AB Calculus Multiple Choice Test

From Calculus Course Description – Effective Fall 2010 (pp. 17-27)

Calculus AB: Section I

Section I consists of 45 multiple-choice questions. Part A contains 28 questions and does not allow the use of a calculator. Part B contains 17 questions and requires a graphing calculator for some questions. Twenty-four sample multiple-choice questions for Calculus AB are included in the following sections. Answers to the sample questions are given on page 27.

Part A Sample Multiple-Choice Questions

A calculator may not be used on this part of the exam.

Part A consists of 28 questions. Following are the directions for Section I, Part A, and a representative set of 14 questions.

Directions: Solve each of the following problems, using the available space for scratch work. After examining the form of the choices, decide which is the best of the choices given and fill in the corresponding oval on the answer sheet. No credit will be given for anything written in the exam book. Do not spend too much time on any one problem.

In this exam:

(1) Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number.

(2) The inverse of a trigonometric function f may be indicated using the inverse function notation f^{-1} or with the prefix "arc" (e.g., $\sin^{-1} x = \arcsin x$).

1. What is $\lim_{h\to 0} \dfrac{\cos\left(\frac{3\pi}{2}+h\right)-\cos\left(\frac{3\pi}{2}\right)}{h}$?

(A) 1

(B) $\dfrac{\sqrt{2}}{2}$

(C) 0

(D) -1

(E) The limit does not exist.

Two equivalent definitions of a derivative:

$$\frac{d}{dx}f(x) = \lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$$

$$\frac{d}{dx}f(x) = \lim_{x\to a}\frac{f(x)-f(a)}{x-a}$$

Solution: This is the definition of the derivative of the function $f(x)=\cos x$, evaluated at $x=\frac{3\pi}{2}$.

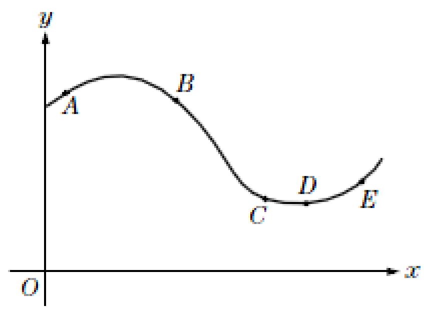
$f(x)=\cos x$

$f'(x)=-\sin x$

$f'\left(\frac{3\pi}{2}\right)=-\sin\left(\frac{3\pi}{2}\right)=-(-1)=\mathbf{1}$ **Answer A**

2. At which of the five points on the graph in the figure at the right are $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ both negative?

(A) A
(B) B
(C) C
(D) D
(E) E



$\frac{dy}{dx}$ being negative means the curve is decreasing.

$\frac{d^2y}{dx^2}$ being negative means the curve is concave down.

Let's consider each of the five points:

- Point A: Curve is increasing. Curve is concave down.
- Point B: Curve is decreasing. Curve is concave down. Bingo!
- Point C: Curve is decreasing. Curve is concave up.
- Point D: Curve is flat. Curve is concave up.
- Point E: Curve is increasing. Curve is concave up.

The only point that meets the conditions specified is **Point B.** **Answer B**

3. The slope of the tangent to the curve $y^3x + y^2x^2 = 6$ at $(2, 1)$ is

(A) $-\frac{3}{2}$
(B) -1
(C) $-\frac{5}{14}$
(D) $-\frac{3}{14}$
(E) 0

Use implicit differentiation.

$$y^3x + y^2x^2 - 6 = 0$$

$$y^3 \cdot 1 + x \cdot 3y^2\frac{dy}{dx} + y^2 \cdot 2x + x^2 \cdot 2y\frac{dy}{dx} = 0$$

$$y^3 + 3xy^2\frac{dy}{dx} + 2xy^2 + 2x^2y\frac{dy}{dx} = 0$$

$$(y^3 + 2xy^2) + (3xy^2 + 2x^2y)\frac{dy}{dx} = 0$$

$$\frac{dy}{dx} = \frac{-(y^3 + 2xy^2)}{(3xy^2 + 2x^2y)}$$

Evaluated at the point $(2, 1)$, we get:

$$\frac{dy}{dx} = \frac{-(1^3 + 2 \cdot 2 \cdot 1^2)}{(3 \cdot 2 \cdot 1^2 + 2 \cdot 2^2 \cdot 1)} = -\frac{\mathbf{5}}{\mathbf{14}}$$

Answer C

4. Let S be the region enclosed by the graphs of $y = 2x$ and $y = 2x^2$ for $0 \le x \le 1$. What is the volume of the solid generated when S is revolved about the line $y = 3$?

