1.4

$U(\theta,\phi) = \cos^4(\theta)\cdot\sin^2(\phi)$ for $0 \le \theta \le \frac{\pi}{2}$, $0 \le \phi \le 2\pi$

$U(\theta,\phi) = 0$ elsewise

a)

$$P_{RAD} = \int_0^{2\pi}\left[\int_0^{\pi/2} \cos^4(\theta)\cdot\sin^2(\phi)\cdot\sin(\theta)\, d\theta\right] d\phi$$

$$= \int_0^{2\pi} \sin^2(\phi)\, d\phi \cdot \int_0^{\pi/2} \cos^4(\theta)\cdot\sin(\theta)\, d\theta$$

$$= \frac{\pi}{5}\ W \quad \text{(apparently)}$$

$$D_0 = \frac{4\pi\cdot U_{max}}{P_{RAD}} = \frac{4\pi}{\pi/5} = 20 = 13\ dB$$

b)

$U(\theta, \phi=\frac{\pi}{2}) = \cos^4(\theta)$

$\cos^4(\frac{HPBW}{2}) = \frac{1}{2} \Rightarrow 2\cdot\cos^{-1}(\sqrt{0.5}) = 65.5^\circ = HPBW$