1. Give an equation for the plane in space which is perpendicular to the x-axis at the point (1, 0, 0).

A) $x = 0$

B) $x + y = 1$

C) $x + z = 1$

D) $x = 1$

E) $z = 1$

F) $x - z = 1$

G) $y = 3$

H) $xy = 1$

I) $x^2 + z^2 = 1$

J) none of the above

2. Find an equation for the sphere with radius r = 2 and center (1, -1, 3).

A) $x^2 + y^2 + z^2 + x - y + 3z = 4$

B) $x^2 + y^2 + z^2 - x + y - 3z = 2$

C) $x^2 + y^2 + z^2 + 2x + 2y - 6z = 4$

D) $x^2 + y^2 + z^2 + x - y + 3z = 2$

E) $x^2 + y^2 + z^2 - x + y - 3z = 4$

F) $x^2 + y^2 + z^2 - 2x + 2y - 6z + 7 = 0$

G) $x^2 + y^2 + z^2 - 2x + 2y - 6z + 4 = 0$

H) $x^2 + y^2 + z^2 + 2x + 2y + 6z - 7 = 0$

I) $x^2 + y^2 + z^2 - x - y + 6z + 7 = 0$

J) none of the above

3. Find the midpoint of the line segment from the point (1, -2, 2) to the point (3, 0, 4).

A) (1, 2, 3)

B) (2, -1 ,0)

C) (2, 1, 2)

D) (1, -1 , 3)

E) (3 , 2, 1)

F) (-2 , 1, 3)

G) (-3 , 2, 4)

H) (-2, 2, 0)

I) (2, -1, 3)

J) none of the above

4. Find the unit vector in the direction of $\mathbf{v} = -2\mathbf{i} + 2\mathbf{j} + \mathbf{k}$

A) $< -2, 2, 1 >$

B) $< 2/3, -2/3, 1/3 >$

C) $< -2/3, 2/3, 1/3 >$

D) $< 1, 0, 0 >$

E) $< 2/5, -2/5, 1/5 >$

F) $< 2/5, 2/5, 1/5 >$

G) $< 1/3, 2/3, 2/3 >$

H) $< -1/5, -2/5, 2/5 >$

I) $< 2/5, 1/3, 1/5 >$

J) none of the above

5. Let $\mathbf{v} = \langle 1, -2, 3 \rangle$. Which of the following vectors is perpendicular to $\mathbf{v}$?

I) $\langle 2, -4, 6 \rangle$ II) $\langle 1, 2, 1 \rangle$ III) $\langle 0, 3, 2 \rangle$

A) I

B) II

C) III

D) I, II

E) I,III

F) II, III

G) all of them

H) none of them

6. Let θ be the acute angle from $\mathbf{a} = \mathbf{I} - 2\mathbf{j} + \mathbf{k}$ to $\mathbf{b} = 3\mathbf{j} - \mathbf{k}$. Find $\cos\theta$ correct to 4 decimal places.

A) 0.0000

B) 1.0000

C) -1.0000

D) 0.1279

E) -0.1279

F) 0.5923

G) -0.5923

H) 0.9037

I) -0.9037

J) none of the above

7. Let $\mathbf{a} = \mathbf{I} - 2\mathbf{j} + \mathbf{k}$ and $\mathbf{b} = 3\mathbf{j} - \mathbf{k}$. Calculate the cross product $\mathbf{a} \times \mathbf{b}$.

A) $\langle -1, 1, 3 \rangle$

B) $\langle -5, -1, 3 \rangle$

C) $\langle 1, -1, 3 \rangle$

D) $\langle 5, 1, 3 \rangle$

E) $\langle 2, 2, 4 \rangle$

F) $\langle -2, 2, -4 \rangle$

G) $\langle 3, 0, 5 \rangle$

H) $\langle -3, 0, 5 \rangle$

I) $\langle -3, 5, 0 \rangle$

J) none of the above

8. Let Π be the plane containing the three points $(1, 1, 1)$, $(2, 1, 3)$ and $(3, -1, 1)$. Find a normal vector $\mathbf{n}$ for Π such that $\mathbf{n}$ has length 1 and a positive first component.

