

MA162 — EXAM I — SPRING 2017 — February 2, 2017  
TEST NUMBER 01

**INSTRUCTIONS:**

1. Do not open the exam booklet until you are instructed to do so.
2. Before you open the booklet fill in the information below and use a # 2 pencil to fill in the required information on the scantron.
3. **MARK YOUR TEST NUMBER ON YOUR SCANTRON**
4. Once you are allowed to open the exam, make sure you have a complete test. There are 7 different test pages (including this cover page).
5. Do any necessary work for each problem on the space provided or on the back of the pages of this test booklet. Circle your answers on this test booklet.
6. The exam has 11 problems and each one is worth 9 points; everyone gets 1 free point. The maximum possible score is 100 points. No partial credit.
7. Do not leave the exam room during the first 20 minutes of the exam.
8. If you do not finish your exam in the first 50 minutes, you must wait until the end of the exam period to leave the room.
9. After you have finished the exam, hand in your scantron and your test booklet to your recitation instructor.

**DON'T BE A CHEATER:**

1. Do not give, seek or obtain any kind of help from anyone to answer questions on this exam. If you have doubts, consult only your instructor.
2. Do not look at the exam or scantron of another student.
3. Do not allow other students to look at your exam or your scantron.
4. You may not compare answers with anyone else or consult another student until after you have finished your exam, given it to your instructor and left the room.
5. Do not consult notes or books.
6. **Do not handle** phones or cameras, calculators or any electronic device until after you have finished your exam, given it to your instructor and left the room.
7. After time is called, the students have to put down all writing instruments and remain in their seats, while the TAs collect the scantrons and the exams.
8. Anyone who violates these instructions will have committed an act of academic dishonesty. Penalties for academic dishonesty include an F in the course. All cases of academic dishonesty will be reported to the Office of the Dean of Students.

I have read and understand the above statements regarding academic dishonesty:

STUDENT NAME: SOLUTIONS

STUDENT SIGNATURE: \_\_\_\_\_

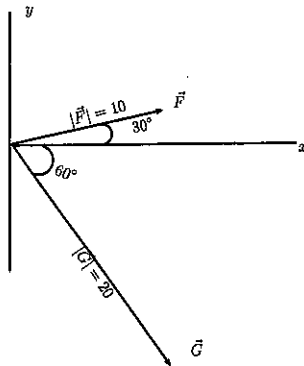
STUDENT ID NUMBER: \_\_\_\_\_

SECTION NUMBER AND RECITATION INSTRUCTOR: \_\_\_\_\_

$$\vec{G} = 20 \cos 60^\circ \vec{i}' - 20 \sin 60^\circ \vec{j}'$$

$$= 20 \cdot \frac{1}{2} \vec{i}' - 20 \frac{\sqrt{3}}{2} \vec{j}'$$

$$\boxed{\vec{G} = 10 \vec{i}' - 10\sqrt{3} \vec{j}'}$$



$$\vec{F} = 10 \cos 30^\circ \vec{i}' + 10 \sin 30^\circ \vec{j}'$$

$$\vec{F} = 10 \frac{\sqrt{3}}{2} \vec{i}' + 10 \cdot \frac{1}{2} \vec{j}'$$

$$\boxed{\vec{F} = 5\sqrt{3} \vec{i}' + 5 \vec{j}'}$$

1. Let  $\vec{F}$  and  $\vec{G}$  be the two-dimensional vectors shown in the figure above. The tangent of the angle the vector  $\vec{F} + \vec{G}$  makes with the positive part of the  $x$ -axis is equal to

A.  $\frac{1+2\sqrt{3}}{2-\sqrt{3}}$

B.  $\frac{1-2\sqrt{3}}{2+\sqrt{3}}$

C.  $\frac{1+5\sqrt{3}}{2+3\sqrt{3}}$

D.  $\frac{1-5\sqrt{3}}{2-3\sqrt{3}}$

E.  $\frac{1-4\sqrt{3}}{2+\sqrt{3}}$

$$\vec{F} + \vec{G} = (5\sqrt{3} + 10) \vec{i}' + (5 - 10\sqrt{3}) \vec{j}'$$

$$\tan \theta = \frac{5 - 10\sqrt{3}}{5\sqrt{3} + 10} = \frac{5(1 - 2\sqrt{3})}{5(\sqrt{3} + 2)}$$

