Grade 8 Science ***Pressure & Hydraulic Advantage***

Name: Answers
Date:
Class:

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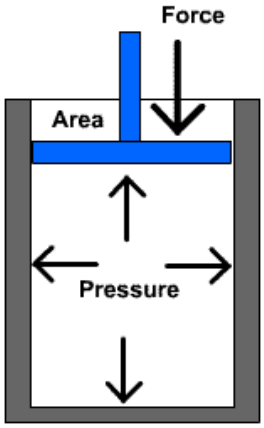
Please make sure that you show all of your work for the questions on this assignment. Remember that you can look back at the PowerPoint presentation that is on my blog at any time to find information like: Pressure in Pascals is Force/Area – N/m^2. ***Don't forget the units where needed!***

Part I - Calculating Pressure

1. Look at the diagram to the right to answer this question:

   If a force of 46 N was applied to the piston as you pushed it down, and the area of the piston is 0.50 m^2, then what would the pressure be inside the cylinder?



P = F/A
= 46N / 0.5m^2
= 92N/m^2
= 92 Pa ∴The pressure would be 92Pa (N/m^2)

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2. What if you kept pushing down on the piston with more and more force until finally you could not push it down any further, and at that point your classmate checked the pressure reading of the fluid inside the cylinder to find it had climbed to 830 Pa. What force would you be pushing down with in order to create that kind of pressure? (***Hint*** – some of the info you need to help you answer this question must be found in question 1)

P = F/A
830 Pa = F/ 0.5m^2
830N/m^2 x 0.5 m^2 = F
415 N = F ∴The force needed would be 415 N.

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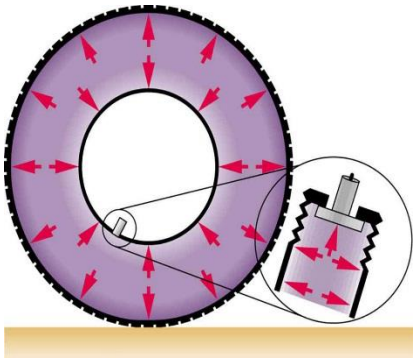
3. 

The diagram of the inflated tire seen in this question is displaying what law regarding pressure and fluids? Please restate the law in the space provided.

What Law? ___Pascal's Law_____

Restate the Law: Any pressure that is exerted in an enclosed system exerts an equal pressure on all surfaces within that enclosed system.

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4. Using the diagram in the previous question… if we used a hand pump like the one shown here, which has an area of 0.012 m² and we needed to inflate the tire to a pressure of 1225 Pa, then what force would we need to push down on the pump to create that kind of kind of pressure? (***please show your answer to the nearest 10th***)

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$P = F/A$

$1225\ Pa = F/ 0.012\ m^2$

$1225\ N/m^2 \times 0.012\ m^2 = F$

$415\ N = F$

$14.7\ N = F$ ∴ The force needed would be 14.7 N.

5. What would the area of a plunger inside a hydraulic ram be if there was a pressure of 1262 Pa inside the ram and it picked up a load with a force of 378 N? (***please round your answer to the nearest 10th***)

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$P = F/A$

$1262\ Pa = 378\ N/ A$

$A \times 1262 N/m^2 = 378\ N$

$A = 378\ N \div 1262\ N/m^2$

$A = 0.30\ m^2$ ∴ The area of the piston would be 0.30 m^2.

6. You needed to create a pressure of at least 650 Pa in order to inflate a water tube to pull behind a boat. With that said, you have an injured arm from tubing the day before so you can only pump with a force of 62 N. You have two choices of pumps to use, each with a different area of plunger. The first pump has an area of 0.11 m². The second pump has an area of only 0.09 m². Please calculate the pressure you can create with each pump and identify whether you would have to use pump 1 or pump 2. (***Round your final answers to the nearest whole number***)

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<u>Pump #1</u>

$P = F / A$

$= 62N / 0.11\ m^2$

$= 564\ N/m^2$

<u>Pump #2</u>

$P = F / A$

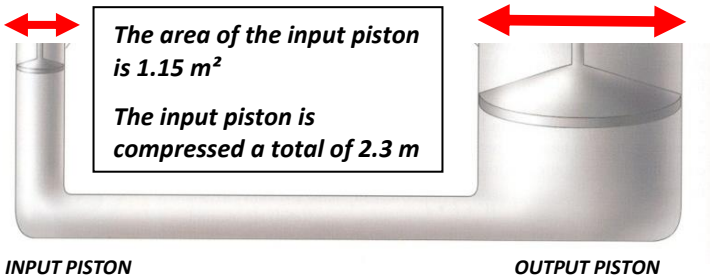
$= 62\ N / 0.09\ m^2$

$= 689\ N/m^2$

Which pump would you have to use with your injured arm to reach the minimum pressure of 650 Pa? <u>You would use Pump #2 since it creates a pressure of at least 650 Pa (689 Pa) and Pump #1 only creates a pressure of 564 Pa which is not enough pressure.</u>

Part II - Calculating Hydraulic Advantage

7.



a) Below, circle the formula in which you have enough information to calculate.

