This print-out should have 23 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

001 10.0 points

Which one of the points

$$P(-3,\,-4,\,-4),\quad Q(-6,\,8,\,9),\quad R(-5,\,3,\,-3)$$

in 3-space is closest to the yz-plane?

1. $P(-3,\,-4,\,-4)$

2. $R(-5,\,3,\,-3)$

3. $Q(-6,\,8,\,9)$

002 10.0 points

A rectangular box is constructed in 3-space with one corner at the origin and other vertices at

$$(6,0,0),\quad (0,3,0),\quad (0,0,2)\,.$$

Find the length of the diagonal of the box.

1. length $=$ 49

2. length $=$ $\sqrt{22}$

3. length $=$ 54

4. length $=$ 7

5. length $=$ $3\sqrt{6}$

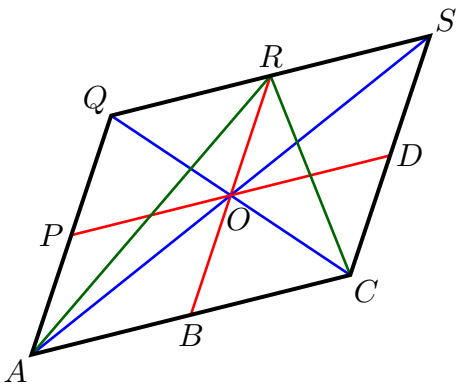
6. length $=$ 22

003 10.0 points

When $\mathbf{u}$, $\mathbf{v}$ are the displacement vectors

$$\mathbf{u} \;=\; \overrightarrow{AB}\,,\qquad \mathbf{v} \;=\; \overrightarrow{AP}\,,$$

determined by the parallelogram



express $\overrightarrow{QC}$ in terms of $\mathbf{u}$ and $\mathbf{v}$, where P, B, D and R are the midpoints of $\overline{AQ}$, $\overline{AC}$, $\overline{CS}$ and $\overline{SQ}$, respectively.

1. $\overrightarrow{QC} \;=\; 2(\mathbf{u}+\mathbf{v})$

2. $\overrightarrow{QC} \;=\; 2(\mathbf{u}-\mathbf{v})$

3. $\overrightarrow{QC} \;=\; \mathbf{u}+2\mathbf{v}$

4. $\overrightarrow{QC} \;=\; 2\mathbf{v}-\mathbf{u}$

5. $\overrightarrow{QC} \;=\; 2\mathbf{v}$

6. $\overrightarrow{QC} \;=\; 2\mathbf{u}$

004 10.0 points

Determine the vector $\mathbf{c} = 2\mathbf{a}+\mathbf{b}$ when

$$\mathbf{a} \;=\; \langle\,1\,,3\,,2\,\rangle\,,\quad \mathbf{b} \;=\; \langle\,2\,,1\,,-1\,\rangle\,.$$

1. $\mathbf{c} \;=\; \langle\,3\,,7\,,4\,\rangle$

2. $\mathbf{c} \;=\; \langle\,4\,,7\,,4\,\rangle$

3. $\mathbf{c} \;=\; \langle\,3\,,8\,,4\,\rangle$

4. $\mathbf{c} \;=\; \langle\,4\,,8\,,3\,\rangle$

5. $\mathbf{c} \;=\; \langle\,4\,,7\,,3\,\rangle$

6. $\mathbf{c} \;=\; \langle\,3\,,8\,,3\,\rangle$

005 10.0 points

Determine the vector $\mathbf{c} = \mathbf{a}+2\mathbf{b}$ when

$$\mathbf{a} \;=\; 3\mathbf{i}+2\mathbf{j}+\mathbf{k}\,,\quad \mathbf{b} \;=\; 2\mathbf{i}+\mathbf{j}+2\mathbf{k}\,.$$

1. $\mathbf{c} = 8\mathbf{i} - 3\mathbf{j} + 5\mathbf{k}$

2. $\mathbf{c} = 7\mathbf{i} + 4\mathbf{j} + 5\mathbf{k}$

3. $\mathbf{c} = 8\mathbf{i} - 3\mathbf{j} - 4\mathbf{k}$

4. $\mathbf{c} = 8\mathbf{i} + 4\mathbf{j} - 4\mathbf{k}$

5. $\mathbf{c} = 7\mathbf{i} + 4\mathbf{j} - 4\mathbf{k}$

6. $\mathbf{c} = 7\mathbf{i} - 3\mathbf{j} + 5\mathbf{k}$

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006 10.0 points

Determine the length of the vector $-2\mathbf{a} + \mathbf{b}$ when

$$\mathbf{a} = \langle 1, 2, -1 \rangle, \quad \mathbf{b} = \langle -3, -1, -2 \rangle.$$

