1. maximum is $\dfrac{3\sqrt{3}}{4}$ at $\left(-\dfrac{3}{2}, -\dfrac{\sqrt{3}}{2}\right)$

2. $\dfrac{C}{12} \times \dfrac{C}{12} \times \dfrac{C}{12}$

3. minimum is 0 at $(0,0)$, maximum is $\dfrac{27}{2}$ at $\left(-\dfrac{3}{\sqrt{2}}, -\dfrac{3}{\sqrt{2}}\right), \left(\dfrac{3}{\sqrt{2}}, \dfrac{3}{\sqrt{2}}\right)$

4. 104

5. $\dfrac{144}{35}$

6. $\dfrac{1}{12}$

7. $\dfrac{13}{6}$

8. $\dfrac{16}{3}r^3$

9. $\dfrac{(e^{25} - e^{16})\pi}{4}$

10. 6π

11. $\dfrac{1}{4}e^{-1} = \dfrac{1}{4e}$

12.

$$\begin{aligned}
\int_0^1 \int_0^{x^2} \int_0^y f(x,y,z)\,dz\,dy\,dx &= \int_0^1 \int_{\sqrt{y}}^1 \int_0^y f(x,y,z)\,dz\,dx\,dy \\
&= \int_0^1 \int_0^y \int_{\sqrt{y}}^1 f(x,y,z)\,dx\,dz\,dy \\
&= \int_0^1 \int_z^1 \int_{\sqrt{y}}^1 f(x,y,z)\,dx\,dy\,dz \\
&= \int_0^1 \int_0^{x^2} \int_z^{x^2} f(x,y,z)\,dy\,dz\,dx \\
&= \int_0^1 \int_{\sqrt{z}}^1 \int_z^{x^2} f(x,y,z)\,dy\,dx\,dz
\end{aligned}$$

13. $-\dfrac{3}{10}$

14. $\dfrac{65\pi}{4}$

15. $\dfrac{\pi}{2}(5e^3 - 2)$

16. Consider the two surfaces $\rho = 3\csc\theta$ in spherical coordinates and $r = 3$ in cylindrical coordinates. Are they the same surface, or different? Explain your answer.

Several ways to do this, this is one:

For the first surface, remember:

$$\begin{aligned}
x &= \rho\cos\theta\sin\phi \\
y &= \rho\sin\theta\sin\phi \\
z &= \rho\cos\phi
\end{aligned}$$

For the second surface, remember:

$$\begin{aligned}
x &= r\cos\theta \\
y &= r\sin\theta \\
z &= z
\end{aligned}$$

So if we let $\phi = 0$ in the first surface, we would get $x = 0$, and $y = 0$. For the second surface, when $x = 0$, that would mean $\cos\theta = 0$ since $r = 3$. Then on the second surface, by Pythagorean Identity, if $\cos\theta = 0$, then $\sin\theta = \pm 1$. Thus $y = \pm 3$ when $x = 0$. But on the first surface $x = 0$ and $y = 0$. Thus these cannot be the same surface.