(A) $\pi \int_0^1 \left(\left(3 - 2x^2\right)^2 - (3 - 2x)^2 \right) dx$

(B) $\pi \int_0^1 \left((3 - 2x)^2 - \left(3 - 2x^2\right)^2 \right) dx$

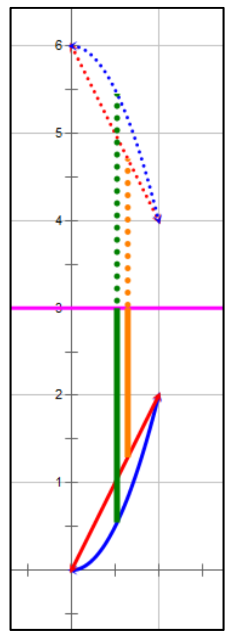
(C) $\pi \int_0^1 \left(4x^2 - 4x^4\right) dx$

(D) $\pi \int_0^2 \left(\left(3 - \frac{y}{2}\right)^2 - \left(3 - \sqrt{\frac{y}{2}}\right)^2 \right) dy$

(E) $\pi \int_0^2 \left(\left(3 - \sqrt{\frac{y}{2}}\right)^2 - \left(3 - \frac{y}{2}\right)^2 \right) dy$

First, find the points of intersection of the two curves. Set equal $\boldsymbol{y = 2x^2}$ and $\boldsymbol{y = 2x}$.

$\boldsymbol{2x^2} = \boldsymbol{2x}$ has the solutions $\boldsymbol{x = \{0, 1\}}$.



Now, let's define the integration we need.

We must use the **washer method** because there is a gap between the region we are revolving and its reflection across the axis of revolution, $\boldsymbol{y = 3}$.

Revolving about a horizontal line means our **disks are vertical**, as shown, and we should **integrate with respect to $\boldsymbol{x}$**.

The height of the **larger disk** is the distance between the axis of revolution, $\boldsymbol{y = 3}$ and the curve $\boldsymbol{y = 2x^2}$, so the height is $\boldsymbol{f(x) = 3 - 2x^2}$.

The height of the **smaller disk** is the distance between the axis of revolution, $\boldsymbol{y = 3}$ and the curve $\boldsymbol{y = 2x}$, so the height is $\boldsymbol{g(x) = 3 - 2x}$.

We move the disks from left to right in the region, i.e., **from $\boldsymbol{x = 0}$ to $\boldsymbol{x = 1}$**.

The volume is determined from the formula: $V = \pi \int_a^b \left[(f(x))^2 - \left(g(x)\right)^2 \right] dx$. Therefore,

$$\boldsymbol{V = \pi \int_0^1 \left[(3 - 2x^2)^2 - (3 - 2x)^2 \right] dx}$$

Answer A

5. Which of the following statements about the function given by $f(x) = x^4 - 2x^3$ is true?

(A) The function has no relative extremum.
(B) The graph of the function has one point of inflection and the function has two relative extrema.
(C) The graph of the function has two points of inflection and the function has one relative extremum.
(D) The graph of the function has two points of inflection and the function has two relative extrema.
(E) The graph of the function has two points of inflection and the function has three relative extrema.

To answer this question, we must find the critical values and possible inflection points.

$f(x) = x^4 - 2x^3$

$f'(x) = 4x^3 - 6x^2 = 2x^2(2x - 3)$ Critical values exist at $x = \left\{0, \frac{3}{2}\right\}$

$f''(x) = 12x^2 - 12x = 12x(x - 1)$ Possible inflection points: $x = \{0,1\}$

Then, build an Ault Table with intervals separated by the critical values and the x-values of any possible inflection points:

From above, the values of x that define the intervals in the table are $x = \left\{0,\ 1,\ \frac{3}{2}\right\}$.

Note: In developing the table below, identify the signs (i.e., "+, "−") first. The word descriptors are based on the signs.

