QUIZ / Curriculum / Advanced Applications/ Pneumatics

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Assume the area of a cylinder arm in contact with compressed air is a circle 2" in diameter, and ignore the effect of frictional forces.

1. **If the air pressure is 30 PSI, how much force will the extending cylinder arm have in pounds?**

   Force (in pounds) is equal to the Pressure (in Pounds per Square Inch) times Area (in Square inches) or F=P x A. In this case, we have a cylinder with a diameter of 2". The area of the cylinder is Pi x r2 or 3.14 x 12 or 3.14 in2. Force, then is 3.14 x 30 = 94.2 pounds of force.

2. **How much is 30 PSI in Newton/(meter)2**

   From the conversion tables, we can see that 1 PSI = 68.95 mbars or 0.06895 bars. Since 1 Bar = 100,000 Newtons/M2, then 1 PSI = .06895 x 100,000 = 6895 N/M2. So 30 PSI = 30 x 6895 = 206,850 N/M2.

3. **How much is 30 PSI in bars?**

   Since 1 PSI = .06895 bars (from above), then 30 PSI = 30 x .06895 = 2.0685 bars.

4. **How much is 30 PSI in millibars?**

   Since there are 1000 millibars in a bar, 30 psi would be 2.0685 bars (from above) x 1000 = 2068.5 millibars

5. **How much force will the extending cylinder arm described above have in Newtons?**

   From Question 1, we know that Force in (Newtons) is equal to Pressure (in Newtons/cm2) x Area (cm2). We know the pressure in N/cm2 is equal the pressure in N/M2 divided by 1000. So the pressure, from the answer to Question 2 would be equal to 206,850/1000 = 206.85 N/cm2. We know the diameter of the cylinder is 2" and the radius is 1" or 2.54 cm. The area then is 3.14 x 2.542 = 20.26 cm2. Since F = P x A, then F = 206.85 x 20.26 = 4191 Newtons

6. **If the air pressure is increased by 50%, by what fraction will the force of the cylinder arm be increased?**

   Since the force in the cylinder is directly and linearly proportional to the pressure, increasing the pressure by 50% would increase the force by 50%, also.

7. **If an extending cylinder arm exerts 2/5 less force than the cylinder arm in question 1, above, how much less air pressure will there be in this system than the system described in question 1, above? What is the name of the law that determines this answer?**

   Since the Cylinder exerts 2/5 less force, it exerts 3/5 of the original force. Since Force = Pressure x Area and the Area hasn't changed, the Pressure is 3/5 of the original Pressure. The Pressure in Question 1 is 30 PSI, so the new Pressure is 30 x 3/5 = 18 PSI. Neither of the Gas Laws are applicable to this problem.

8. **How much pressure will the system described in question 7 have in millibars?**

   Since the answer to Question 4 is 2068.5 mbar (equivalent to 30 PSI), the new Pressure will be 2068.5 x3/5 = 1241.1 mbar.

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9. If the temperature of the air in the system described in question 1, above, were to increase by 12.5%, by what fraction would the pressure increase or decrease? (Specify whether it would increase or decrease). What is the name of the law that determines this answer?

From the General Gas Law, we know the PV/T = C, if we assume that the Volume stays constant, then P/T = a Constant. If the temperature were to increase 12.5%, the Pressure would also have to increase by the same amount, so the final equation would be 1.125 x P / 1.1.25 x T = Constant

10. If you multiplied the pressure and volume of any system, then divided it by temperature, would it equal the pressure and volume of any other system divided by the temperature, assuming you used the same units? What is name of the law that determines this answer?

The General Gas Law states that PV/T = C. This is true for all systems as long as the units are the same.

11. If you want the cylinder arm described in question 1 to exert a force of 300 pounds, how much pressure in PSI would have to be in the system?

Since F = P A, then P = F / A. Since we're given the force of 300 Pounds and we calculated the area in Problem 1 as 3.14 in2, then P = 300 / 3.14 = 95.6 PSI.

12.If a pneumatics system has a pressure of 50 millibar, how much force would the cylinder arm described above produce in Newtons? How much in pounds?

We know that 1000 mbar is equal to 10 N/cm2. so 50 mbar would be equal 1/20 of 10 N/cm2 or 0.5 N/cm2. Since the radius of the cylinder is 2.54 cm, the area of the cylinder is 20.26 cm2 (from Question 5). Since F = P x A, Force = 0.5 x 20.26 = 10.13 Newtons. If 68.95 mbar = 1 PSI, then 50 mbar would equal 50/68.95 PSI or 0.73 PSI. Since the area of the cylinder is 3.14 in2 (From Question 1), so the Force is 0.73 x 3.14 = 2.29 pounds of force.

13.If you substituted a cylinder arm with a pressured surface that was circular and 1" in diameter for the cylinder arm described above and kept the pressure the same, what would be the ratio of the the force exerted by the extension of the two cylinder arms?

If you were to decrease the diameter from 2" to 1" you would be cutting the total area by 4, since the ratio of the areas is proportional to the square of the diameter. Since the pressure is the same but the area is 1/4 the original area, the force exerted would be 1/4 of the original force.