1. \( \nabla f(a, b, c) = \sqrt{3} (2, 6, -4) \)

2. See the solution set.

3. (a) The differential at \( x = a, y = b \) is 
\[ \frac{dx}{e^{f(a,b)+b}} + \frac{1-f(a,b)}{e^{f(a,b)-b}} \, dy \]
(b) \( f(0.99, 0.01) \approx 0 \)

4. \( (\frac{1}{\sqrt{2}}, -1, -\frac{1}{2}) \) and \( (\frac{1}{\sqrt{2}}, -1, -\frac{1}{2}) \)

5. (a) \( (0,0) \) and \( (3,0) \) and \( (0,3) \) are saddle points
(1,1) is a local min
(b) The minimum is \(-1\) at \((1,1)\) and the maximum is \(80\) at \((4,4)\).

6. (a) \( D = \{ (r \cos \theta, r \sin \theta) \mid -\pi/2 \leq \theta \leq \pi/4, \ 0 \leq r \leq 2 \cos \theta \} \)
(b) Volume = \( \frac{40}{18\sqrt{2}} + \frac{16}{9} \)

7. (a) The unit vector in the direction of maximum rate of increase is \( \frac{1}{\sqrt{10}} (3, 0, 1) \).
(b) \( 2\pi \)

8. (a) \( \int_0^a \int_0^{3\pi/2} \int_0^{\sqrt{a^2-z^2}} r^2 \, dz \, d\theta \, dr \, r(r^2+z^2)^{2014} \)
(b) \( \int_0^{\pi/2} \int_0^{3\pi/2} \int_0^a d\varphi \int_0^{\pi/2} d\theta \int_0^a d\rho \rho^{4030} \sin \varphi \)
(c) \( \frac{\Delta^{4031}}{8062} \)

9. \( \int_{y=-\sqrt{6}}^{y=\sqrt{6}} \int_{z=0}^{z=2} \int_{x=3}^{x=6} f(x, y, z) \, dz \, dx \, dy \)
\( \int_{y=-\sqrt{6}}^{y=\sqrt{6}} \int_{z=0}^{z=2} \int_{x=3}^{x=6} f(x, y, z) \, dx \, dz \, dy \)
\( \int_{z=0}^{z=6} \int_{x=3}^{x=6} \int_{y=-\sqrt{2}}^{y=\sqrt{2}} f(x, y, z) \, dy \, dx \, dz \)