$$\boxed{\tan \theta = \frac{1 - 2\sqrt{3}}{2 + \sqrt{3}}}$$

2. Find the center and the radius of the sphere  $4x^2 + 4y^2 + 4z^2 - 4x - 12y + 8z = 2$

A. Center  $(\frac{1}{2}, -\frac{5}{4}, -1)$  and radius 2

B. Center  $(\frac{1}{2}, \frac{3}{4}, 1)$  and radius 2

C. Center  $(\frac{1}{2}, \frac{3}{4}, 1)$  and radius 4

D. Center  $(\frac{1}{2}, \frac{3}{2}, -1)$  and radius 2

E. Center  $(\frac{1}{2}, \frac{3}{2}, -1)$  and radius 4

Divide equation by 4:

$$x^2 + y^2 + z^2 - x - 3y + 2z = \frac{1}{2}$$

$$x^2 - x + y^2 - 3y + z^2 + 2z = \frac{1}{2}$$

$$(x - \frac{1}{2})^2 - \frac{1}{4} + (y - \frac{3}{2})^2 - \frac{9}{4} + (z + 1)^2 - 1 = \frac{1}{2}$$

$$(x - \frac{1}{2})^2 + (z - \frac{3}{2})^2 + (z + 1)^2 = \frac{1}{2} + \frac{10}{4} + 1$$

$$\boxed{(x - \frac{1}{2})^2 + (z - \frac{3}{2})^2 + (z + 1)^2 = 4}$$

Center  $(\frac{1}{2}, \frac{3}{2}, -1)$

Radius 2.

3. Find the number  $b$  such that the angle between the vectors  $\vec{u} = \vec{i} + \vec{j} + \vec{k}$  and  $\vec{v} = b\vec{i} - \vec{j} + \vec{k}$  is equal to  $\frac{\pi}{3}$ .

A.  $b = 1$

B.  $b = -\sqrt{6}$

C.  $b = \sqrt{2}$

**D.  $b = \sqrt{6}$**

E.  $b = -\sqrt{2}$

$$\vec{u} \cdot \vec{v} = |\vec{u}| \cdot |\vec{v}| \cdot \cos \theta$$

$$\vec{u} \cdot \vec{v} = b \quad ; \quad |\vec{u}| = \sqrt{3} \quad ; \quad \sqrt{b^2+2} = |\vec{v}|$$

$$b = \sqrt{3} \sqrt{(b^2+2)} \cdot \cos \theta$$

If  $\theta = \frac{\pi}{3}$  ;  $\cos \frac{\pi}{3} = 1/2$

$$b = \sqrt{3} \cdot \sqrt{b^2+2} \cdot \frac{1}{2} \quad ; \quad 2b = \sqrt{3} \cdot \sqrt{b^2+2}$$

$$4b^2 = 3(b^2+2) \quad ; \quad 4b^2 = 3b^2 + 6 \quad ; \quad b^2 = 6$$

**$b = \sqrt{6}$**  if  $b = -\sqrt{6}$  ;  $\cos \theta = -1/2$

4. Which of the following statements are correct?

I) The vectors  $\vec{u} = 3\vec{i} + 2\vec{j} - 2\vec{k}$  and  $\vec{v} = 2\vec{i} - 2\vec{j} + \vec{k}$  are perpendicular.

II) The area of the parallelogram defined by  $\vec{a} = \vec{i} + 2\vec{j} + \sqrt{5}\vec{k}$  and  $\vec{i}$  is equal to 3.

III) The volume of the parallelepiped defined by  $\vec{a} = \vec{i} + \vec{j} + \vec{k}$ ,  $\vec{b} = 2\vec{i} - \vec{j}$  and  $\vec{c} = -3\vec{i} + \vec{j}$  is equal to 1.

(I)  $\vec{u} \cdot \vec{v} = 6 - 4 - 2 = 0$ , Yes  $\vec{u}$  and  $\vec{v}$  are perpendicular.

A. I and II only

B. I and III only

**C. I, II and III**

D. II and III only

E. III only

(II)  $\vec{a} \times \vec{b} = \begin{vmatrix} \vec{i}' & \vec{j}' & \vec{k}' \\ 1 & 2 & \sqrt{5} \\ 1 & 0 & 0 \end{vmatrix} = \sqrt{5}\vec{j}' - 2\vec{k}'$

