1. Find the area of the triangle whose vertices are 
   \( P = (3, 4, -5) \), \( Q = (3, 5, -4) \) and \( R = (5, 2, -5) \).

   a. \( \sqrt{3} \)
   
   b. \( 2\sqrt{3} \)
   
   c. \( 4\sqrt{3} \)
   
   d. 1
   
   e. 6

2. Which of the following is a line perpendicular to the plane \( 2x - 3y + z = 1 \)?

   a. \( \frac{x - 1}{2} = \frac{y - 2}{3} = \frac{z - 3}{1} \)
   
   b. \( \frac{x - 2}{1} = \frac{y - 3}{2} = \frac{z - 1}{3} \)
   
   c. \( 2x + 3y + z = -1 \)
   
   d. \( (x, y, z) = (1 + 2t, 2 + 3t, 3 + t) \)
   
   e. \( (x, y, z) = (1 + 2t, 2 - 3t, 3 + t) \)
An airplane is travelling due North with constant speed and constant altitude as it flies over College Station. Since its path is part of a circle around the earth, its acceleration points directly toward the center of the earth. In which direction does it binormal $\vec{B}$ point?

a. North  
b. East  
c. South  
d. West  
e. Up

The plot at the right is which surface?

a. $x^2 - y^2 - z^2 = 4$  
b. $x^2 - y^2 - z^2 = -4$  
c. $4x^2 + y^2 + z^2 = 1$  
d. $x = 4y^2 - 4z^2$  
e. $x = 4y^2 + 4z^2$

The plot at the right represents which vector field?

a. $\vec{A} = \langle x, y \rangle$  
b. $\vec{B} = \left\langle \frac{x}{\sqrt{x^2 + y^2}}, \frac{y}{\sqrt{x^2 + y^2}} \right\rangle$  
c. $\vec{C} = \langle -x, -y \rangle$  
d. $\vec{D} = \left\langle \frac{-x}{\sqrt{x^2 + y^2}}, \frac{-y}{\sqrt{x^2 + y^2}} \right\rangle$  
e. $\vec{E} = \langle -y, x \rangle$
6. For the curve \( \vec{r}(t) = (e^t, \sqrt{2}t, e^{-t}) \) which of the following is FALSE?

   a. \( \vec{v} = \langle e^t, \sqrt{2}, -e^{-t} \rangle \)
   b. \( |\vec{v}| = e^t + e^{-t} \)
   c. Arc length between \( t = 0 \) and \( t = 1 \) is \( e + \frac{1}{e} \)
   d. \( \vec{a} = \langle e^t, 0, -e^{-t} \rangle \)
   e. \( a_T = e^t - e^{-t} \)

7. A wire in the shape of the curve \( \vec{r}(t) = (e^t, \sqrt{2}t, e^{-t}) \) has linear mass density \( \rho = x + z \). Find its total mass between \( t = 0 \) and \( t = 1 \).

   a. \( \frac{e^2}{2} + 1 - \frac{1}{2e^2} \)
   b. \( \frac{e^2}{2} + 2 - \frac{1}{2e^2} \)
   c. \( \frac{e^2}{2} + 2 + \frac{1}{2e^2} \)
   d. \( e - \frac{1}{e} \)
   e. \( e + \frac{1}{e} \)

8. Find the work done to move an object along the curve \( \vec{r}(t) = (e^t, \sqrt{2}t, e^{-t}) \) between \( t = 0 \) and \( t = 1 \) by the force \( \vec{F} = \langle z, 0, -x \rangle \)?

   a. \( 2e - \frac{2}{e} \)
   b. \( 2e + \frac{2}{e} \)
   c. \( e - \frac{1}{e} \)
   d. \( e + \frac{1}{e} \)
   e. 2
9. The plot at the right is the graph of which function?

a. \( f(x,y) = (x^2 + y^2 - 4)^2 \)

b. \( f(x,y) = (x^2 + y^2)^2 - 16 \)

c. \( f(x,y) = x^2 + y^2 - 4 \)

d. \( f(x,y) = (x - 2)^2 + (y - 2)^2 \)

e. \( f(x,y) = 2x^2 + 2y^2 \)

10. If \( z = x^3e^{3y} \) which of the following is FALSE?

a. \( \frac{\partial z}{\partial x} = 3xe^{x+1}e^{3y} \)

b. \( \frac{\partial z}{\partial y} = 3xe^{3y} \)

c. \( \frac{\partial^2 z}{\partial x^2} = (9e^2 - 6e)xe^{x-2}e^{3y} \)

d. \( \frac{\partial^2 z}{\partial y \partial x} = 9e^2xe^{3y} \)

e. \( \frac{\partial^2 z}{\partial x \partial y} = 9ex^{3e-1}e^{3y} \)

11. Find the plane tangent to the graph of \( z = x\ln(y) \) at the point \( (2, e) \). Its \( z \)-intercept is

a. \( -e \)

b. \( -2 \)

c. \( 0 \)

d. \( 2 \)

e. \( e \)
12. Find the vector projection of the vector \( \vec{a} = \langle 1, 2, 3 \rangle \) along the vector \( \vec{b} = \langle 2, 1, -2 \rangle \).

13. Find the point where the line \( \frac{x-4}{-1} = \frac{y-5}{2} = \frac{z-7}{2} \) intersects the plane \( x - 3y + z = 6 \).
14. The pressure, $P$, volume, $V$, and temperature, $T$, of an ideal gas are related by

$$P = \frac{kT}{V}$$

for some constant $k$.

At a certain instant, for a certain sample $k = 5 \text{ cm}^3 \text{ atm} \cdot \text{K}$, $V = 1000 \text{ cm}^3$, and $T = 300 \text{ K}$.

At that instant, the volume and temperature are increasing at $\frac{dV}{dt} = 10 \text{ cm}^3 \text{ sec}^{-1}$, and $\frac{dT}{dt} = 2 \text{ K sec}^{-1}$.

At that instant, what is the pressure, is it increasing or decreasing and at what rate?

15. For an adjustable lens, the distance from the lens to the image, $v$, is related to the distance from the lens to the object, $u$, and the focal length, $f$, by the formula

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} \quad \text{or} \quad v = \frac{fu}{u-f}$$

Currently $f = 4 \text{ cm}$, $u = 6 \text{ cm}$, and so $v = 12 \text{ cm}$.

If the focal length is increased by $\Delta f = 0.2 \text{ cm}$, and the distance from the lens to the object is increased by $\Delta u = 0.3 \text{ cm}$, use differentials to estimate how much the image moves.

Does the distance from the lens to the image increase or decrease?