$f(x) = x^4 - 2x^3$				
	$(-\infty, 0)$	$(0, 1)$	$(1, 1.5)$	$(1.5, \infty)$
$s(t)$	decreasing	decreasing	decreasing	increasing
$s'(t)$ and is:	− increasing	− decreasing	− increasing	+ increasing
$s''(t)$ so $s(t)$ is:	+ concave up	− concave down	+ concave up	+ concave up

What can we say about extrema and inflection points based on this?

- There is a minimum at $x = 1.5$ because the curve changes from decreasing to increasing.
- There are two inflections points, at $x = \{0, 1\}$ because concavity changes at those points.

So, this curve has one relative extreme and two inflection points. **Answer C**

6. If $f(x) = \sin^2(3 - x)$, then $f'(0) =$

(A) $-2\cos 3$
(B) $-2\sin 3\cos 3$
(C) $6\cos 3$
(D) $2\sin 3\cos 3$
(E) $6\sin 3\cos 3$

We will use the power rule and the chain rule here:

$$f(x) = \sin^2(3 - x)$$

$$f'(x) = 2\sin(3 - x) \cdot \frac{d}{dx}\sin(3 - x)$$

$$= 2\sin(3 - x) \cdot \cos(3 - x) \cdot \frac{d}{dx}(3 - x)$$

$$= 2\sin(3 - x) \cdot \cos(3 - x) \cdot (-1) = -2\sin(3 - x) \cdot \cos(3 - x)$$

$$f'(0) = -2\sin(3 - 0) \cdot \cos(3 - 0)$$

$$= \mathbf{-2\sin(3) \cdot \cos(3)}$$ **Answer B**

7. Which of the following is the solution to the differential equation $\frac{dy}{dx} = \frac{4x}{y}$, where $y(2) = -2$?

(A) $y = 2x$ for $x > 0$

(B) $y = 2x - 6$ for $x \neq 3$

(C) $y = -\sqrt{4x^2 - 12}$ for $x > \sqrt{3}$

(D) $y = \sqrt{4x^2 - 12}$ for $x > \sqrt{3}$

(E) $y = -\sqrt{4x^2 - 6}$ for $x > \sqrt{1.5}$

$$\frac{dy}{dx} = \frac{4x}{y}$$

$$y\,dy = 4x\,dx$$

$$\int y\,dy = \int 4x\,dx$$

$$\frac{1}{2}y^2 = 2x^2 + C_1$$

$$y^2 = 4x^2 + C_2$$

Since $(2, -2)$ is a point on the curve, we get:

$$(-2)^2 = 4(2)^2 + C_2$$

$$C_2 = -12$$

$$y^2 = 4x^2 - 12$$

$$y = \pm\sqrt{4x^2 - 12}$$

This narrows our solutions down to **Answer C** and **Answer D**. Again, we need to consider the point on the curve: $(2, -2)$. Let's try it in each of these answers.

- **Answer C**: $y = -\sqrt{4x^2 - 12} \quad \Rightarrow \quad -2 = -\sqrt{4 \cdot 2^2 - 12}$ ✓
- **Answer D**: $y = +\sqrt{4x^2 - 12} \quad \Rightarrow \quad -2 = +\sqrt{4 \cdot 2^2 - 12}$ ✗

Therefore, our solution is **Answer C**

8. What is the average rate of change of the function f given by $f(x) = x^4 - 5x$ on the closed interval [0, 3]?

(A) 8.5
(B) 8.7
(C) 22
(D) 33
(E) 66

The **average rate of change** over an interval is the slope of the line connecting its endpoints.

The endpoints are determined as follows:

- $f(x) = x^4 - 5x$
- For $x = 0$, $f(0) = 0^4 - 5 \cdot 0 = 0$ So a point is $(0, 0)$.
- For $x = 3$, $f(3) = 3^4 - 5 \cdot 3 = 66$ So a point is $(3, 66)$.

The slope, then, is:

$$m = \frac{66 - 0}{3 - 0} = \mathbf{22}$$ **Answer C**

9. The position of a particle moving along a line is given by $s(t) = 2t^3 - 24t^2 + 90t + 7$ for $t \geq 0$. For what values of t is the speed of the particle increasing?

(A) $3 < t < 4$ only
(B) $t > 4$ only
(C) $t > 5$ only
(D) $0 < t < 3$ and $t > 5$
(E) $3 < t < 4$ and $t > 5$

Speed is increasing on the interval(s) where the first and second derivatives have the same sign.

