INSTRUCTIONS:

This quiz is open-book, open-note, and you may work with your classmates.

GIVEN:

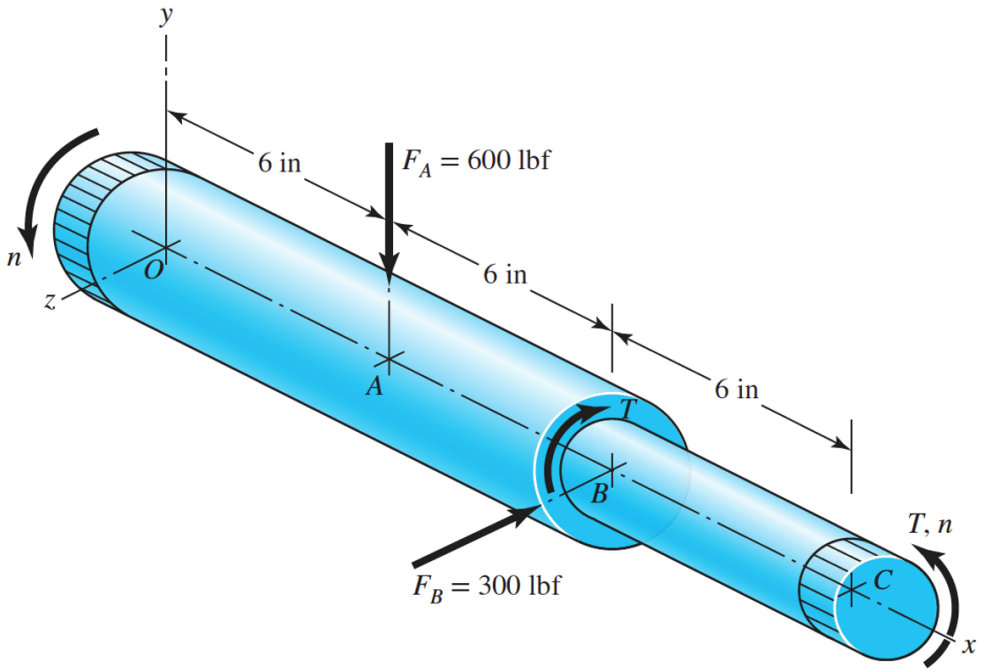
The steel shaft shown is supported by journal bearings at locations O and C. Dimensions are in inches.

The lubricant is SAE 40 and the operating temperature is 200°F.

The shaft rotates at 1200 rpm.

The shaft diameter at O is 3.250 in and the bearing diameter of 3.256 in. The bearing is 3 in long.

Note that 1 reyn = 1 lbf·s/in^2 = 1 psi·s.

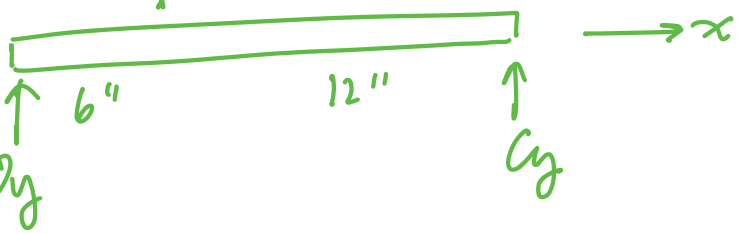


FIND:

a) The radial load supported by bearing O.

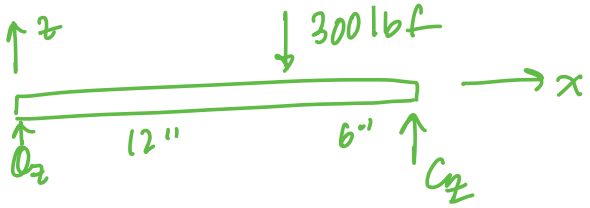
b) The Sommerfeld number S for the bearing at O.

a) y↑ 600 lbf



$\Sigma M_C = 0 \rightarrow (600\,\text{lbf})(12\,\text{in}) - O_y \cdot (18\,\text{in}) = 0$