$MA = \frac{F_{output}}{F_{input}}$ $SAR = \frac{A_{output\ piston}}{A_{input\ piston}}$ $SR = \frac{D_{input}}{D_{output}}$

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b) Complete the calculation you circled above. Please show the formula and all of your work for this question. (***Follow the three line method and don't forget the units… round your answer to the nearest 100th***)

$SAR = A_{output\ piston} \div A_{input\ piston}$

$SAR = 8.2\ m^2 \div 1.15\ m^2$

/ 3 $SAR = 7.13$

∴ The surface area ratio would be 7.13.

c) Using your calculation from the previous question as well as the information given in the diagram, what will the output distance be that the output piston travels? (***Please round your answer to the nearest 100th***)

$SR = D_{input\ piston} \div D_{output\ piston}$

$7.13 = 2.3\ m \div D_{output\ piston}$

/ 3 $D_{output\ piston} \times 7.13 = 2.3\ m$

$D_{output\ piston} = 0.32\ m$

∴ The output piston travels 0.32 m.

d) Using the information from the diagram and the calculations you have already made, please calculate what the input force will have to be to make the output piston lift with its maximum force? (***please round your answer to the nearest 10th***)

$MA = F_{out} \div F_{in}$

$7.13 = 2530\ N \div F_{in}$

/ 3 $F_{in} \times 7.13 = 2530\ N$

$F_{in} = 354.8\ N$

∴ The input force will have to be 354.8 N.

e) Again, using the information you have calculated and the information given in the diagram, please calculate what the pressure will be for both the input and output piston? (Please show the formula and all of your work… ***Follow the three line method and do not forget the units. Also, round your answers to the nearest 10th)***

Input piston →

Output piston →

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Input Piston

$P = F / A$

$= 354.8\ N / 1.15\ m^2$

$= 308.4\ N/m^2$

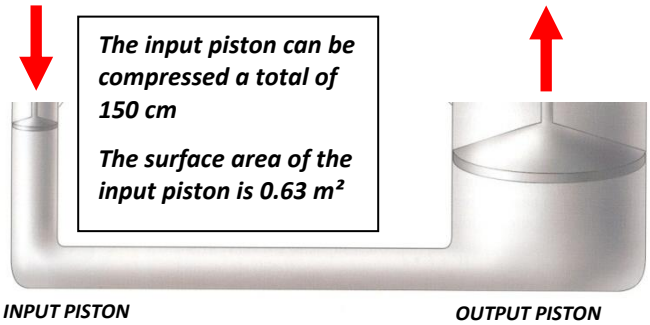
Output Piston

$P = F / A$

$= 2530\ N / 8.2\ m^2$

$= 308.5\ N/m^2$

8.



a) Below, circle the formula in which you have enough information to calculate.

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$MA = \frac{F_{output}}{F_{input}}$ $SAR = \frac{A_{output\ piston}}{A_{input\ piston}}$ $SR = \frac{D_{input}}{D_{output}}$

b) Complete the calculation you circled above. Please show the formula and all of your work for this question. (***Follow the three line method and don't forget the units… Round your answer to the nearest 10th***)

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$SR = D_{input\ piston} \div D_{output\ piston}$

$SR = 150\ m \div 32\ m$

$SR = 4.7$

∴ The Speed Ratio (SR) is 4.7.

c) Using your calculation from the previous question as well as the information given in the diagram, what will the surface area of the output piston be? (***Round your answer to the nearest 100th***)

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$SAR = A_{output\ piston} \div A_{input\ piston}$

$4.7 = A_{output\ piston} \div 0.63\ m^2$

$4.7 \times 0.63\ m^2 = A_{output\ piston}$

$2.96\ m^2 = A_{output\ piston}$

∴ The surface area of the output piston would be $2.96\ m^2$.

Using the information from the diagram and the calculations you have already made, please calculate what the input force will have to be to make the output piston reach its lifting force of 361 N? (***Round your answer to the nearest 100th***)

$MA = F_{out} \div F_{in}$

$4.7 = 361\ N \div F_{in}$

/ 3 $F_{in} \times 4.7 = 361\ N$

$F_{in} = 76.81\ N$

∴ The input force will have to be 76.81 N.

d) Again, using the information you have calculated and the information given in the diagram, please calculate what the pressure will be for both the input and output piston? (please show the formula and all of your work… ***do not forget the units)***