1. length $= 2\sqrt{11}$

2. length $= \sqrt{46}$

3. length $= 4\sqrt{3}$

4. length $= 5\sqrt{2}$

5. length $= 2\sqrt{13}$

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007 10.0 points

Find all scalars λ so that $\lambda(\mathbf{a} + 2\mathbf{b})$ is a unit vector when

$$\mathbf{a} = \langle 1, 2 \rangle, \quad \mathbf{b} = \langle 1, -2 \rangle.$$

1. $\lambda = -\dfrac{1}{13}$

2. $\lambda = \dfrac{1}{13}$

3. $\lambda = -\dfrac{1}{\sqrt{13}}$

4. $\lambda = \dfrac{1}{\sqrt{13}}$

5. $\lambda = \pm\dfrac{1}{13}$

6. $\lambda = \pm\dfrac{1}{\sqrt{13}}$

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008 10.0 points

Find a unit vector $\mathbf{n}$ with the same direction as the vector

$$\mathbf{v} = 3\,\mathbf{i} + 6\,\mathbf{j} - 2\,\mathbf{k}.$$

1. $\mathbf{n} = \dfrac{3}{7}\,\mathbf{i} + \dfrac{6}{7}\,\mathbf{j} - \dfrac{2}{7}\,\mathbf{k}$

2. $\mathbf{n} = \dfrac{1}{3}\,\mathbf{i} - \dfrac{2}{3}\,\mathbf{j} + \dfrac{2}{9}\,\mathbf{k}$

3. $\mathbf{n} = \dfrac{1}{3}\,\mathbf{i} + \dfrac{2}{3}\,\mathbf{j} - \dfrac{2}{9}\,\mathbf{k}$

4. $\mathbf{n} = \dfrac{3}{10}\,\mathbf{i} - \dfrac{3}{5}\,\mathbf{j} + \dfrac{1}{5}\,\mathbf{k}$

5. $\mathbf{n} = \dfrac{3}{7}\,\mathbf{i} - \dfrac{6}{7}\,\mathbf{j} + \dfrac{2}{7}\,\mathbf{k}$

6. $\mathbf{n} = \dfrac{3}{10}\,\mathbf{i} + \dfrac{3}{5}\,\mathbf{j} - \dfrac{1}{5}\,\mathbf{k}$

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009 10.0 points

Determine the dot product of the vectors

$$\mathbf{a} = \langle -1, -2, 3 \rangle, \quad \mathbf{b} = \langle 1, -3, 1 \rangle.$$

1. $\mathbf{a} \cdot \mathbf{b} = 6$

2. $\mathbf{a} \cdot \mathbf{b} = 2$

3. $\mathbf{a} \cdot \mathbf{b} = 8$

4. $\mathbf{a} \cdot \mathbf{b} = 4$

5. $\mathbf{a} \cdot \mathbf{b} = 0$

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010 10.0 points

Determine the dot product of the vectors

$$\mathbf{a} = 2\mathbf{i} + \mathbf{j} - 3\mathbf{k}, \quad \mathbf{b} = 3\mathbf{i} + 2\mathbf{j} - \mathbf{k}.$$

1. $\mathbf{a} \cdot \mathbf{b} = 9$

2. $\mathbf{a} \cdot \mathbf{b} = 13$

3. $\mathbf{a} \cdot \mathbf{b} = 15$

4. $\mathbf{a} \cdot \mathbf{b} = 17$

5. $\mathbf{a} \cdot \mathbf{b} = 11$

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011 10.0 points

Determine the dot product of vectors $\mathbf{a}$, $\mathbf{b}$ when

$$|\mathbf{a}| = 3\,, \qquad |\mathbf{b}| = 6$$

and the angle between $\mathbf{a}$ and $\mathbf{b}$ is $\pi/3$.

