(6 pt) 1. Which vector is perpendicular to the plane containing the points

$$(1, 2, -3),\ (0, 1, 1),\ \text{and}\ (-2, 0, 0)?$$

A. $5\vec{i} - 9\vec{j} - \vec{k}$

B. $5\vec{i} + 9\vec{j} + 5\vec{k}$

C. $10\vec{i} + 6\vec{j} + \vec{k}$

D. $5\vec{i} + 9\vec{j} + \vec{k}$

E. $16\vec{i} - 6\vec{j} - \vec{k}$

(6 pt) 2. The traces of the surface $x^2 - y^2 + z^2 = 1$ in the planes $x = 1,\ y = 2$, and $z = 3$ are respectively

A. pair of lines, hyperbola, hyperbola

B. pair of lines, circle, hyperbola

C. a hyperbola, hyperbola, pair of lines

D. pair of lines, hyperbola, circle

E. circle, pair of lines, hyperbola

(6 pt) 3. Determine the value of b such that the line with parametric equations

$$x = 2t + 1, \qquad y = 3t - 1, \qquad z = t + 2$$

is parallel to the plane

$$x - by + 2bz = 6$$

A. $b = -2$

B. $b = -1$

C. $b = 0$

D. $b = 1$

E. $b = 2$

(6 pt) 4. The point $(-1, 1, \sqrt{\frac{2}{3}})$ in rectangular coordinates has spherical coordinates (ρ, θ, φ):

A. $(2\sqrt{\frac{2}{3}}, \pi/4, \pi/3)$

B. $(2\sqrt{\frac{2}{3}}, \frac{3\pi}{4}, \pi/3)$

C. $(2\sqrt{\frac{2}{3}}, \frac{\pi}{4}, \pi/6)$

D. $(\sqrt{\frac{2}{3}}, \frac{\pi}{4}, \pi/6)$

E. $(2, \frac{3\pi}{4}, \pi/3)$

(6pt) 5. Find the point P on the curve

$$\vec{r}(t) = t\vec{i} + t^2\vec{j} + t^3\vec{k}$$

at which the tangent vector is parallel to the vector $\langle 2, 4, 6\rangle$. P has coordinates

A. $(1, 1, 1)$

B. $(2, 4, 12)$

C. $(1, 2, 3)$

D. $(1, 1, -1)$

E. $(0, 0, 0)$

(7 pt) 6. The curvature $k(t)$ of the curve

$$\vec{r}(t) = \frac{t}{\sqrt{2}}\vec{i} + \sin\ \frac{t}{\sqrt{2}}\vec{j} + \cos\ \frac{t}{\sqrt{2}}\vec{k}$$

is

A. t

B. 1

C. $t/2$

D. $1/2$

E. $\sqrt{2}\,t$

(7 pt) 7. The portion of the helix

$$\vec{r}(t) = 2\cos t\vec{i} + 2\sin t\vec{j} + \sqrt{5}\ t\vec{k},\ 0 \le t \le \pi/2$$

has length

A. 3π

B. 6π

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

D. 4π

E. $3\pi/4$

(7 pt) 8. A particle travels with velocity $\vec{v}(t) = 2\vec{i} - 4t\vec{j} + 3t\vec{k}$. At $t = 1$ the position vector at the particle is $3\vec{i} + \vec{j} + 5\vec{k}$. What is the position vector of the particle at time $t = 0$?

A. $\vec{i} + 3\vec{j} + 4\vec{k}$

B. $\vec{i} + 3\vec{j} + \frac{14}{3}\ \vec{k}$

C. $2\vec{i} - 2\vec{j} + \vec{k}$

D. $-2\vec{i} + 2\vec{j} - \vec{k}$

E. $\vec{i} + 3\vec{j} + \frac{7}{2}\ \vec{k}$

(7 pt) 9. Find $\dfrac{\partial f}{\partial x}$ if $f(x,y) = xy\sin(x^2y)$.

A. $y\sin(x^2y)+2x^2y\cos(x^2y)$

B. $y\sin(x^2y)+2x^2y\sin(x^2y)$

C. $y\sin(x^2y)+2x^2y^2\cos(x^2y)$

D. $x\sin(x^2y)+2x^2y\sin(x^2y)$

E. $x\cos(x^2y)+2x^2y^2\cos(x^2y)$

(7 pt) 10. The level curves of $f(x,y) = 3x^2 - y^2$

A. are always hyperbolas

B. are always lines

C. are always points

D. are sometimes hyperbolas and sometimes pairs of lines

E. are sometimes hyperbolas and sometimes points

(7 pt) 11. A parameterization of a curve that begins at $2\vec{i}$ when $t = 0$ and travels on the circle $x^2 + y^2 = 4$ in a clockwise direction is:

A. $\vec{r}(t) = 2\cos t\vec{i} + 2\sin t\vec{j}$

B. $\vec{r}(t) = -2\cos t\vec{i} + 2\sin t\vec{j}$

C. $\vec{r}(t) = 2\cos t\vec{i} - 2\sin t\vec{j}$

D. $\vec{r}(t) = 2\sin t\vec{i} + 2\cos t\vec{j}$

E. $\vec{r}(t) = 2\sin t\vec{i} - 2\cos t\vec{j}$

(7 pt) 12. Let $x^2 + y^2 + z^2 - x - y - 3z = 58$. Then at $(3, 4, -5)$, $\dfrac{\partial z}{\partial x} =$

A. $-1/13$

B. $6/13$

C. $-5/7$

D. $5/13$

E. $1/3$

(7 pt) 13. Find $\lim_{h \to 0} \dfrac{e^{x(h+2)^2} - e^{4x}}{h}$

A. $2xe^{4x}$

B. $4xe^{4x}$

C. 0

D. does not exist

E. e^{4x}

(7 pt) 14. Let $f(x, y) = x^2 - 2y^2 + 3x$. In what direction from $(1, 2)$ should we proceed so that the change in f in that direction would increase most rapidly?

A. toward $(6, -6)$

B. toward $(0, 0)$

C. toward $(5, -8)$

D. toward $(4, -6)$

E. toward $(-4, 10)$

(7 pt) 15. Let $z = f(x, y) = 2x^2 + y^3$. Use the total differential for f at $(x_0, y_0) = (1, 2)$ to find dy given $dz = -1.2$ and $dx = 0.3$.

A. $dy = 0.2$

B. $dy = 0.1$

C. $dy = 0$

D. $dy = -0.1$

E. $dy = -0.2$