5. $\vec{AB} = \langle 1, 0, 1 \rangle$
$\vec{AC} = \langle 1, 1, 0 \rangle$
$\vec{BC} = \langle 0, 1, -1 \rangle$
$A = \cos^{-1}\left(\frac{1}{2}\right) = \pi/3$
$B = \cos^{-1}\left(\frac{-1}{2}\right) = 2\pi/3$
$C = \cos^{-1}\left(\frac{1}{2}\right) = \pi/3$

6. $\nabla f = \langle 3x^2 + yz, 3y^2 + xz, 3z^2 + xy \rangle = \langle 4, 4, 4 \rangle$
$u = \langle -\frac{1}{\sqrt{3}}, -1/\sqrt{3}, -1/\sqrt{3} \rangle$
$\nabla f \cdot u = \langle 4, 4, 4 \rangle \cdot \langle -\frac{1}{\sqrt{3}}, -\frac{1}{\sqrt{3}}, -1/\sqrt{3} \rangle = -4/\sqrt{3} - 4/\sqrt{3} - \frac{4}{\sqrt{3}} = -12/\sqrt{3}$

7. $\frac{dg}{du} = \frac{dg}{dx} \cdot \frac{dx}{du} + \frac{dg}{dy} \cdot \frac{dy}{du} = 6x \cdot e^u \cos v + (-6y) \cdot e^u \cos v$
$= 6(e^u \cos v) \cdot e^u \cos v + (-6(e^u \sin v) \cdot e^u \cos v)$
$= 6(1 \cdot \cos 1) \cdot 1 \cdot \cos 1 + (-6 \cdot \sin 1 \cdot \cos 1)$
$= 6 \cos^2(1) - 6 \sin(1) \cos(1)$

\- 8. $\text{div } F = 3 - 2 + 5 = 6$
$\int_0^2 \int_{-2}^0 \int_0^{\sqrt{4-x^2-y^2}} 6 \, dz\,dy\,dx = \int_0^2 \int_{-2}^0 6\sqrt{4-x^2-y^2} \, dy\,dx = \int_0^2 \frac{-6y}{\sqrt{4-x^2-y^2}} \Big|_{-2}^{0} dx$
$= \int_0^2 \frac{12}{\sqrt{-x^2}} dx =$ Nonsense can't take square root of negative number, no real answers

9. $\int_0^1 \int_0^1 \int_0^{2x+3y} 1 \, dz\,dy\,dx = \int_0^1 \int_0^1 2x + 3y \, dy\,dx = \int_0^1 2xy + \frac{3}{2}y^2 \Big|_0^1 dx$
$\int_0^1 2x + \frac{3}{2} dx = x^2 + \frac{3}{2}x \Big|_0^1 = 1 + \frac{3}{2} = \frac{5}{2}$

\- 10. $f_x = 4 - 2/2x+y$
$f_y = -2y - 1/2x+y$
$f_{xx} = 4/(2x+y)^2$
$f_{yy} = -2 + 1/(2x+y)^2$
$f_{xy} = 2/(2x+y)^2$

$4 - \frac{2}{2x+y} = -2y - \frac{1}{2x+y}$
$4 + 2y = \frac{1}{2x+y}$
$2 = 2$
$x = 3/4 \quad y = -1$

$(3/4, -1)$:
$D = f_{xx} f_{yy} - (f_{xy})^2$
$= (16)(2) - (8)^2$
$= 32 - 64 = -32$
$(3/4, -1)$ is a saddle point b/c $D < 0$, according to the 2nd Derivative Test

11. $f_x = \dfrac{2x}{\sqrt{2x^2+3y^2+z^2}} = \dfrac{2}{3}$ $\quad f_y = \dfrac{3y}{\sqrt{2x^2+3y^2+z^2}} = \dfrac{3}{3} = 1$ $\quad f_z = \dfrac{z}{\sqrt{2x^2+3y^2+z^2}} = \dfrac{2}{3}$

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

$\frac{2}{3}x + y + \frac{2}{3}z - \frac{2}{3} - \frac{3}{3} - \frac{4}{3} = 0 \qquad \frac{2}{3}(1.001) + 0.999 + \frac{2}{3}(2.001) = 3.0003333$

12. $\int_0^{\frac{\pi}{4}} \int_0^1 r\cos\theta \, r \, dr \, d\theta + \int_{\frac{\pi}{4}}^{\frac{\pi}{2}} \int_0^1 r\cos\theta \, r \, dr \, d\theta$

$\int_0^{\frac{\pi}{4}} \frac{r^3}{3}\cos\theta \Big|_0^1 d\theta = \int_0^{\frac{\pi}{4}} \frac{1}{3}\cos\theta \, d\theta = \frac{1}{3}\sin\theta \Big|_0^{\frac{\pi}{4}} = \frac{\sqrt{2}}{6}$

$\int_{\pi/4}^{\pi/2} \frac{r^3}{3}\cos\theta \Big|_0^1 d\theta = \frac{1}{3}\sin\theta \Big|_{\pi/4}^{\pi/2} = \frac{1}{3} - \frac{\sqrt{2}}{6}$

$= \frac{\sqrt{2}}{6} + \left(\frac{1}{3} - \frac{\sqrt{2}}{6}\right) = \frac{1}{3}$

13. $\int_0^2 \int_0^{\sqrt{4-z^2}} \int_{-\sqrt{4-z^2-y^2}}^0 x^2 y z \, dx \, dy \, dz$

$\int_0 \int \int_0^2 r^2 \sin^2\Phi \cos^2\theta \, r\sin\Phi \sin\theta \, r\cos\Phi \, r^2 \sin\Phi \, dr \, d\Phi \, d\theta$

$\int_0^{2\pi} \int_0^{\pi} \int_0^2 r^6 \sin^4\Phi \cos^3\theta \sin\theta \, dr \, d\Phi \, d\theta$

14. $r'(t) = \langle 0, 3\cos t, -3\sin t \rangle$
$r''(t) = \langle 0, -3\sin t, -3\cos t \rangle$ $\Big\} \times \; \langle -9, 0, 0 \rangle$

$\kappa(t) = \dfrac{|r'(t) \times r''(t)|}{|r'(t)|^3} = \dfrac{|\langle -9, 0, 0 \rangle|}{|\langle 0, 3\cos t, -3\sin t \rangle|^3} = \dfrac{9}{3^3} = \dfrac{9}{27} = \dfrac{1}{3}$

15. $r_u = \langle 2u, v, 0 \rangle$
$r_v = \langle 0, u, 2v \rangle$ $\Big\} \times \; \langle 2v^2, -4uv, 2u^2 \rangle$