Some equations you ought to know. These are the basic equations for analyizing triode gain stages.

Converting numerical amplification to decibel amplification. Note, they are the same, one is expressed in decibels, which is how we here, the other is a ratio of output voltage to input voltage (tubes are dependent on voltage, with bipolar transistors you will typically note current amplification.)

$$A_{\mathrm{dB}} = 20\log\left(\frac{V_{\mathrm{out}}}{V_{\mathrm{in}}}\right) \qquad \frac{V_{out}}{V_{\mathrm{in}}} = \text{voltage gain of the stage}$$

Next, is the gain of a common triode gain stage with the cathode resistor fully bypassed. The cathode resitor bypass capacitor allows the tube to "see" less resistance for AC signals, thus giving more gain while maintaining the DC offset. Remember that capacitors idealy only allow alternating current through, which is how we can maximize gain for AC signals and keep the DC bias that we designed for. Not that the negative sign indicates an inverted signal.

$$\mathrm{A}_{\mathrm{C}_k\,\mathrm{fully\,bypassed}} = \frac{-\mu\cdot R_a}{R_a + r_a}$$

For an unbypassed or partially bypassed stage, the gain at a frequency is:

$$A = \frac{-\mu\cdot R_a}{R_a + r_a}\cdot\sqrt{\frac{1+\left(2\pi\cdot f\cdot R_k\cdot C_k\right)^2}{\left[1+\frac{R_k\cdot(\mu+1)}{R_a+r_a}\right]^2+\left(2\,\pi\cdot f\cdot R_k\cdot C_k\right)^2}}$$

To find the frequency which has a gain halfway between the maximum boost for a partially bypassed cathode and the minimum boost, we use this equation:

$$f_{-3\,\mathrm{dB}} = \frac{1}{2\,\pi\cdot R_k\cdot C_k}\cdot\sqrt{1+\frac{R_k\cdot(\mu+1)}{2\left(R_a+r_a\right)+\frac{1}{2}R_k(\mu+1)}}$$

If we have the frequency we want to be the half boost, we can find the capacitor value with:

$$C_k = \frac{1}{2\pi\cdot f\cdot R_k}\cdot\sqrt{1+\frac{R_k\cdot(\mu+1)}{2\left(R_a+r_a\right)+\frac{1}{2}R_k(\mu+1)}}$$

To find the input capacitence we use this equation:

$$C_{\mathrm{in}} = C_{gk} + C_{ga}\cdot A$$

The output impedance of an upbypassed cathode resistor at the anode can be found by:

$$Z_{\mathrm{out}} = R_a \,\|\, r_a + R_k(\mu+1) = \frac{R_a\cdot\left[r_a + R_k\cdot(\mu+1)\right]}{R_a + r_a + R_k(\mu+1)}$$

But if we have a fully bypassed resistor, we can simplify it to:

$$Z_{\mathrm{out}} = R_a \,\|\, r_a = \frac{R_a\cdot r_a}{R_a + r_a}$$

Input impedance:

$$Z_{\mathrm{in}} = R_g$$

A= Amplification, voltage gain of a triode gain stage.

$f_{-3\,dB}$ = Frequency with -3dB compared to the largest signal

C_k = Cathode bypass capacitor

R_k = Cathode Resistor

C_{in} = Input capacitance
C_{gk}= Capacitance from grid to cathode (from the datasheet)
C_{ga}= Capacitance from grid to anode (from the datasheet)
R_a= Anode load resistor
r_a= Plate resistance at the operating point (from the datasheet)
Z_{out}= Output impedance
Z_{in} = Input impedance
R_g = Grid leak resistor
μ = gain of the valve (from the datasheet)