1. $\mathbf{a} \cdot \mathbf{b} = \dfrac{19}{2}$

2. $\mathbf{a} \cdot \mathbf{b} = 9$

3. $\mathbf{a} \cdot \mathbf{b} = 10$

4. $\mathbf{a} \cdot \mathbf{b} = \dfrac{21}{2}$

5. $\mathbf{a} \cdot \mathbf{b} = \dfrac{17}{2}$

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012 10.0 points

Find the angle between the vectors

$$\mathbf{a} = \langle\, -2\sqrt{3},\, 1 \,\rangle\,, \quad \mathbf{b} = \langle\, -3\sqrt{3},\, -5 \,\rangle\,.$$

1. angle $= \dfrac{\pi}{4}$

2. angle $= \dfrac{5\pi}{6}$

3. angle $= \dfrac{3\pi}{4}$

4. angle $= \dfrac{\pi}{6}$

5. angle $= \dfrac{2\pi}{3}$

6. angle $= \dfrac{\pi}{3}$

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013 10.0 points

Which, if any, of the following pairs of vectors are perpendicular?

I. $\langle\, 3,\, 2 \,\rangle\,, \quad \langle\, 4,\, -6 \,\rangle\,,$

II. $\mathbf{i} + 5\mathbf{j} - 2\mathbf{k}\,, \quad 3\mathbf{i} - 2\mathbf{j} - 4\mathbf{k}\,.$

1. both of them

2. II only

3. I only

4. neither of them

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014 10.0 points

Find the scalar projection of $\mathbf{b}$ onto $\mathbf{a}$ when

$$\mathbf{b} = \langle\, -5,\, 4 \,\rangle\,, \qquad \mathbf{a} = \langle\, 4,\, -3 \,\rangle\,.$$

1. scalar projection $= -\dfrac{31}{5}$

2. scalar projection $= -\dfrac{32}{5}$

3. scalar projection $= -\dfrac{33}{5}$

4. scalar projection $= -\dfrac{29}{5}$

5. scalar projection $= -6$

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015 10.0 points

Find the scalar projection of $\mathbf{b}$ onto $\mathbf{a}$ when

$$\mathbf{b} = 2\,\mathbf{i} + \mathbf{j} + 3\,\mathbf{k}\,, \quad \mathbf{a} = 2\,\mathbf{i} - 2\,\mathbf{j} - \mathbf{k}\,.$$

1. scalar projection $= \dfrac{2}{3}$

2. scalar projection $= -\dfrac{1}{3}$

3. scalar projection $= 0$

4. scalar projection $= 1$

5. scalar projection $= \dfrac{1}{3}$

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016 10.0 points

Find the vector projection of $\mathbf{b}$ onto $\mathbf{a}$ when

$$\mathbf{b} = \langle -2, -1 \rangle, \qquad \mathbf{a} = \langle -1, -3 \rangle.$$

1. vector proj. $= \dfrac{7}{10}\langle -1, -3 \rangle$

2. vector proj. $= \dfrac{1}{2}\langle -2, -1 \rangle$

3. vector proj. $= \dfrac{7}{\sqrt{10}}\langle -1, -3 \rangle$

4. vector proj. $= \dfrac{1}{2}\langle -1, -3 \rangle$

5. vector proj. $= \dfrac{7}{\sqrt{10}}\langle -2, -1 \rangle$

6. vector proj. $= \dfrac{5}{\sqrt{10}}\langle -2, -1 \rangle$

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017 10.0 points

Find the vector projection of $\mathbf{b}$ onto $\mathbf{a}$ when

$$\mathbf{b} = 2\,\mathbf{i} + 2\,\mathbf{j} + \mathbf{k}, \quad \mathbf{a} = 3\,\mathbf{i} - \mathbf{j} + 2\,\mathbf{k}.$$

1. vector proj. $= \dfrac{14}{9}(2\,\mathbf{i} + 2\,\mathbf{j} + \mathbf{k})$

2. vector proj. $= \dfrac{2}{3}(2\,\mathbf{i} + 2\,\mathbf{j} + \mathbf{k})$

3. vector proj. $= \dfrac{2}{3}(3\,\mathbf{i} - \mathbf{j} + 2\,\mathbf{k})$

4. vector proj. $= \dfrac{14}{9}(3\,\mathbf{i} - \mathbf{j} + 2\,\mathbf{k})$

5. vector proj. $= \dfrac{3}{7}(3\,\mathbf{i} - \mathbf{j} + 2\,\mathbf{k})$

6. vector proj. $= \dfrac{3}{7}(2\,\mathbf{i} + 2\,\mathbf{j} + \mathbf{k})$

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018 10.0 points

Find the value of the determinant

$$D = \begin{vmatrix} 1 & 2 & -1 \\ -3 & -2 & -2 \\ -1 & 1 & -3 \end{vmatrix}.$$

1. $D = -3$

2. $D = -1$

3. $D = 5$

4. $D = 3$

5. $D = 1$

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019 10.0 points

Find the cross product of the vectors

$$\mathbf{a} = 2\mathbf{i} - 3\mathbf{j} - 2\mathbf{k}, \quad \mathbf{b} = \mathbf{i} + \mathbf{j} + 2\mathbf{k}.$$

