1(a) The wavelength is $\lambda = c/400$ MHz $= 0.75$ m, so the ratio is $\lambda/d = 15$. The antenna is less than 10% of the size of the wavelength.
(b) The phase difference is $1/15$ of a full wave (which is $2\pi$), so $\Delta \phi = 2\pi/15 = 0.42$ radians.

2 (a) Given that $v = 1 \times 10^{12}$ Hz, therefore the period is $1/v = 10^{-12}$ sec, and $\omega = 2\pi v = 6.28 \times 10^{12}$ rad/sec. We can also calculate the wavelength, $\lambda = c/v = 3 \times 10^{-4}$ m, and then the magnitude of the k-vector, $k = 2\pi/\lambda = 2.09 \times 10^4$ m$^{-1}$. We can also calculate the amplitude of the wave:

$$A = \left| \vec{E}_0 \right| = \sqrt{\frac{2I}{c_0\varepsilon_0}} = \sqrt{\frac{2 \left( 10^{-6} W/m^2 \right)}{(3 \times 10^8) \left( 8.854 \times 10^{-12} \right)}} = 0.027 \ V/m$$

We are not given enough information to compute the absolute phase, so our expression contains the absolute phase as a symbol, $\theta$:

$$\vec{E}(\vec{r},t) = (0.027 \ V/m) e^{i \left[ (2.09 \times 10^4 \ m^{-1})x - (6.28 \times 10^{12} \ \text{rad/sec})t \right] + \theta}$$

3(a) The de Broglie wavelength of any object is given by $\lambda_{\text{dB}} = h/mv$, where $h$ is Planck’s constant, $m$ is the mass, and $v$ is its velocity. Using $m = 145$ grams (Wikipedia) and $v = 44.7$ m/s (go Nolan), we find $\lambda_{\text{dB}} = 10^{-34}$ m.
(b) Obviously the size of the ball is huge compared to $\lambda_{\text{dB}}$. Take-home lesson: quantum effects are completely irrelevant until the mass and/or size of the object gets really small.

4(a) Irradiance $= 1360$ W/m$^2$. Therefore the energy density $U = 2I/c = 9.1 \times 10^{-6}$ J/m$^3$. But J/m$^3$ is the same as pressure, N/m$^2$. To figure out the total force, simply multiply by the area presented by the earth to the sun: $A = \pi R_{\text{earth}}^2 = 1.28 \times 10^{14}$ m$^2$. Thus the total force due to photon pressure is $F_{\text{photons}} = 1.16 \times 10^9$ N. That’s over a gigaNewton, which sounds like a large force. But compare it to the force of gravity, which comes out to $F_{\text{gravity}} = 3.54 \times 10^{22}$ N, and you’ll see that the photon force is a tiny fraction.
(b) Same procedure, but here the area is much smaller: $A = \pi R_{\text{satellite}}^2 = 3.14$ m$^2$. This gives a light pressure of $F_{\text{photons}} = 2.9 \times 10^5$ N.

5. $\frac{7+j}{4-5j} + e^{i\pi/3} = \frac{7+j}{4-5j} \cdot \frac{4+5j}{4+5j} + e^{i\pi/3} = \frac{23+39j}{41} + e^{i\pi/3}$

So the imaginary part is: $\frac{39}{41} + \sin \left( \frac{\pi}{3} \right) = \frac{39}{41} + \frac{\sqrt{3}}{2}$

This is as far as you should be able to get without a calculator. And it should take you less than 2 minutes to get to this point. If you struggled at all with this, ask for help.