$s(t) = 2t^3 - 24t^2 + 90t + 7$ for $t \geq 0$

$\boldsymbol{s'(t)} = 6t^2 - 48t + 90 = 6(t^2 - 8t + 15) = \boldsymbol{6(t-3)(t-5)}$ $\Rightarrow$ critical values: $t = \{3, 5\}$

$\boldsymbol{s''(t)} = 12t - 48 = \boldsymbol{12(t-4)}$ $\Rightarrow$ Possible inflection points at: $t = 4$

It's time for an Ault Table:

$\boldsymbol{s(t) = 2t^3 - 24t^2 + 90t + 7}$				
	$\boldsymbol{(0, 3)}$	$\boldsymbol{(3, 4)}$	$\boldsymbol{(4, 5)}$	$\boldsymbol{(5, \infty)}$
$\boldsymbol{s(t)}$	increasing	decreasing	decreasing	increasing
$\boldsymbol{s'(t)}$ and is:	$+$ decreasing	$-$ decreasing	$-$ increasing	$+$ increasing
$\boldsymbol{s''(t)}$ so $\boldsymbol{s(t)}$ is:	$-$ concave down	$-$ concave down	$+$ concave up	$+$ concave up

The signs are the same on the intervals: $\boldsymbol{(3, 4)}$ **and** $\boldsymbol{(5, \infty)}$. **Answer E**

10. $\int (x-1)\sqrt{x}\, dx =$

(A) $\frac{3}{2}\sqrt{x} - \frac{1}{\sqrt{x}} + C$

(B) $\frac{2}{3}x^{3/2} + \frac{1}{2}x^{1/2} + C$

(C) $\frac{1}{2}x^2 - x + C$

(D) $\frac{2}{5}x^{5/2} - \frac{2}{3}x^{3/2} + C$

(E) $\frac{1}{2}x^2 + 2x^{3/2} - x + C$

$$\int (x-1)\sqrt{x}\, dx = \int \left(x^{3/2} - x^{1/2}\right) dx$$

$$= \frac{2}{5}x^{5/2} - \frac{2}{3}x^{3/2} + C$$

Answer D

11. What is $\lim_{x\to\infty} \frac{x^2-4}{2+x-4x^2}$?

(A) -2

(B) $-\frac{1}{4}$

(C) $\frac{1}{2}$

(D) 1

(E) The limit does not exist.

The limit is indeterminate as $x \to \infty$. Use L'Hospital's Rule:

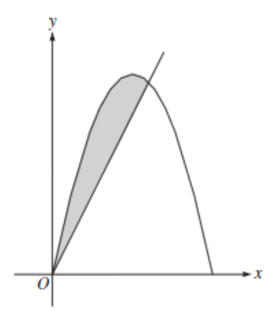
$$\lim_{x\to\infty} \frac{x^2-4}{2+x-4x^2} = \lim_{x\to\infty} \frac{2x}{1-8x}$$

The limit is **still** indeterminate as $x \to \infty$. Use L'Hospital's Rule:

$$\lim_{x\to\infty} \frac{2x}{1-8x} = \lim_{x\to\infty} \frac{2}{-8} = -\frac{1}{4}$$

Answer B

12. The figure shows the graph of $y = 5x - x^2$ and the graph of the line $y = 2x$. What is the area of the shaded region?



(A) $\frac{25}{6}$

(B) $\frac{9}{2}$

(C) 9

(D) $\frac{27}{2}$

(E) $\frac{45}{2}$

$y = 5x - x^2$ is the curve on top, and $y = 2x$ is the curve on the bottom. They intersect where $5x - x^2 = 2x \Rightarrow x^2 - 3x = 0$, i.e., at $x = \{0, 3\}$.