1. $\mathbf{a} \times \mathbf{b} = -4\mathbf{i} - 5\mathbf{j} + 5\mathbf{k}$

2. $\mathbf{a} \times \mathbf{b} = -3\mathbf{i} - 6\mathbf{j} + 4\mathbf{k}$

3. $\mathbf{a} \times \mathbf{b} = -3\mathbf{i} - 5\mathbf{j} + 4\mathbf{k}$

4. $\mathbf{a} \times \mathbf{b} = -4\mathbf{i} - 6\mathbf{j} + 4\mathbf{k}$

5. $\mathbf{a} \times \mathbf{b} = -3\mathbf{i} - 6\mathbf{j} + 5\mathbf{k}$

6. $\mathbf{a} \times \mathbf{b} = -4\mathbf{i} - 6\mathbf{j} + 5\mathbf{k}$

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020 10.0 points

Find the cross product of the vectors

$$\mathbf{a} = \langle -1, 1, 3 \rangle, \quad \mathbf{b} = \langle 1, -3, 1 \rangle.$$

1. $\mathbf{a} \times \mathbf{b} = \langle 11, 4, 1 \rangle$

2. $\mathbf{a} \times \mathbf{b} = \langle 11, -7, 1 \rangle$

3. $\mathbf{a} \times \mathbf{b} = \langle 11, 4, 2 \rangle$

4. $\mathbf{a} \times \mathbf{b} = \langle 10, 4, 2 \rangle$

5. $\mathbf{a} \times \mathbf{b} = \langle 10, -7, 1 \rangle$

6. $\mathbf{a} \times \mathbf{b} = \langle\, 10,\, -7,\, 2\,\rangle$

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021 10.0 points

Determine all unit vectors $\mathbf{v}$ orthogonal to

$$\mathbf{a} = \mathbf{i} + 4\,\mathbf{j} + 3\mathbf{k}, \quad \mathbf{b} = 2\,\mathbf{i} + 6\,\mathbf{j} + 3\,\mathbf{k}\,.$$

1. $\mathbf{v} = \pm\Big(\dfrac{3}{7}\,\mathbf{i} - \dfrac{6}{7}\,\mathbf{j} - \dfrac{2}{7}\,\mathbf{k}\Big)$

2. $\mathbf{v} = -\dfrac{6}{7}\,\mathbf{i} + \dfrac{3}{7}\,\mathbf{j} - \dfrac{2}{7}\,\mathbf{k}$

3. $\mathbf{v} = -3\,\mathbf{i} + 6\,\mathbf{j} + 2\,\mathbf{k}$

4. $\mathbf{v} = -\dfrac{3}{7}\,\mathbf{i} + \dfrac{6}{7}\,\mathbf{j} - \dfrac{2}{7}\,\mathbf{k}$

5. $\mathbf{v} = \pm\Big(\dfrac{6}{7}\,\mathbf{i} - \dfrac{3}{7}\,\mathbf{j} + \dfrac{2}{7}\,\mathbf{k}\Big)$

6. $\mathbf{v} = -6\,\mathbf{i} + 3\,\mathbf{j} - 2\,\mathbf{k}$

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022 10.0 points

Find the area of the triangle having vertices

$$P(-3,\, -1)\,, \quad Q(-2,\, -2)\,, \quad R(3,\, 3)\,.$$

1. area $= 5$

2. area $= \dfrac{9}{2}$

3. area $= 4$

4. area $= 6$

5. area $= \dfrac{11}{2}$

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023 10.0 points

Find a vector $\mathbf{v}$ orthogonal to the plane through the points

$$P(5, 0, 0), \;\; Q(0, 4, 0), \;\; R(0, 0, 2)\,.$$

1. $\mathbf{v} = \langle 8, 5, 20 \rangle$

2. $\mathbf{v} = \langle 8, 2, 20 \rangle$

3. $\mathbf{v} = \langle 4, 10, 20 \rangle$

4. $\mathbf{v} = \langle 8, 10, 20 \rangle$

5. $\mathbf{v} = \langle 2, 10, 20 \rangle$