$$Transfer\ function\ with\ 2\ poles \quad \rightarrow \quad A(s) = \frac{k}{\left(1+\frac{s}{p1}\right)\cdot\left(1+\frac{s}{p2}\right)}$$

As the solution of the problem guides us to find that phase margin = 70º by making pole 2 (p2) proportional to Gain*BandWidth, the assumption that **BW=p1** is accurate.

As the problem places the question in an OP amp application, then **gain of Op amp=k** is very very big is an accurate assumption.

<u>Find the cross over frequency= ω_g</u>

$$|A(\omega_g)| = 1 \ <=> \ \frac{k}{\sqrt{1+(\frac{\omega}{p1})^2}\cdot\sqrt{1+(\frac{\omega}{p2})^2}} = 1$$

By solving the above equation, 4 solutions can be found but 3 of them are NONE SENSE, so the only solution making sense is the following:

$$\omega_g = \sqrt{\frac{-({p_1}^2+{p_2}^2)+\sqrt{({p_1}^2+{p_2}^2)^2-4(p_1p_2)^2+4k^2(p_1p_2)^2}}{2}} \qquad (1)$$

Let's solve the problem the other way around i.e. by finding the pole 2 in order to have PH=70º.

$$70º = 180º - 90º - arctg\left(\frac{\omega_g}{p2}\right) <=> arctg\left(\frac{\omega_g}{p2}\right) = 20º <=> \frac{\omega_g}{p2} = 0.364 <=> {\omega_g}^2 = 0.13{p_2}^2$$

$$equation\ (1)\ squared = 0.13\cdot {p_2}^2 \qquad By\ simplifying\ this\ equation, you\ arrive\ to:$$

$${p_2}^2 = {p_1}^2\cdot(6.8\cdot k^2 - 7.7) \ \overset{1\ solution\ only}{\Longleftrightarrow} \ p_2 = p_1\cdot\sqrt{6.8\cdot k^2-7.7} \ \cong \ p_1\cdot k\cdot\sqrt{6.8}$$

And simplifying the radical: $(6.8)^{1/2}$=2.6   q.e.d

NOTES:

- $6.8*k^2$ >>>>7.7 because "k" is the open loop gain of the OP Amp so 7.7 is neglected
- I have assumed 90º contributed by the pole 1 because is the only way possible to get 70º phase margin.