Input piston →

Output piston →

<u>Input Piston</u>

$P = F / A$

$= 76.81\ N / 0.63\ m^2$

$= 121.92\ N/m^2$

<u>Output Piston</u>

$P = F / A$

$= 361\ N / 2.96\ m^2$

$= 121.96\ N/m^2$

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9. Why is it that the calculated input piston pressure and the output piston pressure are the same for each question… why is the pressure is the same at both ends of the hydraulic system? (Be specific in you answer… use a quote from someone who we have talked about in class)

The pressure should be equal on all surfaces according to Pascal's Law

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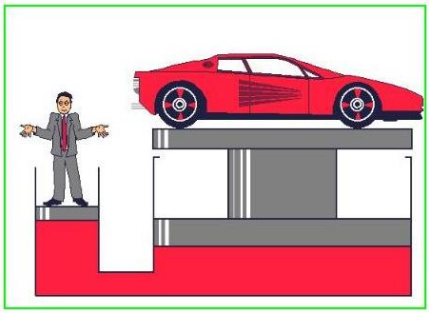
10. The man stepped onto a piston with an area of 2.1 m^2 while the Ferrari sat on a piston with an area of 25.2 m^2. The Ferrari then started to lift. If we know that it takes 2124 N of force to lift the Ferrari, what force is the man applying on the input piston? (***Show all of you work in two separate parts… do not forget the units when needed***)



<u>*Part I*</u>

$SAR = A_{output\ piston} \div A_{input\ piston}$

/ 5 $SAR = 25.2\ m^2 \div 2.1\ m^2$

$SAR = 12$

<u>*Part II*</u>

Use the SAR to get MA and use it to calculate the input force – $MA = F_{out} \div F_{in}$

$12 = 2124\ N \div F_{in}$

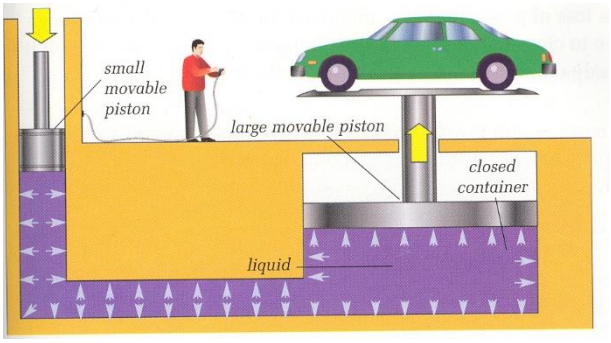
$F_{in} = 2124\ N \div 12$

$F_{in} = 177\ N$

∴ The Force the man would have to apply would be 177 N.

*Can use cross multiplication too.

11. If the input piston pushed down a total of 75 cm, and that lifted the car up 25 cm. What would the mechanical advantage and speed ratio be for this particular hydraulic lift? (***Please show your work using the 3 line method if you can***)



SR = $D_{input\ piston} \div D_{output\ piston}$

SR = 75 cm ÷ 25 cm

SR = 3

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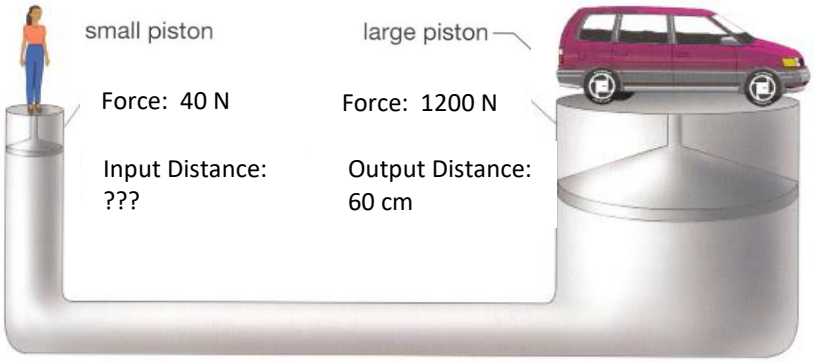
Since MA = SR

∴The Speed Ratio (SR) and Mechanical Advantage (MA) would both be 3. is 4.7.

12. Use the information found in the diagram to figure out how far the lady needs to push down on her end in order to lift the van 60 cm in the air?



Part I

MA = $F_{out} \div F_{in}$

MA = 1200 N ÷ 40 N

MA = 30

Part II

Use the MA of 30 and the SR formula to get Din

SR = $D_{input\ piston} \div D_{output\ piston}$

30 = $D_{input\ piston} \div$ 60 cm

1800cm = $D_{input\ piston}$

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∴The lady would have to push down 1800 cm or 1.8 m to raise the van 60 cm.

*Can do cross multiplication too

13. Give two reasons why the efficiency would be close to 100% for all hydraulic systems. Explain your answers in a sentence or two (assume that the liquid used to transfer pressure in the system is an oil which is very slick)

1 – Hydraulic systems transfer force efficiently since liquids are incompressible.

2- Hydraulic liquids are usually oil and oil lubricates to reduce friction.

3. No system is 100% efficient due to friction. While it is close, it is never 100%.

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