The area of the shaded region, then, is:

$$\int_0^3 (5x - x^2 - 2x)\, dx = \int_0^3 (-x^2 + 3x)\, dx = \left(-\frac{1}{3}x^3 + \frac{3}{2}x^2\right)\Big|_0^3$$

$$= \left(-\frac{1}{3}\cdot 3^3 + \frac{3}{2}\cdot 3^2\right) - \left(-\frac{1}{3}\cdot 0^3 + \frac{3}{2}\cdot 0^2\right) = -9 + \frac{27}{2} = \frac{9}{2}$$

Answer B

13. If $y = 5 + \int_2^{2x} e^{-t^2}\,dt$, which of the following is true?

(A) $\frac{dy}{dx} = e^{-x^2}$ and $y(0) = 5$

(B) $\frac{dy}{dx} = e^{-x^2}$ and $y(1) = 5$

(C) $\frac{dy}{dx} = e^{-4x^2}$ and $y(1) = 5$

(D) $\frac{dy}{dx} = 2e^{-4x^2}$ and $y(0) = 5$

(E) $\frac{dy}{dx} = 2e^{-4x^2}$ and $y(1) = 5$

$$f(x) = 5 + \int_2^{2x} e^{-t^2}\,dt$$

$$f'(x) = 0 + \frac{d}{dx}\int_2^{2x} e^{-t^2}\,dt = e^{-(2x)^2} \cdot \frac{d}{dx}(2x) = \mathbf{2e^{-4x^2}}$$

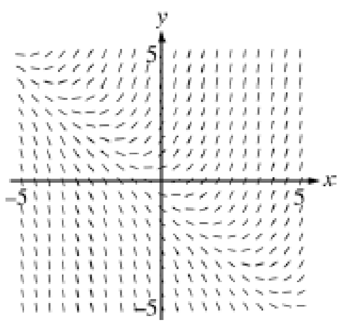
$$f(0) = 5 + \int_2^{0} e^{-t^2}\,dt \neq 5$$

$$f(1) = 5 + \int_2^{2} e^{-t^2}\,dt = \mathbf{5}$$

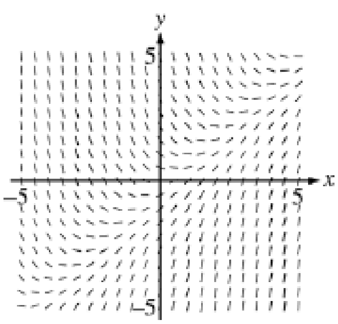
Answer E

14. Which of the following is a slope field for the differential equation $\frac{dy}{dx} = \frac{x}{y}$?

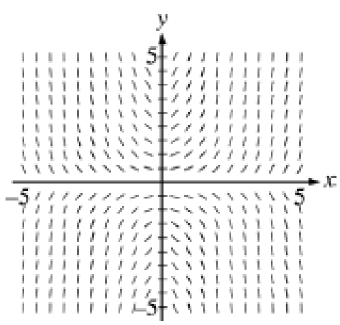
(A)



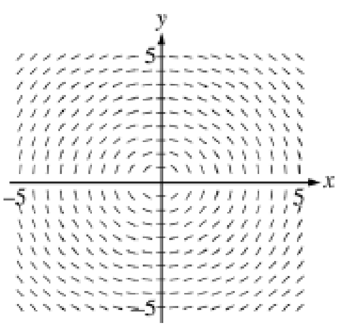
(B)



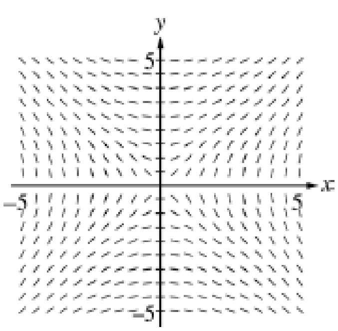
(C)



(D)



(E)



You can solve for the equation implied by the differential equation if you like. However, it is easier to find a couple of slopes in the field.

I like to find the slopes at points that are **not** near the origin.

Try:

Point $(5, 5)$, $\frac{dy}{dx} = 1$

Point $(-5, 5)$, $\frac{dy}{dx} = -1$

Point $(-5, -5)$, $\frac{dy}{dx} = 1$

Point $(5, -5)$, $\frac{dy}{dx} = -1$

Answer E is the only one with these slopes.

Answer E

Part B Sample Multiple-Choice Questions

A graphing calculator is required for some questions on this part of the exam.

Part B consists of 17 questions. Following are the directions for Section I, Part B, and a representative set of 10 questions.

Directions: Solve each of the following problems, using the available space for scratch work. After examining the form of the choices, decide which is the best of the choices given and fill in the corresponding oval on the answer sheet. No credit will be given for anything written in the exam book. Do not spend too much time on any one problem.