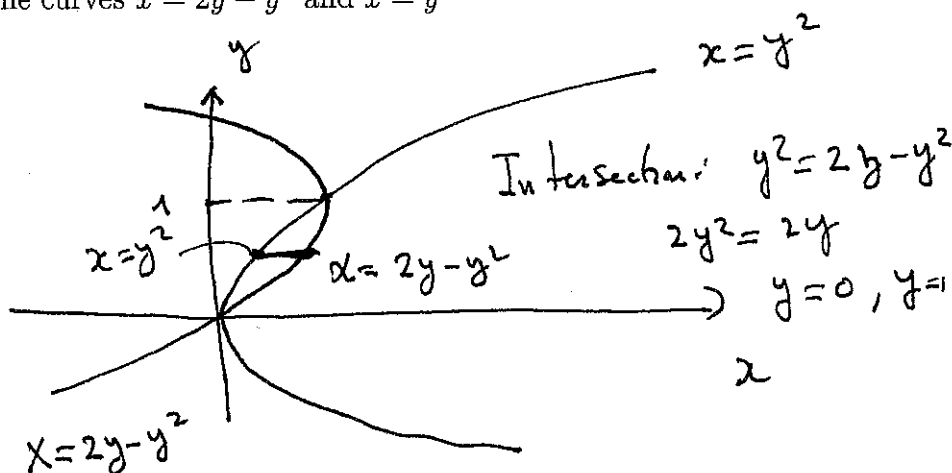
$|\vec{a} \times \vec{b}| = \sqrt{5+4} = 3$  . **Area = 3.** True.

(III)  $|\vec{a}, (\vec{b} \times \vec{c})| = \begin{vmatrix} 1 & 1 & 1 \\ 2 & -1 & 0 \\ -3 & 1 & 0 \end{vmatrix}$

$= |-1| = 1$  . True

5. Find the area enclosed by the curves  $x = 2y - y^2$  and  $x = y^2$

- A.  $\frac{1}{3}$
- B.  $\frac{1}{2}$
- C.  $\frac{2}{3}$
- D. 1
- E.  $\frac{5}{3}$

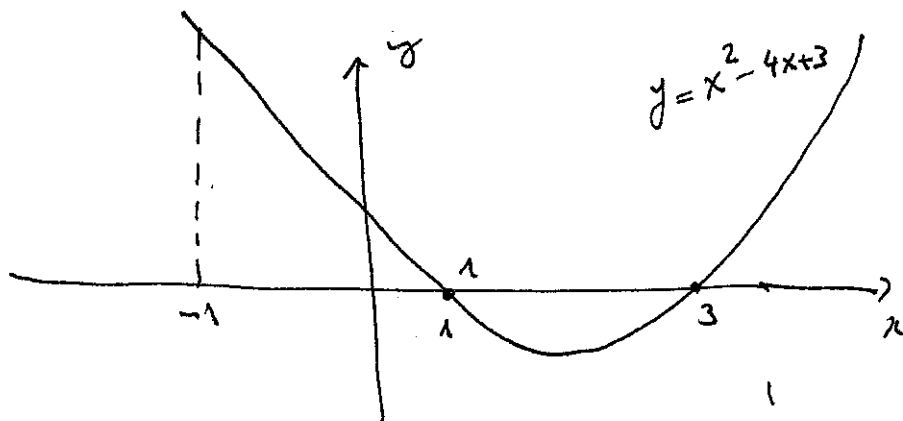


$$A = \int_0^1 (2y - y^2 - y^2) dy = \int_0^1 (2y - 2y^2) dy$$

$$= 2 \left( \frac{1}{2} - \frac{1}{3} \right) = \frac{1}{3}$$

6. Find the area of the region between the graph of  $y = x^2 - 4x + 3$ ,  $-1 \leq x \leq 1$ , and the  $x$ -axis.

- A.  $\frac{11}{3}$
- B.  $\frac{19}{3}$
- C.  $\frac{20}{3}$
- D.  $\frac{22}{3}$
- E.  $\frac{26}{3}$



$$A = \int_{-1}^1 (x^2 - 4x + 3) dx$$

$x$  is odd, so  $\int_{-1}^1 4x dx = 0$   
 $x^2 + 3$  is even

$$A = 2 \int_0^1 (x^2 + 3) dx = 2 \left( 3 + \frac{1}{3} \right) = \frac{20}{3}$$

7. Find the volume of the solid generated by revolving the region bounded by  $y = \sqrt{x}$ ,  $x = 0$  and  $y = 2$  about the  $y$ -axis.

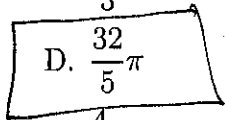
A.  $\frac{8}{3}\pi$

B.  $\frac{16}{5}\pi$

C.  $\frac{16}{3}\pi$

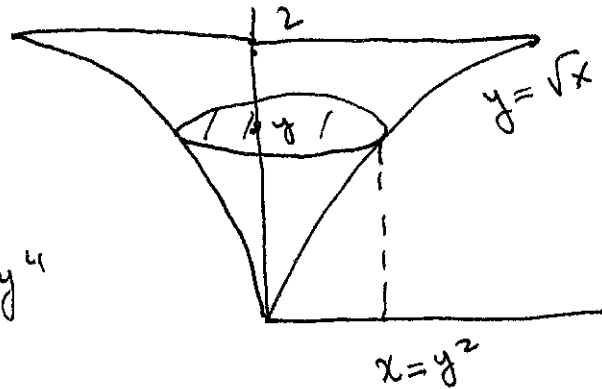
D.  $\frac{32}{5}\pi$

E.  $\frac{4}{5}\pi$



Area of the  
Cross-section.

