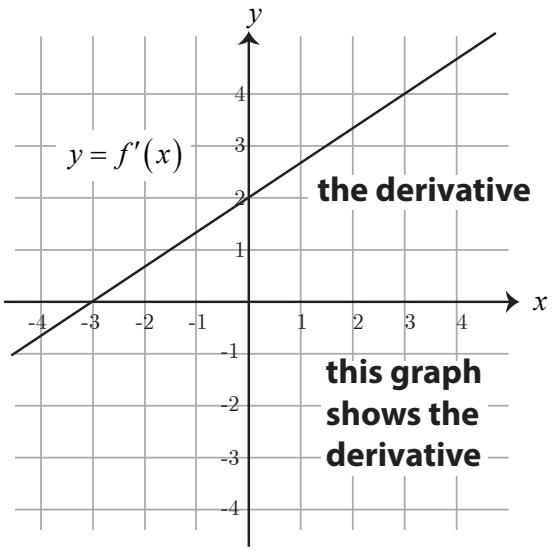
(a) nowhere

(b) $(-\infty, -3)$

(c) everywhere

(d) $(2, \infty)$

(e) $(-3, \infty)$




8. The following is the graph of the derivative, $f'(x)$, of the function $f(x)$.
Where is the original function $f(x)$ concave up?

**Possibilities:**

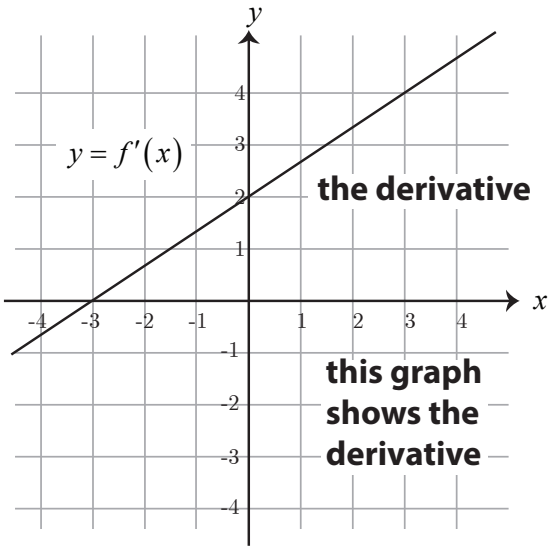
(a) nowhere

(b) $(2, \infty)$

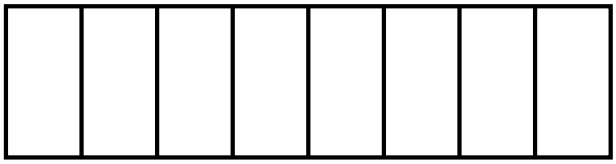
(c) $(-\infty, -3)$

(d) $(-3, \infty)$

(e) everywhere



9. A farmer builds a rectangular pen with 8 vertical partitions (9 vertical sides) using 400 feet of fencing. What is the maximum possible total area of the pen?



**Possibilities:**

(a) 2000

(b) 400

(c) 10000

(d) $\frac{20000}{9}$

(e) $\frac{10000}{3}$

10. A car rental agency rents 190 cars per day at a rate of \$27 dollars per day. For each 1 dollar increase in the daily rate, 3 fewer cars are rented. At what rate should the cars be rented to produce maximum income?

**Possibilities:**

(a) \$44.57 per day

(b) \$45.17 per day

(c) \$44.77 per day

(d) \$45.37 per day

(e) \$45.97 per day

11. Find the critical numbers of the function $f(x) = xe^{13x+3}$.

**Possibilities:**

(a) $-\frac{3}{13}, 0$

(b) $0$

(c) $-\frac{1}{13}, 0, e^{13}$

(d) $-\frac{1}{13}$

(e) $-\frac{3}{13}$

12. Given the function $f(x) = \begin{cases} -x & \text{if } x < 0 \\ x & \text{if } x \geq 0 \end{cases}$

evaluate the definite integral

$$\int_{-90}^{80} f(x)\, \mathrm{d}x$$

**Possibilities:**

(a) 7250

(b) 0

(c) 850

(d) 14450

(e) $-850$

13. The graph of $y = f(x)$ shown below consists of straight lines. Evaluate the definite integral $\int_{-3}^{3} f(x)\,\mathrm{d}x$.