In this exam:

(1) The exact numerical value of the correct answer does not always appear among the choices given. When this happens, select from among the choices the number that best approximates the exact numerical value.

(2) Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number.

(3) The inverse of a trigonometric function f may be indicated using the inverse function notation f^{-1} or with the prefix "arc" (e.g., $\sin^{-1} x = \arcsin x$).

15. A particle travels along a straight line with a velocity of $v(t) = 3e^{(-t/2)}\sin(2t)$ meters per second. What is the total distance, in meters, traveled by the particle during the time interval $0 \le t \le 2$ seconds?

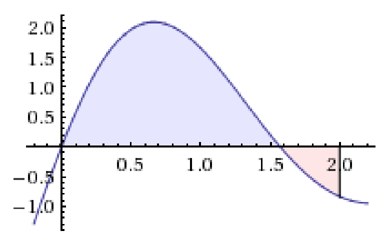
(A) 0.835
(B) 1.850
(C) 2.055
(D) 2.261
(E) 7.025

We might think this a straightforward integration, but we must be careful. If velocity is both positive and negative over the interval, we must break the interval into multiple sections and integrate each.

$$v(t) = 3e^{-t/2} \cdot \sin 2t$$

Since $e^{-t/2} > 0$ everywhere, $3e^{-t/2} \cdot \sin 2t = 0$ when $\sin 2t = 0$.

$\sin 2t = 0$ when $t = \left\{0, \frac{\pi}{2}\right\}$ in the domain $0 \le t \le 2$.



So, our solution is:

$$d = \int_0^{\pi/2} 3e^{-t/2} \cdot \sin 2t \, dt - \int_{\pi/2}^{2} 3e^{-t/2} \cdot \sin 2t \, dt$$

$$d = 2.055 - (-0.206) = \mathbf{2.261}$$ **Answer D**

16. A city is built around a circular lake that has a radius of 1 mile. The population density of the city is $f(r)$ people per square mile, where r is the distance from the center of the lake, in miles. Which of the following expressions gives the number of people who live within 1 mile of the lake?

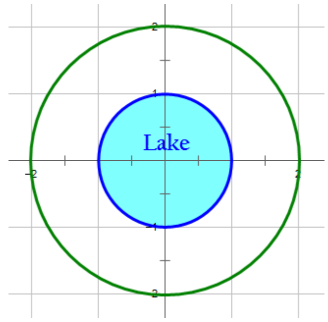
(A) $2\pi\int_0^1 r\,f(r)\,dr$

(B) $2\pi\int_0^1 r(1+f(r))\,dr$

(C) $2\pi\int_0^2 r(1+f(r))\,dr$

(D) $2\pi\int_1^2 r\,f(r)\,dr$

(E) $2\pi\int_1^2 r(1+f(r))\,dr$



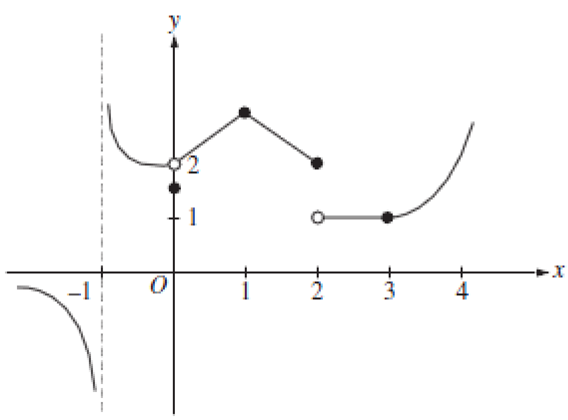
A visualization of this situation is provided above. The people who live within one mile of the lake live between 1 mile and 2 miles from the center of the lake.

We can think of this as a volume problem with a circular cross section of radius r and height $h = f(r)$. The volume of solid of revolution is given by the cylindrical shell formula:

$$V = 2\pi \int_a^b x\,f(x)\,dx$$

Then,

$$V = 2\pi \int_1^2 r\,f(r)\,dx$$ **Answer D**



17. The graph of a function f is shown above. If $\lim_{x\to b} f(x)$ exists and f is not continuous at b, then $b =$

(A) −1
(B) 0
(C) 1
(D) 2
(E) 3

In Problem 17, we are looking for the x-value of a point where the curve is not continuous but the limit exists. This implies a hole in the graph in a location where the function would be continuous if the hole were filled in.