$$A(y) = \pi y^4$$



$$V = \int_0^2 \pi y^4 dy = \pi \left. \frac{y^5}{5} \right|_0^2 = \frac{32\pi}{5}$$

8. Use the method of cylindrical shells to find the volume generated by rotating the region bounded by the curves  $y = x - x^2$  and  $y = 0$ , about the line  $x = -1$ .

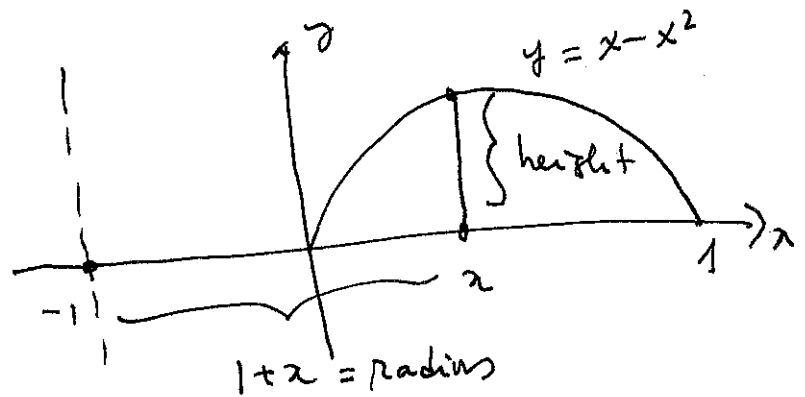
A.  $\frac{\pi}{2}$

B.  $\frac{\pi}{3}$

C.  $\frac{2\pi}{3}$

D.  $\frac{\pi}{4}$

E.  $\frac{3\pi}{4}$



$$V = 2\pi \int_0^1 (1+x)(x-x^2) dx = 2\pi \int_0^1 x(1+x)(1-x) dx$$

$$= 2\pi \int_0^1 x(1-x^2) dx = 2\pi \left( \frac{1}{2} - \frac{1}{4} \right) = \frac{\pi}{2}$$

9. A force of 50 N is required to hold a spring that has been stretched from its natural length of 1 m to a length of 1.5 m. How much work is done (in joules) by stretching the spring from a length of 2 m to a length of 3 m?

A. 75

B. 125

C. 150

D. 250

E. 300

$$F = kx; \quad F = 50 \text{ N} \quad x = \frac{1}{2} \text{ m.}$$

$$50 = \frac{k}{2}; \quad \boxed{k = 100}$$

$$W = \int_1^2 100x \, dx = 50x^2 \Big|_1^2$$

$$= 50(4-1) = 150 \text{ J}$$

10. A circular tank containing a liquid of density 10 lb/ft<sup>3</sup> has a radius of 2 ft. Its sides are 5 ft. high and the depth of the liquid is 4 ft. How much work is required (in ft.-lbs.) to pump all the liquid out over the top of the tank?

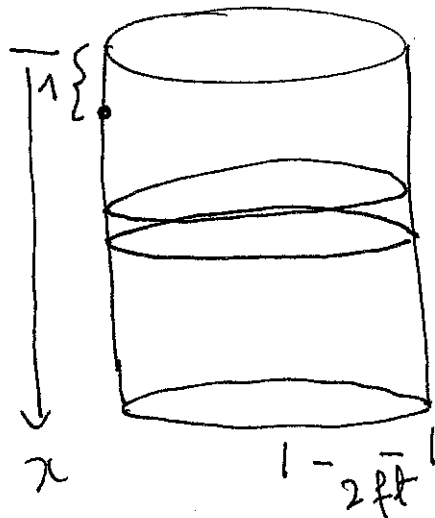
A.  $240\pi$

B.  $960\pi$

C.  $1,000\pi$

D.  $480\pi$

E.  $640\pi$



Weight of the slab

$$\underbrace{4\pi \, dx}_{\text{Volume}} \cdot \underbrace{10}_{\text{density}}$$

$$= 40\pi \, dx$$

Work to move slab to the top of the tank

$$= 40\pi x \, dx$$

$$W = \int_1^5 40\pi x \, dx = 40\pi \cdot \frac{x^2}{2} \Big|_1^5$$

$$= 20\pi (25-1) = \underline{\underline{480\pi}}$$

11. On a day in January, the temperature  $t$  hours after 8:00 am was  $T(t) = -10 + t^2$  degrees Fahrenheit. What was the average temperature between 8:00 am and 2:00 pm?