A) $\langle 2, 2, 1 \rangle$

B) $\langle 2/3, -2/3, 1/3 \rangle$

C) $\langle 2/3, 2/3, -1/3 \rangle$

D) $\langle 1, 0, 0 \rangle$

E) $\langle 2/5, -2/5, 1/5 \rangle$

F) $\langle 2/5, 2/5, 1/5 \rangle$

G) $\langle 1/3, 2/3, 2/3 \rangle$

H) $\langle 1/5, -2/5, 2/5 \rangle$

I) $\langle 2/5, 1/3, 1/5 \rangle$

J) none of the above

9. Let L be the line on the point (2, 4, 5) which is perpendicular to the plane $3x + 7y - 5z - 2 = 0$. Find a direction vector for L.

A) $< 3, 7, 2 >$

B) $< 3, 7, -2 >$

C) $< 7, 5, 2 >$

D) $< 7, -5, 2 >$

E) $< 3, 7, -5 >$

F) $< 3, 7, 5 >$

G) $< -3, 5, 2 >$

H) $< 2, 4, 5 >$

I) $< -2, -4, -5 >$

J) none of the above

10. Find the distance from the point (2, 2, 3) to the plane $2x + y + 2z - 4 = 0$.

A) 0

B) 1/4

C) 1/3

D) 1/2

E) 1

F) 4/3

G) 2

H) 8/3

I) 3

J) none of the above

11. Let $\mathbf{r}(t) = \langle t, \sin t, \cos t \rangle$. Let $\mathbf{T}(t)$ be the unit tangent vector (the vector of length 1 in the direction of $\mathbf{r}'(t)$). Find $\mathbf{T}(\pi/2)$.

A) $\langle 1, 0, 0 \rangle$

B) $\langle 0, 1, 0 \rangle$

C) $\langle 0, 0, 1 \rangle$

D) $\langle \frac{1}{\sqrt{2}}, 0, \frac{1}{\sqrt{2}} \rangle$

E) $\langle \frac{1}{\sqrt{2}}, 0, -\frac{1}{\sqrt{2}} \rangle$

F) $\langle -\frac{1}{\sqrt{2}}, 0, -\frac{1}{\sqrt{2}} \rangle$

G) $\langle -1, 0, 0 \rangle$

H) $\langle \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}} \rangle$

I)) $\langle \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, -\frac{1}{\sqrt{3}} \rangle$

J) none of the above

12. Let $\mathbf{u}(t) = \langle \cos t,\ \sin t,\ t \rangle$ and $\mathbf{v}(t) = \langle t,\ 2,\ t^3 \rangle$. Let $f(t)$ be the dot product of $\mathbf{u}(t)$ and $\mathbf{v}(t)$, so $f(t) = \mathbf{u}(t) \cdot \mathbf{v}(t)$. Find $f'(0)$.

A) 0

B) 1

C) -1

D) 2

E) -2

F) 3

G) -3

H) 4

I) -4

J) none of the above

13. Evaluate $\int_0^1 < (6-6t), 3\sqrt{t}, t^2 > dt.$

A) < -2, 2, 1 >

B) < 3, 2, 1/3 >

C) < -2/3, 2/3, 1/3 >

D) < 1, 0, 0 >

E) < 2/5, -2/5, 1/5 >

F) < 2/5, 2/5, 1/5>

G) < 1/3, 2/3, 2/3 >

H) < -1/5, -2/5, 2/5>

I) < 2/5, 1/3, 1/5>

J) none of the above

14. A projectile is fired from the origin over a flat plane, with no air resistance. The cannon is inclined at an angle of 60 degrees above the horizontal, and the muzzle velocity is 700 meters per second. To the nearest kilometer, what is the range?

A) 13

B) 17

C) 21

D) 28

E) 34

F) 39

G) 43

H) 47

I) 50

J) none of the above

15. Find the arc length of the space curve swept out by $r(t) = \langle t, 0, \frac{2}{3}t^{3/2} \rangle$ as the parameter t varies from 0 to 8.

A) 1/3

B) 4

C) 23/3

D) 7

E) 56/5

F) 52/3

G) 61/5

H) 58/3

I) 13

J) none of the above

Name:_____ ID#_____

Hand graded problem. 25 points. Show your work to allow for partial credit. Use reverse side of this sheet if needed.

Suppose a particle moves in 3-space in such a way that its position at time t is given by the vector

$\mathbf{r}(t) = \langle 3t + 1, \sqrt{t}, t^2 \rangle$. Find: i) its velocity $\mathbf{v}(t)$; ii) its speed $s(t)$; iii) its acceleration $\mathbf{a}(t)$; the unit tangent vector when $t = 1$, $\mathbf{T}(1)$; v) the acute angle between the velocity and acceleration vectors when $t = 1$.