16.5

2 a) curl $F = \langle 4y^3z^3, 2x^3yz, -x^3z^2 \rangle$

b) div $F = 3yz^2(x^2+y^3)$

7. a) curl $F = \langle -e^y\cos z, -e^z\cos x, -e^x\cos y \rangle$

b) div $F = \langle e^x\sin y + e^y\sin z + e^z\sin x \rangle$

9. a) div F is negative because $\frac{\partial F_y}{\partial y}$ is negative.

b) Yes

10. a) div F is positive because $\frac{\partial F_x}{\partial x}$ and $\frac{\partial F_y}{\partial y}$ are positive

b) yes

11. a) div F is zero because $\frac{\partial F_x}{\partial x}$ and $\frac{\partial F_y}{\partial y}$ are zero.

b) No, curl F points downward.

12. a) No, cannot take curl of a scalar field

c) yes, scalar field

e) No, cannot take grad of vector field

g) yes, scalar field

i) Yes, vector field

14. curl $F = \langle 0, -4yxz^3, xz^4 \rangle$, so F is not conservative.

15. curl $F = \langle -2x\sin y, 0, 2z\sin y \rangle$, so F is not conservative.

19. div $\langle x\sin y, \cos y, z-xy \rangle = 1$, and thus this cannot be a curl field.

21. curl $F = \langle \frac{\partial F_z}{\partial y} - \frac{\partial F_y}{\partial z}, \frac{\partial F_x}{\partial z} - \frac{\partial F_z}{\partial x}, \frac{\partial F_y}{\partial x} - \frac{\partial F_x}{\partial y} \rangle = \langle 0, 0, 0 \rangle$

22. div $F = \frac{\partial f}{\partial x} + \frac{\partial g}{\partial y} + \frac{\partial h}{\partial z} = 0+0+0 = 0$.

26. curl$(fF) = \begin{vmatrix} i & j & k \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ fF_x & fF_y & fF_z \end{vmatrix}$

$$= \langle \frac{\partial f}{\partial y}F_z + f\frac{\partial F_z}{\partial y} - \left(\frac{\partial f}{\partial z}F_y + f\frac{\partial F_y}{\partial z}\right), \frac{\partial f}{\partial z}F_x + f\frac{\partial F_x}{\partial z} - \left(\frac{\partial f}{\partial x}F_z + f\frac{\partial F_z}{\partial x}\right), \frac{\partial f}{\partial x}F_y + f\frac{\partial F_y}{\partial x} - \left(\frac{\partial f}{\partial y}F_x + f\frac{\partial F_x}{\partial y}\right) \rangle$$

$$= f\,\text{curl}\,F + (\nabla f)\times F.$$

16.6

2. a) P does not lie on the surface

b) $u=2, v=1$ gives us Q.

4. paraboloid opening towards the x-axis

6. elliptical cylinder opening along the y-axis

22. $x = \sin\phi\cos\theta$ $\quad 0 \le \theta \le 2\pi$

$y = \frac{1}{\sqrt{2}}\cos\phi$ $\quad 0 \le \phi \le \frac{\pi}{2}$

$z = \frac{1}{\sqrt{3}}\sin\phi\sin\theta$

24. $x = 3\cos\theta$ $\quad 0 \le \theta \le \pi$

$z = 3\sin\theta$ $\quad -4 \le y \le 4$

$y = y$

26. $x = x$ $\quad -1 \le x \le 1$

$y = y$ $\quad -\sqrt{1-x^2} \le y \le \sqrt{1-x^2}$

$z = x+3$

34. $u=2 \quad v=1$ $\quad r_u = \langle 2u, 0, 1\rangle$

$r_v = \langle 0, 3v^2, 1\rangle$

$r_u \times r_v = \langle -3, -4, 12\rangle$

$-3(x-5) - 4(y-2) + 12(z-3) = 0$

36. $r_u = \langle \cos u, -\sin u \sin v, 0\rangle$

$r_v = \langle 0, \cos u \cos v, \cos v\rangle$

$r_u \times r_v = \langle -\frac{\sqrt{3}}{8}, -\frac{3}{4}, \frac{3\sqrt{3}}{8}\rangle$

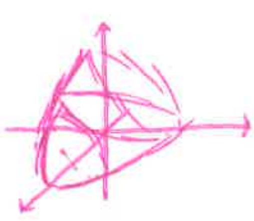
$-\frac{\sqrt{3}}{8}(x-\frac{1}{2}) - \frac{3}{4}(y-\frac{\sqrt{3}}{4}) + \frac{3\sqrt{3}}{8}(z-\frac{1}{2}) = 0$

37. $u=1 \quad v=1$

$r_u = \langle -2u, 0, -1\rangle$

$r_v = \langle -2v, -\phi, \phi\rangle$

$r_u \times r_v = \langle -1, 2, 2\rangle$



$-1(x+1) + 2(y+1) + 2(z+1) = 0$