2:pm = 14:00.  
time = 6h

A. -4

B. 2

C. 4

D. 8

E. 12

$$\text{Average} = \frac{1}{6} \int_0^6 (t^2 - 10) dt$$

$$= \frac{1}{6} \left( \frac{t^3}{3} - 10t \right) \Big|_0^6$$

$$= \frac{1}{6} \left( \frac{6^3}{3} - 10 \times 6 \right)$$

$$= \frac{6^2}{3} - 10 = 12 - 10 = 2.$$

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TEST NUMBER 02

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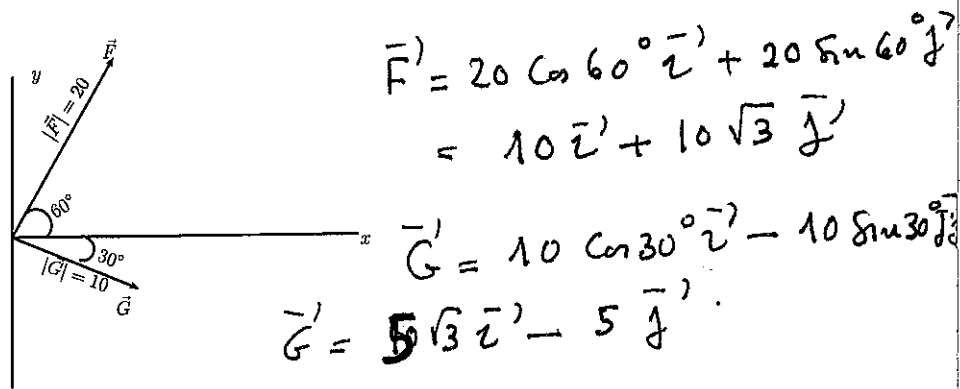
STUDENT NAME: SOLUTIONS.

STUDENT SIGNATURE: \_\_\_\_\_

STUDENT ID NUMBER: \_\_\_\_\_

SECTION NUMBER AND RECITATION INSTRUCTOR: \_\_\_\_\_





1. Let  $\vec{F}$  and  $\vec{G}$  be the two-dimensional vectors shown in the figure above. The tangent of the angle the vector  $\vec{F} + \vec{G}$  makes with the positive part of the  $x$ -axis is equal to

A.  $\frac{1+2\sqrt{3}}{2-\sqrt{3}}$

B.  $\frac{1-2\sqrt{3}}{2+\sqrt{3}}$

C.  $\frac{1+5\sqrt{3}}{2+3\sqrt{3}}$

D.  $\frac{1-5\sqrt{3}}{2-3\sqrt{3}}$

E.  $\frac{2\sqrt{3}-1}{2+\sqrt{3}}$

$$\vec{F} + \vec{G} = (10 + 5\sqrt{3}) \vec{i}' + (10\sqrt{3} - 5) \vec{j}'$$

$$\tan \theta = \frac{10\sqrt{3} - 5}{10 + 5\sqrt{3}} = \frac{5(2\sqrt{3} - 1)}{5(2 + \sqrt{3})}$$

$$\tan \theta = \frac{2\sqrt{3} - 1}{2 + \sqrt{3}}$$

2. Find the center and the radius of the sphere  $3x^2 + 3y^2 + 3z^2 - 2x - 3y + 3z = \frac{7}{6}$

A. Center  $(\frac{1}{2}, \frac{1}{2}, -\frac{1}{2})$  and radius 1

B. Center  $(\frac{1}{3}, \frac{1}{2}, -\frac{1}{2})$  and radius 1

C. Center  $(\frac{1}{2}, \frac{1}{2}, -\frac{1}{2})$  and radius 2

D. Center  $(\frac{1}{3}, \frac{1}{2}, -\frac{1}{2})$  and radius  $\frac{4}{\sqrt{18}}$

E. Center  $(\frac{1}{3}, -\frac{1}{2}, \frac{1}{2})$  and radius 1

Divide equation by 3:

$$x^2 - \frac{2}{3}x + y^2 - y + z^2 + z = \frac{7}{18}$$

$$(x - \frac{1}{3})^2 - \frac{1}{9} + (y - \frac{1}{2})^2 - \frac{1}{4} + (z + \frac{1}{2})^2 - \frac{1}{4} = \frac{7}{18}$$

$$(x - \frac{1}{3})^2 + (y - \frac{1}{2})^2 + (z + \frac{1}{2})^2 = \frac{7}{18} + \frac{1}{9} + \frac{1}{4}$$

$$(x - \frac{1}{3})^2 + (y - \frac{1}{2})^2 + (z + \frac{1}{2})^2 = 1$$

Center  $(\frac{1}{3}, \frac{1}{2}, -\frac{1}{2})$ ; Radius 1.

