This print-out should have 13 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

001 10.0 points

The equality

$$\mathbf{v} \cdot \mathbf{v} \;=\; \|\mathbf{v}\|^2$$

holds for all vectors $\mathbf{v}$ in $\mathbb{R}^n$.

True or False?

1. TRUE
2. FALSE

002 10.0 points

For $\mathbf{u}$ and $\mathbf{v}$ in $\mathbb{R}^n$ and any scalar c,

$$\mathbf{u} \cdot (c\mathbf{v}) \;=\; c(\mathbf{u} \cdot \mathbf{v})$$

True or False?

1. FALSE
2. TRUE

003 10.0 points

Which of the following statements are true for all vectors $\mathbf{a}$, $\mathbf{b}$?

A. $\|\mathbf{a} + \mathbf{b}\|^2 \;=\; \|\mathbf{a}\|^2 + 2\,\mathbf{a} \cdot \mathbf{b} + \|\mathbf{b}\|^2$,

B. $|\mathbf{a} \cdot \mathbf{b}| \;=\; \|\mathbf{a}\|\,\|\mathbf{b}\|,\ \mathbf{a} \neq 0,\ \mathbf{b} \neq 0 \implies \mathbf{a} \perp \mathbf{b}$,

C. $\mathbf{a} \cdot \mathbf{b} = 0 \implies \mathbf{a} = 0$ or $\mathbf{b} = 0$.

1. C only
2. none of them
3. B and C only
4. B only
5. A only
6. all of them
7. A and C only
8. A and B only

004 10.0 points

The equality

$$\mathbf{u} \cdot \mathbf{v} \;=\; \mathbf{v} \cdot \mathbf{u}$$

holds for all $\mathbf{u}$ and $\mathbf{v}$ in $\mathbb{R}^n$.

True or False?

1. TRUE
2. FALSE

005 10.0 points

For all $\mathbf{v}$ in $\mathbb{R}^n$ and a any scalar c,

$$\|c\mathbf{v}\| \;=\; c\|\mathbf{v}\|$$

True or False?

1. FALSE
2. TRUE

006 10.0 points

Simplify the expression

$$(\mathbf{u} + 2\mathbf{v}) \cdot (\mathbf{u} - 3\mathbf{v}) - \|2\mathbf{u} - 3\mathbf{v}\|^2$$

for vectors $\mathbf{u}$, $\mathbf{v}$ in $\mathbb{R}^n$.

1. $3\|\mathbf{u}\|^2 + 7\,\mathbf{u} \cdot \mathbf{v} + 15\|\mathbf{v}\|^2$
2. $3\|\mathbf{u}\|^2 + 7\,\mathbf{u} \cdot \mathbf{v} - 15\|\mathbf{v}\|^2$
3. $-3\|\mathbf{u}\|^2 + 7\,\mathbf{u} \cdot \mathbf{v} + 15\|\mathbf{v}\|^2$
4. $-3\|\mathbf{u}\|^2 + 11\,\mathbf{u} \cdot \mathbf{v} + 15\|\mathbf{v}\|^2$
5. $-3\|\mathbf{u}\|^2 + 11\,\mathbf{u} \cdot \mathbf{v} - 15\|\mathbf{v}\|^2$
6. $3\|\mathbf{u}\|^2 - 11\,\mathbf{u} \cdot \mathbf{v} - 15\|\mathbf{v}\|^2$

007 10.0 points

An example of a linear combination of vectors $\mathbf{v}_1$ and $\mathbf{v}_2$ is the vector $-2\mathbf{v}_1$.

True or False?

1. FALSE
2. TRUE

008 10.0 points

When

$$\mathbf{u} \;=\; \begin{bmatrix} -2 \\ 5 \end{bmatrix}, \quad \mathbf{v} \;=\; \begin{bmatrix} -5 \\ 2 \end{bmatrix},$$

then the vectors in Span{**u**, **v**} lie on a line through the origin.

True or False?

1. TRUE
2. FALSE

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009 10.0 points

When **u**, **v** are nonzero vectors, then Span{**u**, **v**} contains the line through **u** and the origin, as well as the line through **v** and the origin.

True or False?

1. TRUE
2. FALSE

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010 10.0 points

Determine a so that the vector

$$\mathbf{u} = \begin{bmatrix} 2 \\ -9 \end{bmatrix}$$

is a linear combination $\mathbf{u} = a\mathbf{v} + b\mathbf{w}$ of vectors

$$\mathbf{v} = \begin{bmatrix} 2 \\ -1 \end{bmatrix}, \qquad \mathbf{w} = \begin{bmatrix} 2 \\ 3 \end{bmatrix}.$$

1. $a = -3$
2. $a = 1$
3. $a = 3$
4. $a = 2$
5. $a = -2$

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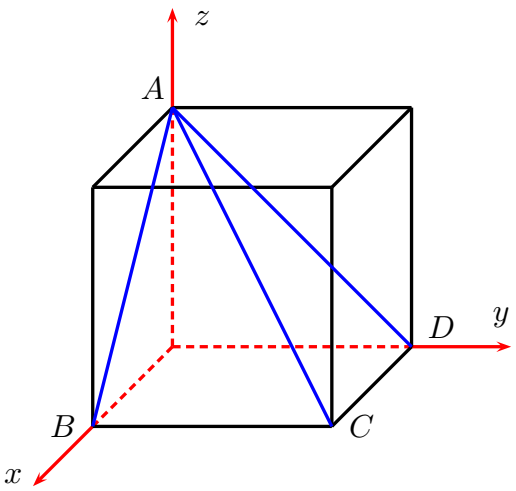
011 10.0 points

The box shown in



is the unit cube having one corner at the origin and the coordinate planes for three of its faces.

Find the cosine of the angle θ between $\overrightarrow{AB}$ and $\overrightarrow{AC}$.

1. $\cos\theta = \dfrac{1}{\sqrt{2}}$

2. $\cos\theta = \dfrac{1}{\sqrt{3}}$

3. $\cos\theta = 0$

4. $\cos\theta = \dfrac{1}{2}$

5. $\cos\theta = \dfrac{\sqrt{3}}{2}$

6. $\cos\theta = \sqrt{\dfrac{2}{3}}$

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012 10.0 points

A triangle ΔPQR in 3-space has vertices

$$P(-1,-2,-3), \quad Q(3,0,-4), \quad R(-2,1,-1).$$

Use vectors to decide which one of the following properties the triangle has.

1. *right-angled at Q*
2. *right-angled at P*
3. *not right-angled at P, Q, or R*
4. *right-angled at R*

013 10.0 points

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

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

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

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

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

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

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

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