**Possibilities:**

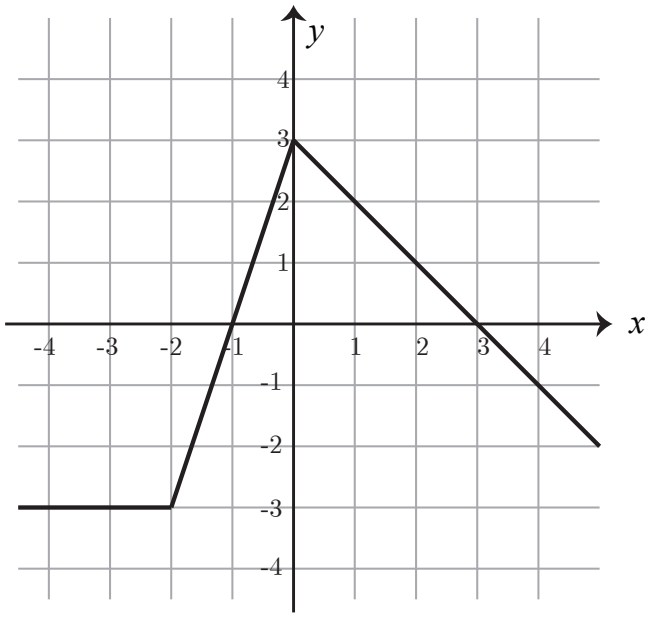
(a) 7.5

(b) 2.5

(c) 6

(d) 21.5

(e) 1.5




14. The graph of $y = f(x)$ shown below includes semicircles and a straight line. Evaluate the definite integral $\int_{-4}^{2} f(x)\,\mathrm{d}x$. Use $\pi = 3.14$.

**Possibilities:**

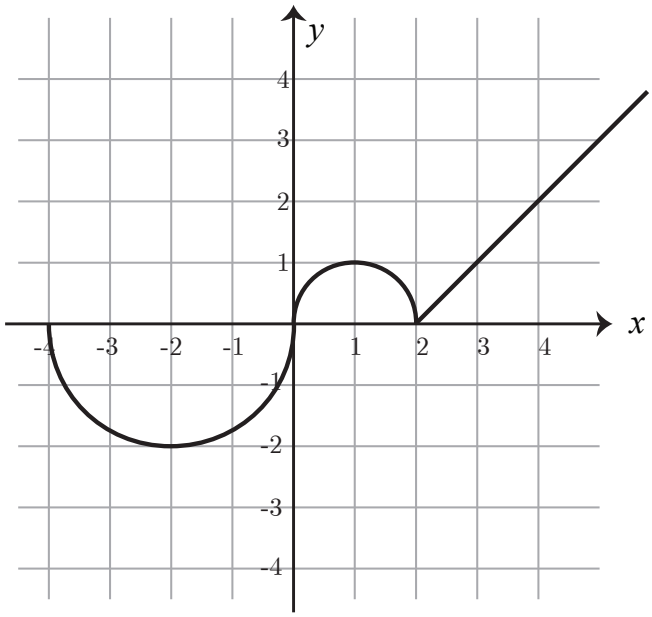
(a) 7.85

(b) $-9.42$

(c) $-4.71$

(d) $-7.85$

(e) 4.71



15. Suppose that $\int_{15}^{17} f(x)\,\mathrm{d}x = 22$ and $\int_{6}^{17} f(x)\,\mathrm{d}x = 7$. Find the value of $\int_{6}^{15} f(x)\,\mathrm{d}x$.

**Possibilities:**

(a) 29

(b) $-15$

(c) $-\dfrac{5}{3}$

(d) $-29$

(e) 15

16. Suppose that $\int_{7}^{23} f(x)\,\mathrm{d}x = 9$ and $\int_{7}^{23} g(x)\,\mathrm{d}x = 19$. Find the value of $\int_{7}^{23} \left(2f(x) + 4g(x)\right)\,\mathrm{d}x$.

**Possibilities:**

(a) 1504

(b) 8

(c) 544

(d) 94

(e) 96

17. Find the average value of $f(x)$ on the interval $[3, 11]$ given that $f(x) = \begin{cases} 90 & \text{if } x < 6 \\ -10 & \text{if } x \geq 6. \end{cases}$

**Possibilities:**

(a) $-\frac{25}{2}$

(b) $\frac{55}{2}$

(c) 6

(d) 110

(e) 40

18. Estimate the area under the graph of $-x^2 + 20x$ for $x$ between 2 and 14, by using a partition that consists of 4 equal subintervals of $[2, 14]$ and use the right endpoint of each subinterval as a sample point.

**Possibilities:**

(a) 1170

(b) 1062

(c) 354

(d) 918

(e) 1008

19. Suppose you estimate the area under the graph of $f(x) = \dfrac{1}{x}$ from $x = 5$ to $x = 45$ by adding the areas of the rectangles as follows: partition the interval into 20 equal subintervals and use the right endpoint of each interval to determine the height of the rectangle. What is the area of the 10th rectangle?

**Possibilities:**

(a) $\frac{2}{25}$

(b) $-\ln(23) + 2\ln(5)$

(c) 2.032416314

(d) $\frac{2}{23}$

(e) $\frac{1}{25}$

20. Suppose you are given the following data points for a function $f(x)$.

| $x$ | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $f(x)$ | 4 | 8 | 13 | 20 |

If $f$ is a linear function on each interval between the given points, find $\int_1^4 f(x)\,\mathrm{d}x$ .

**Possibilities:**

(a) 41

(b) 45

(c) 139

(d) 33

(e) 25

## Some Formulas

**1. Areas:**

(a) Triangle $A = \frac{bh}{2}$

(b) Circle $A = \pi r^2$

(c) Rectangle $A = lw$

(d) Trapezoid $A = \frac{h_1 + h_2}{2} b$

**2. Volumes:**

(a) Rectangular Solid $V = lwh$

(b) Sphere $V = \frac{4}{3}\pi r^3$

(c) Cylinder $V = \pi r^2 h$

(d) Cone $V = \frac{1}{3}\pi r^2 h$

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