3. Find the number  $b$  such that the angle between the vectors  $\vec{v} = b\vec{i} - \vec{j} + \vec{k}$  and  $\vec{i}$  is equal to  $\frac{\pi}{4}$ .

A.  $b = -\sqrt{2}$

B.  $b = \sqrt{2}$

C.  $b = \sqrt{5}$

D.  $b = \sqrt{6}$

E.  $b = \sqrt{3}$

$$\vec{u} \cdot \vec{v} = |\vec{u}| \cdot |\vec{v}| \cdot \cos \theta$$

$$\vec{i} \cdot \vec{v} = b, \quad |\vec{i}| = 1; \quad |\vec{v}| = \sqrt{2+b^2}$$

$$\sqrt{2+b^2} \cdot \cos \theta = b \quad \text{if } \theta = \frac{\pi}{4}$$

$$\cos \theta = \frac{\sqrt{2}}{2}, \quad \text{So } b = \frac{\sqrt{2}}{2} \sqrt{2+b^2}$$

$$b = \frac{1}{\sqrt{2}} \sqrt{2+b^2}; \quad 2b^2 = 2+b^2;$$

$$b^2 = 2; \quad \boxed{b = \sqrt{2}}$$

$$\text{If } b = -\sqrt{2}; \quad \cos \theta = -\frac{1}{\sqrt{2}}$$

4. Which of the following statements are correct?

I) The vectors  $\vec{u} = \vec{i} + 2\vec{j} - 2\vec{k}$  and  $\vec{v} = 2\vec{i} - 2\vec{j} + \vec{k}$  are perpendicular.

II) The area of the parallelogram defined by  $\vec{a} = \vec{i} + 2\vec{j} + \sqrt{5}\vec{k}$  and  $\vec{j}$  is equal to 3.

III) The volume of the parallelepiped defined by  $\vec{a} = \vec{i} + \vec{j} + \vec{k}$ ,  $\vec{b} = 2\vec{i} - \vec{j}$  and  $\vec{c} = -3\vec{i} + \vec{j}$  is equal to 1.

$$\vec{u} \cdot \vec{v} = 2 - 4 - 2 = -4 \neq 0 \quad \text{F.}$$

A. None

B. I and III only

C. I, II and III

D. II and III only

E. III only

$$\vec{a} \times \vec{j} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 1 & 2 & \sqrt{5} \\ 0 & 1 & 0 \end{vmatrix} = -\sqrt{5}\vec{i} + \vec{k}$$

$$|\vec{a} \times \vec{j}| = \sqrt{5+1} = \sqrt{6} \quad \text{F.}$$

$$\text{Volume} = \begin{vmatrix} 1 & 1 & 1 \\ 2 & -1 & 0 \\ -3 & 1 & 0 \end{vmatrix} = \begin{vmatrix} 2 & -1 \\ -3 & 1 \end{vmatrix} = |-2| = 1 \quad \text{T}$$

