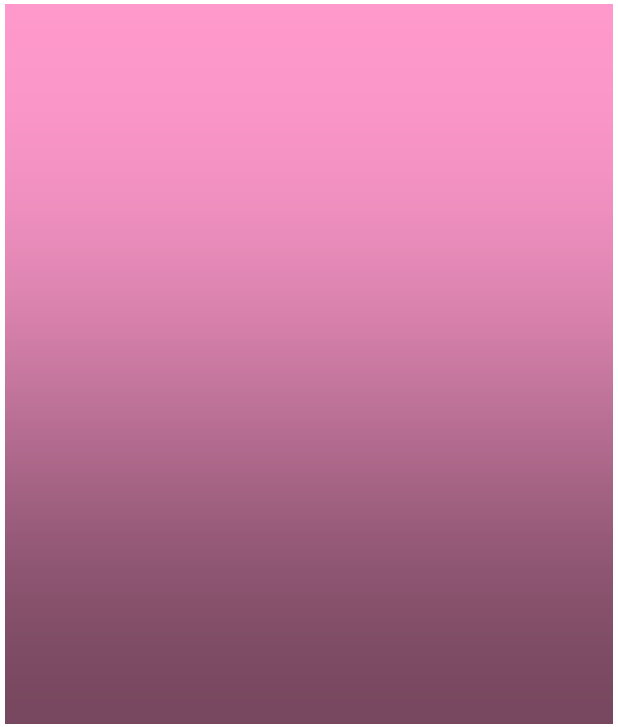
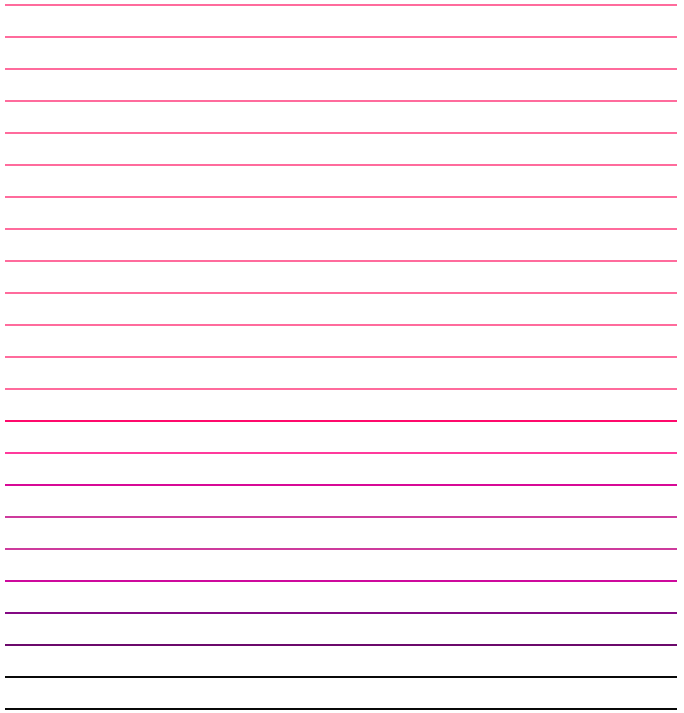
# Planck’s Innovation: assume radiation is quantized



Classical radiation

All frequencies

are possible



Quantized radiation

Only frequencies $nh\nu$

are allowed

# Mathematical Form of the Planck Law

- The energy levels will be populated according to a thermal weighting. The higher levels will be less populated than the lower levels.
- The average energy of the radiation is given by:

$$< E >= \frac{h\,c/\lambda}{e^{hc/\lambda k_B T} - 1}$$

- In the high temperature limit the average energy becomes $k_B T$.
- If we replace $k_B T$ in the Rayleigh-Jeans equations we obtain the energy density:

$$\rho(\lambda) = \frac{8\pi hc}{\lambda^5} \frac{1}{e^{hc/\lambda k_B T} - 1}$$

# Resolution of UV Catastrophe

$$\rho = \frac{8\pi hc}{\lambda^5}\frac{1}{e^{hc/\lambda k_B T} - 1}$$