1. $\dfrac{4\sin t\cos t}{\sqrt{3+4\sin^2 t}}$
2. $w_t = \dfrac{8s}{(12st+4s-t)^2}$
3. $V'(t)=0$ so the volume remains the same.
4. $\dfrac{dy}{dx} = -\dfrac{2x^3y^2}{3(x^4+y^2+3)+y^3}$
5. $f_{st} = 48s$
6. $\nabla p(x,y) = \left\langle -\dfrac{4x}{\sqrt{14-4x^2-y^2}}, -\dfrac{y}{\sqrt{14-4x^2-y^2}} \right\rangle$; $\nabla p(1,1) = \left\langle -\dfrac{4}{3}, -\dfrac{1}{3} \right\rangle$
7. $-\dfrac{1}{3\sqrt{2}}$
8. Steepest ascent $\left\langle \dfrac{5}{\sqrt{34}}, -\dfrac{3}{\sqrt{34}} \right\rangle$. Steepest descent $\left\langle -\dfrac{5}{\sqrt{34}}, \dfrac{3}{\sqrt{34}} \right\rangle$. No change $\left\langle \dfrac{3}{\sqrt{34}}, \dfrac{5}{\sqrt{34}} \right\rangle$.
9. $m = \dfrac{2\sqrt{2}}{3}$; $\nabla f\left(3\sqrt{2},-2\right) = \left\langle -\dfrac{2\sqrt{2}}{3}, 1 \right\rangle$. They are orthogonal so the dot product is 0.

1. $\nabla f(0,4,1) = \left\langle 20e^{-3},0,0 \right\rangle$; directional derivative is $-\dfrac{120}{11}e^{-3}$
2. $4x+4y-z=0$
3. $z = -2\sqrt{3}\left(x-\dfrac{\pi}{6}\right) + 2\sqrt{3}\left(y+\dfrac{\pi}{6}\right) + 5$
4. $L(x,y) = -\dfrac{3}{5}(x+3) + \dfrac{4}{5}(y-5) + 5 = \dfrac{-3x+4y}{5}$; $L(-2.97, 4.06) = 5.03$
5. $dz = -0.07$
6. $dw = -\dfrac{5y+7z}{(x+u)^2}du - \dfrac{5y+7z}{(x+u)^2}dx + \dfrac{5}{x+u}dy + \dfrac{7}{x+u}dz$
7. $(1,-1,-4)$
8. $(1,1), (-1,-1), (0,0)$
9. CP at $(\ln 5, 0)$ and it is a saddle point.

10. Use $z=\frac{13.5}{xy}$ and minimize $xy+2xz+2yz=xy+\frac{27}{y}+\frac{27}{x}=f\left(x,y\right)$ dimensions: 3 x 3 x 1.5

11. Absolute max $f\left(\frac{3}{2},\frac{1}{2}\right)=1$; absolute min $f\left(0,2\right)=-8$

12. Absolute max is 98, absolute min is -14.

13. $\frac{608}{9}$

14. $\frac{1}{9}e^{8}-1$

15. $\frac{256-e^{4}}{4}$

16. $\int_{0}^{\ln 5}\int_{-5}^{5}e^{-x}dydx$ or $\int_{-5}^{5}\int_{0}^{\ln 5}e^{-x}dxdy$

17. $\int_{0}^{\frac{\pi}{6}}\int_{0}^{2}x\sec^{2}\left(xy\right)dydx=-\frac{1}{2}\ln\frac{1}{2}$

18. $\frac{18}{\pi^{2}}$

19. $\int_{0}^{2}\int_{x^{4}}^{8x}f\left(x,y\right)dydx$

20. -4

21. $\int_{0}^{12}\int_{0}^{y(12-y)}f\left(x,y\right)dydx$

22. $\int_{0}^{3}\int_{x^{2}}^{3x}f\left(x,y\right)dydx$

23. $\int_{0}^{1}\int_{y}^{1}3e^{x^{2}}dxdy=\int_{0}^{1}\int_{0}^{x}3e^{x^{2}}dydx=\frac{3}{2}\left(e-1\right)$. The function was not able to be integrated in the first order without use of a power series.

24. $\int_{0}^{2}\int_{0}^{4-2x}\left(-4x-2y+8\right)dydx=\frac{32}{3}$

25. $\int_{0}^{\pi}\int_{12-12\sin x}^{12+12\sin x}dydx=48$

26. $\int_{0}^{2\pi}\int_{2\sqrt{2}}^{2\sqrt{6}}\left(8r-r\sqrt{1+r^{2}}\right)drd\theta=\frac{188}{3}\pi$

27. $\int_{0}^{\frac{\pi}{2}}\int_{1}^{2}2r^{3}\sin\theta\cos\theta drd\theta=\frac{15}{2}$

28. $\int_0^{\frac{\pi}{2}}\int_0^5 r^2\,dr\,d\theta = \frac{125}{6}\pi$

29. $\int_{\frac{\pi}{8}}^{\frac{3\pi}{8}}\int_{2\sqrt{2}}^{4\sin 2\theta} r\,dr\,d\theta$