5. Find the area enclosed by the curves  $x = 3y - y^2$ ,  $x = 2y^2$ .

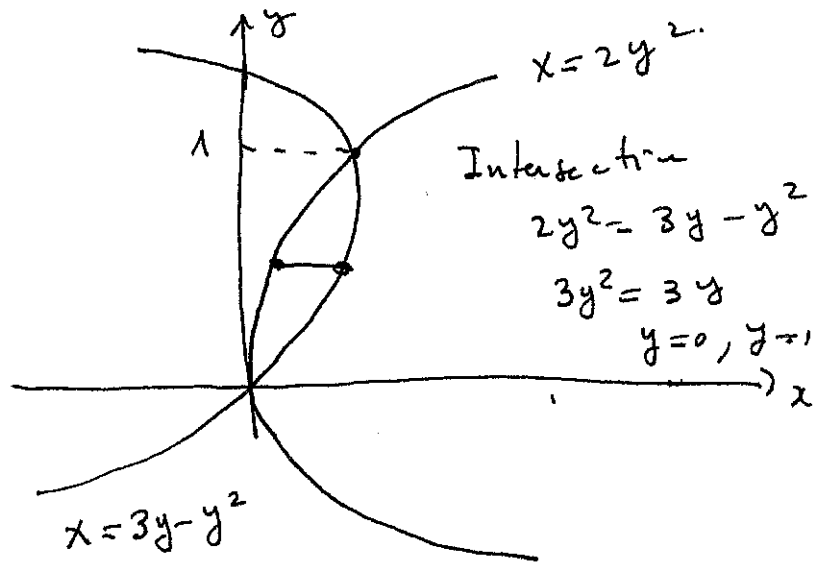
A.  $\frac{1}{3}$

B.  $\frac{1}{2}$

C.  $\frac{2}{3}$

D. 1

E.  $\frac{5}{3}$



Intersection  
 $2y^2 = 3y - y^2$   
 $3y^2 = 3y$   
 $y = 0, y = 1$

$$V = \int_0^1 (3y - y^2 - 2y^2) dy = 3 \int_0^1 (y - y^2) dy = 3 \left( \frac{1}{2} - \frac{1}{3} \right) = \frac{1}{2}$$

6. Find the area of the region between the graph of  $y = x^2 - 6x + 5$ ,  $-1 \leq x \leq 1$ , and the  $x$ -axis.

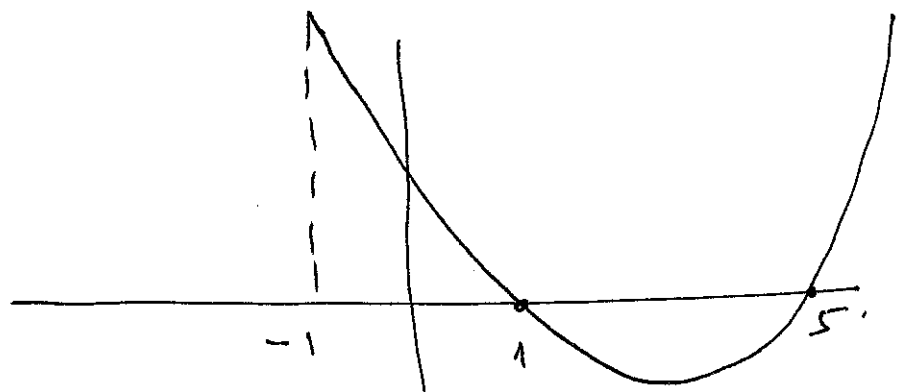
A.  $\frac{20}{3}$

B.  $\frac{22}{3}$

C.  $\frac{26}{3}$

D.  $\frac{29}{3}$

E.  $\frac{32}{3}$



$$A = \int_{-1}^1 (x^2 - 6x + 5) dx = 2 \int_0^1 (x^2 + 5) dx$$

$$= 2 \left( \frac{1}{3} + 5 \right) = \frac{32}{3}$$

Notice that  $x$  is odd  $\int_{-1}^1 x dx = 0$ ,  $x^2 + 5$  is even  $\int_{-1}^1 (x^2 + 5) dx = 2 \int_0^1 (x^2 + 5) dx$ .

7. Find the volume of the solid generated by revolving the region bounded by  $y = \frac{\sqrt{x}}{2}$ ,  $x = 0$  and  $y = 1$  about the  $y$ -axis.

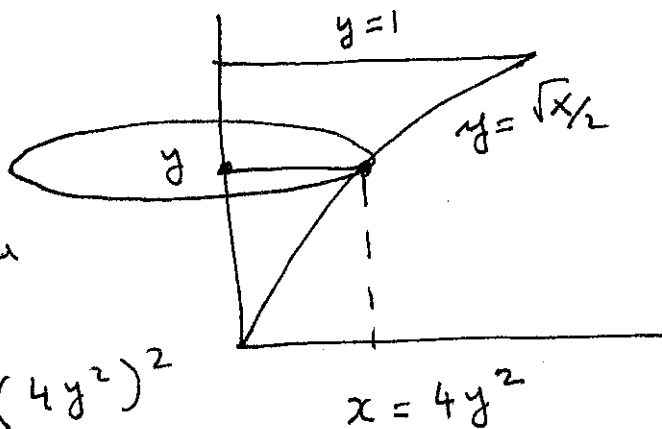
A.  $\frac{8}{3}\pi$

B.  $\frac{16}{5}\pi$

C.  $\frac{16}{3}\pi$

D.  $\frac{32}{5}\pi$

E.  $\frac{4}{5}\pi$



Area of the  
Cross-section

$$A(y) = \pi (4y^2)^2 = 16\pi y^4.$$

$$V = \int_0^1 16\pi y^4 dy = \frac{16\pi}{5} y^5 \Big|_0^1 = \frac{16\pi}{5}.$$

8. Use the method of cylindrical shells to find the volume generated by rotating the region bounded by the curves  $y = 2x - x^2$  and  $y = 0$ , about the line  $x = -2$ .