This occurs only at $x = 0$.

Answer B

x	1.1	1.2	1.3	1.4
$f(x)$	4.18	4.38	4.56	4.73

18. Let f be a function such that $f''(x) < 0$ for all x in the closed interval $[1, 2]$. Selected values of f are shown in the table above. Which of the following must be true about $f'(1.2)$?

(A) $f'(1.2) < 0$
(B) $0 < f'(1.2) < 1.6$
(C) $1.6 < f'(1.2) < 1.8$
(D) $1.8 < f'(1.2) < 2.0$
(E) $f'(1.2) > 2.0$

Let's look at average slopes in the applicable intervals shown:

- Average slope from $x = 1.1$ to $x = 1.2$: $m = \frac{4.38-4.18}{1.2-1.1} = 2.0.$
- Average slope from $x = 1.2$ to $x = 1.3$: $m = \frac{4.56-4.38}{1.3-1.2} = 1.8.$

Since $f''(x) < 0$ over the entire interval, the curve is concave down over the interval, and so the slope is decreasing throughout the interval. Therefore, the slope of the curve at $x = 1.2$ must be **between 1.8 and 2.0.** **Answer D**

19. Two particles start at the origin and move along the x-axis. For $0 \le t \le 10$, their respective position functions are given by $x_1 = \sin t$ and $x_2 = e^{-2t} - 1$. For how many values of t do the particles have the same velocity?

(A) None
(B) One
(C) Two
(D) Three
(E) Four

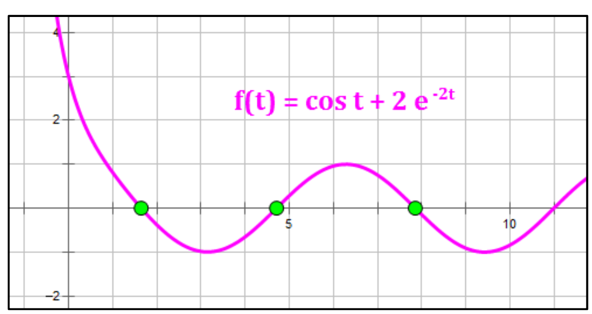
Position Functions: $x_1(t) = \sin t$ $x_2(t) = e^{-2t} - 1$

Velocity Functions: $x_1{}'(t) = \cos t$ $x_2{}'(t) = -2e^{-2t}$

Then we set the velocity functions equal and see how many solutions exist on the interval $[0, 10]$.

$\cos t = -2e^{-2t}$

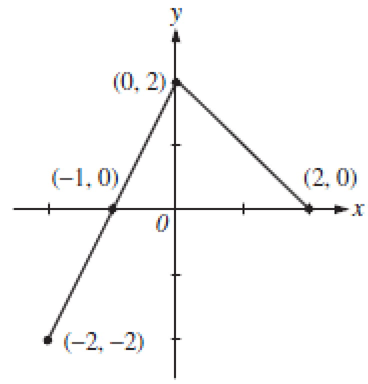
$\cos t + 2e^{-2t} = 0$



A look at the graph of this function tells us that there are **three points** where the velocity functions are equal on the interval $[0, 10]$. **Answer D**

20. The graph of the function f shown consists of two line segments. If g is the function defined by $g(x) = \int_0^x f(t)\,dt$, then $g(-1) =$