$O_y = 400\,\text{lbf}$



$\Sigma M_z = 0 \rightarrow (6\,in)(300\,lbf) - (18\,in)\cdot O_z = 0$

$O_z = 100\ lbf$

$|\vec{F}_o| = \sqrt{O_y^2 + O_z^2} = \sqrt{400^2 + 100^2} = \underline{412.3\ lbf}$

b) $S = \left(\frac{r}{c}\right)^2 \frac{\mu N}{P}$

$r = \frac{3.25\,in}{2} = 1.625\,in$

$c = \frac{3.256\,in - 3.25\,in}{2} = 0.003\,in$

$\mu = 1.6\ \mu reyn$

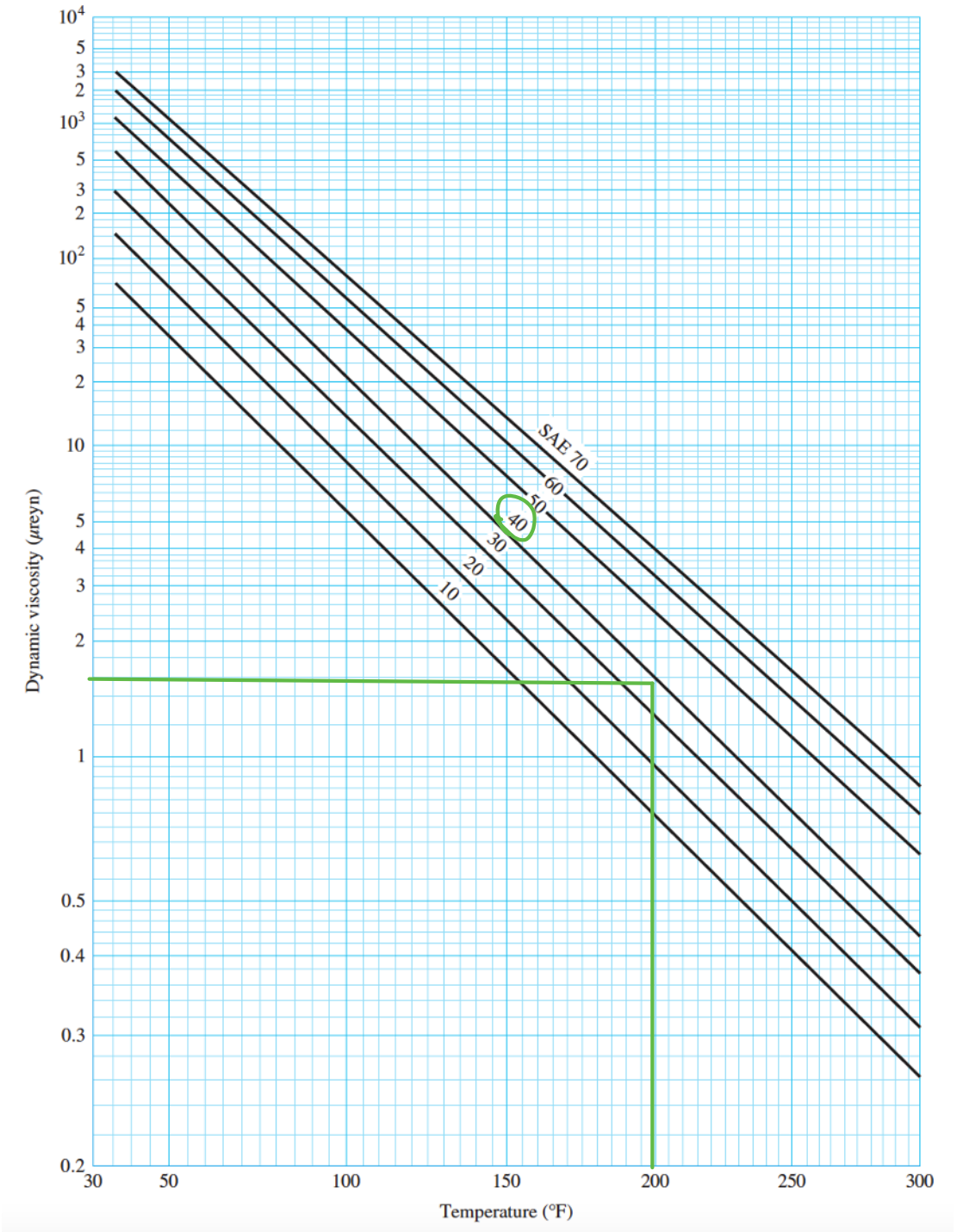
$N = 1200\ \frac{rev}{min} \cdot \frac{1\,min}{60\,s} = 20\ \frac{rev}{s}$

$P = \frac{W}{2rl} = \frac{412.3\,lbf}{(3.25in)(3in)} = 42.29\ psi$

$S = \left(\frac{1.625\,in}{0.003in}\right)^2 \frac{1.6\cdot 10^6\ psi\cdot s \cdot 20\ rev/s}{42.29\ psi}$

$= \underline{0.222}$

note: S is dimensionless... even though its units are technically rev.


Dynamic viscosity (μreyn)
Temperature (°F)
SAE 70
60
50
40
30
20
10
10^4
5
3
2
10^3
5
3
2
10^2
5
4
3
2
10
5
4
3
2
1
0.5
0.4
0.3
0.2
30
50
100
150
200
250
300