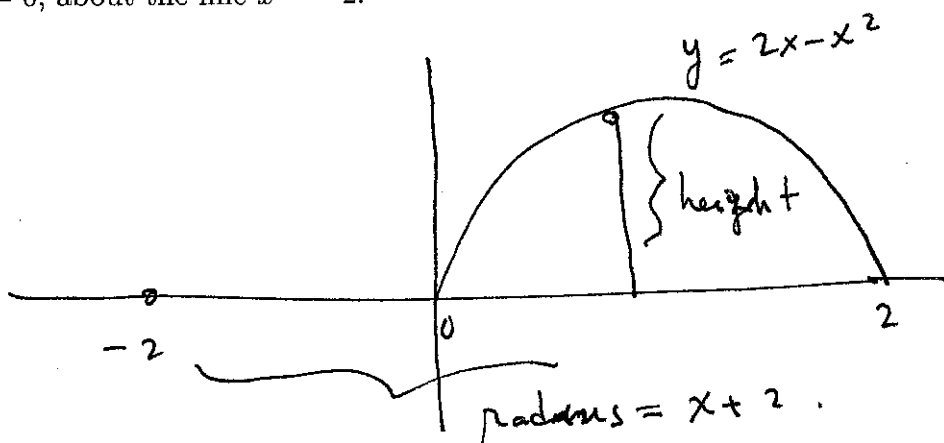
A.  $2\pi$

B.  $6\pi$

C.  $12\pi$

D.  $16\pi$

E.  $8\pi$



$$V = 2\pi \int_0^2 (x+2)(2x-x^2) dx$$

$$= 2\pi \int_0^2 x(2+x)(2-x) dx = 2\pi \int_0^2 (4x - x^3) dx = 2\pi (8 - 4) = 8\pi$$

9. A force of 120 N is required to hold a spring that has been stretched from its natural length of 1 m to a length of 2.5 m. How much work is done (in joules) by stretching the spring from a length of 3 m to a length of 4 m?

A. 160

B. 200

C. 280

D. 300

E. 320

$$F = kx ; \quad F = 120$$

$$x = 1.5$$

$$120 = 1.5k$$

$$k = 80$$

$$W = \int_2^3 80x \, dx = 40x^2 \Big|_2^3$$

$$= 40(9 - 4) = 200$$

10. A circular tank containing a liquid of density 10 lb/ft<sup>3</sup> has a radius of 4 ft. Its sides are 6 ft. high and the depth of the liquid is 4 ft. How much work is required (in ft.-lbs.) to pump all the liquid out over the top of the tank?

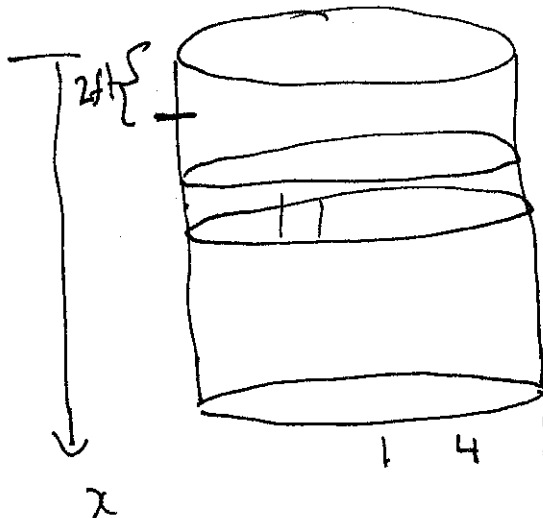
A. 3,000π

B. 5,120π

C. 2,560π

D. 1,280π

E. 2,420π



Weight of the  
 Slab =  $\underbrace{16\pi \, dx}_{\text{Volume}} \cdot \underbrace{10}_{\text{density}}$   
 $= 160\pi \, dx$

Work to move slab  
 to the top  
 $= 160\pi x \, dx$

$$W = \int_2^6 160\pi x \, dx = 80\pi x^2 \Big|_2^6$$

$$= 80\pi(36 - 4) = 80\pi \cdot 32 = 2,560\pi$$

11. On a day in January, the temperature  $t$  hours after 6:00 am was  $T(t) = -30 + t^2$  degrees Fahrenheit. What was the average temperature between 6:00 am and 3:00 pm?

A. -3

B. -5

C. 5

D. 2

E. -2

Time interval = 9h.

$$\text{Average} = \frac{1}{9} \int_0^9 (t^2 - 30) dt$$

$$= \frac{1}{9} \left( \frac{9^3}{3} - 270 \right)$$

$$= \frac{9^2}{3} - 30 = 27 - 30 = -3$$