(A) -2
(B) -1
(C) 0
(D) 1
(E) 2



Graph of f

$$g(-1) = \int_0^{-1} f(t)\,dt = -\int_{-1}^{0} f(t)\,dt$$

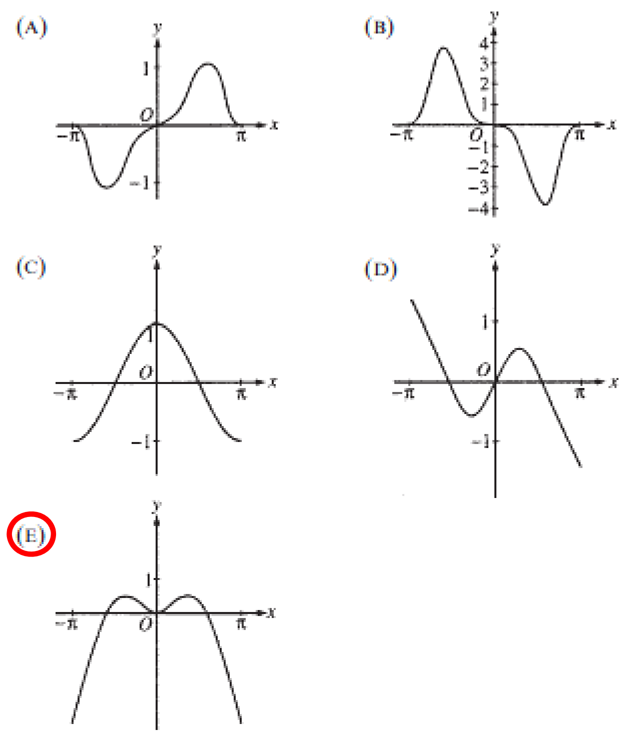
$\int_{-1}^{0} f(t)\,dt$ is the area under the curve from $x = -1$ to $x = 0$.

Based on the lines in the graph, the area is bounded by a triangle with base $b = 1$ and height $h = 2$. So, the area of the triangle is $A = \frac{1}{2}bh = \frac{1}{2} \cdot 1 \cdot 2 = 1$. Then,

$$g(-1) = -\int_{-1}^{0} f(t)\,dt = -1$$

Answer B

21. The graphs of five functions are shown below. Which function has a nonzero average value over the closed interval $[-\pi, \pi]$?



The average **value** of a function over an interval is given by:

$$\frac{1}{x_2 - x_1} \cdot \int_{x_1}^{x_2} f(x)\,dx$$

Note that this is also the average **area** under the graph over the interval.

In Problem 21, we are looking for a function with non-zero area under the graph. That is, we are looking for a function that does not have equal positive and negative areas over the interval $[-\pi, \pi]$.

All of the graphs shown have equal positive and negative areas over this interval except **Graph E**.

Answer E

22. A differentiable function f has the property that $f(5) = 3$ and $f'(5) = 4$. What is the estimate for $f(4.8)$ using the local linear approximation for f at $x = 5$?

(A) 2.2
(B) 2.8
(C) 3.4
(D) 3.8
(E) 4.6

Clearly, this is a problem involving differentials, so we need the differential formula:

$$f(x) = f(c) + f'(c) \cdot (x - c)$$

Let's find the pieces to go into this formula.

$x = 4.8$. So, let our reference point be $c = 5$

We are given: $f(5) = 3$ and $f'(5) = 4$

Then: $f(4.8) = f(5) + f'(5) \cdot (4.8 - 5) = 3 + 4 \cdot (-0.2) = \mathbf{2.2}$

Answer A

23. Oil is leaking from a tanker at the rate of $R(t) = 2{,}000e^{-0.2t}$ gallons per hour, where t is measured in hours. How much oil leaks out of the tanker from time $t = 0$ to $t = 10$?

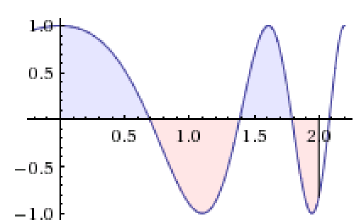
(A) 54 gallons
(B) 271 gallons
(C) 865 gallons
(D) 8,647 gallons
(E) 14,778 gallons

$$\int_0^{10} R(t)\ dt = \int_0^{10} 2{,}000\, e^{-0.2t}\ dt = \frac{1}{-0.2} 2{,}000\, e^{-0.2t} \Big|_0^{10} = -10{,}000 e^{-0.2t} \Big|_0^{10}$$

$= -10{,}000\,(e^{-2} - 1) = \mathbf{8,647}$ gallons **Answer D**

24. If $f'(x) = \sin\left(\frac{\pi e^x}{2}\right)$ and $f(0) = 1$, then $f(2) =$

(A) −1.819
(B) −0.843
(C) −0.819
(D) 0.157
(E) 1.157



$$f(2) - f(0) = \int_0^2 f'(x)\ dx = \int_0^2 \sin\left(\frac{\pi e^x}{2}\right)\ dx$$

$$f(2) = f(0) + \int_0^2 \sin\left(\frac{\pi e^x}{2}\right)\ dx = 1 + .157 = \mathbf{1.157}$$

Answer E