7.30 For one polarization, the electric energy for wave with momentum $\vec{k}$ is given by $u(\vec{k}) = \frac{\varepsilon_0}{4}\vec{E}(\vec{k},t)\cdot\vec{E}^*(\vec{k},t)$, and corresponding photon number is $n(\vec{k}) = \frac{\varepsilon_0}{4\hbar c k}\vec{E}(\vec{k},t)\cdot\vec{E}^*(\vec{k},t)$, where $k = |\vec{k}|$. Then, the total number of photons from electric field with specific polarization is

$$\frac{\varepsilon_0}{4\hbar c}\int n(\vec{k})\, d^3k = \frac{\varepsilon_0}{4\hbar c}\int d^3k \frac{\vec{E}(\vec{k},t)\cdot\vec{E}^*(\vec{k},t)}{k}$$

$$= \frac{\varepsilon_0}{4\hbar c}\int d^3k \left(\frac{1}{k}\left[\int \frac{d^3x}{(2\pi)^{3/2}}\vec{E}(\vec{x},t)e^{-i\vec{k}\cdot\vec{x}}\right]\left[\int \frac{d^3x'}{(2\pi)^{3/2}}\vec{E}(\vec{x}',t)e^{-i\vec{k}\cdot\vec{x}'}\right]^*\right)$$

$$= \frac{\varepsilon_0}{4\hbar c}\int d^3x \int d^3x'\, \vec{E}(\vec{x},t)\cdot\vec{E}^*(\vec{x}',t)\int \frac{d^3k}{(2\pi)^3}\frac{e^{-i\vec{k}\cdot(\vec{x}-\vec{x}')}}{k}$$

The Fourier transform of Coulomb potential is well-known,

$$\int \frac{e^{-i\vec{q}\cdot\vec{r}}}{r}d^3r = \frac{4\pi}{q^2}$$

Then, the number of photons from electric field of a particular polarization is

$$\frac{\varepsilon_0}{8\pi^2\hbar c}\int d^3x\int d^3x' \frac{\vec{E}(\vec{x},t)\,\vec{E}^*(\vec{x}',t)}{|\vec{x}-\vec{x}'|^2}$$

and the total contribution from electric field is twice the result.

$$n_E = \frac{\varepsilon_0}{4\pi^2\hbar c}\int d^3x\int d^3x' \frac{\vec{E}(\vec{x},t)\cdot\vec{E}^*(\vec{x}',t)}{|\vec{x}-\vec{x}'|}$$

We have the similar result for magnetic field.

$$n_B = \frac{1}{4\pi^2\hbar c}\int d^3x\int d^3x' \frac{\vec{B}(\vec{x},t)\cdot\vec{B}^*(\vec{x}',t)}{\mu_0|\vec{x}-\vec{x}'|^2}$$

Therefore, the total number of photons is

$$n = n_E + n_B = \frac{\varepsilon_0}{4\pi^2\hbar c}\int d^3x\int d^3x'\left[\frac{\vec{E}(\vec{x},t)\cdot\vec{E}(\vec{x}',t) + (\mu_0\varepsilon_0)^{-1}\vec{B}(\vec{x},t)\cdot\vec{B}^*(\vec{x}',t)}{|\vec{x}-\vec{x}'|^2}\right]$$

$$= \frac{\varepsilon_0}{4\pi^2\hbar c}\int d^3x\int d^3x' \frac{\vec{E}(\vec{x},t)\cdot\vec{E}(\vec{x}',t) + c^2\vec{B}(\vec{x},t)\vec{B}^*(\vec{x}',t)}{|\vec{x}-\vec{x}'|^2}$$