Hydraulics Math Problems

1. A water tank contains 14 feet of water. What is the pressure at the bottom of the tank?
2. A standpipe type water tank is 50 ft tall and 50 ft in diameter. The tank is filled to a depth of 24 ft and contains 2.9 million pounds of water. A globe type water tank is 75 feet tall and 35 feet in diameter. The water level is currently 24 ft above ground level. If water enters the distribution system at ground level for both tanks, which tank will provide the greatest system pressure?
3. A manhole lid is 48-inches in diameter and weighs 150 pounds. Stormwater has filled the manhole and lifted the lid out of place. How much pressure, in psi, was required to move the lid?
4. A distribution system contains 24-inch butterfly valves for directing flow. If the system pressure is 80 psi, how many pounds of force will be exerted on each closed valve?
5. An operator wants to use a hydraulic jack to lift a 30,000 lb vehicle. The jack platform is 7 ft wide and 18 feet long. How much hydraulic pressure (psi) is needed to lift the car?
6. According to Bernoulli's equation, increasing the velocity of the water moving through a pipe will also increase ________________ ________________.
7. A 12-inch diameter pipe is flowing full at 4 fps. If the pipe diameter decreases to 6-inch diameter, what will the new velocity be?
8. According to the *Safety Data Sheet, ferric chloride has a specific gravity of 1.4.* How much does one gallon of ferric chloride weigh?
9. A 6-inch pipeline needs to be flushed. If the pipe is 316 ft long, how many minutes will it take to flush the pipe at 31 gpm?
10. The pressure at the lowest bottom point of a well is 13.2 psi. What is the water depth of the *clear well at its lowest point?*
11. What is the pressure head on a system exerting a static pressure of 62 psi?
12. What is the velocity of flow in feet per second for a 10-inch diameter pipe if it delivers 550 gpm?

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1. $14\text{ ft} \left| \frac{0.433\text{ psi}}{1\text{ ft}} \right| = 6.06\text{ psi}$

2. Both tanks have the same height of water, so pressure is the same in each

3. Force = Pressure × Area
   lbs = psi × in^2 ← find area in square inches

Area = 0.785 × diameter^2
Area = (0.785)(48 in)(48 in)
Area = 1808.64 in^2

Force = Pressure × Area
150 lbs = Pressure × 1808.64 in^2

$\frac{150\text{ lbs}}{1808.64\text{ in}^2}$ = pressure

0.08 psi = pressure } just greater than this to move the lid

4. Force = Pressure × Area
   Force = (80 psi) × Area
   ↑ find this

Area = 0.785 diameter^2
Area = (0.785)(24 in)(24 in)
Area = 452.16 in^2

cont. 4. Force = Pressure × Area

Force = (80 psi)(452.16 in^2)

Force = 36,172 lbs

$$36{,}172 \text{ lbs} \left| \frac{1 \text{ ton}}{2000 \text{ lb}} \right| = 18 \text{ tons}$$

5. First, convert feet to inches

$$7 \text{ ft} \left| \frac{12 \text{ in}}{1 \text{ ft}} \right| = 84 \text{ in}$$

$$18 \text{ ft} \left| \frac{12 \text{ in}}{1 \text{ ft}} \right| = 216 \text{ in}$$

AREA = (LENGTH X WIDTH)

AREA = (216 in X 84 in)

AREA = 18144 in^2

Force = Pressure × Area

30,000 lb = Pressure × 18,144 in^2

$$\frac{30{,}000 \text{ lb}}{18{,}144 \text{ in}^2} = \text{Pressure}$$

1.65 psi

6. velocity head and total dynamic head

7. When the diameter of a pipe is doubled, the area increases by a factor of 4. Velocity will increase by a factor of 4.

(4 fps)(4) = 16 fps

8. $$\text{Specific Gravity} = \frac{\text{Density of X}}{\text{Density of Water}}$$

$$1.4 = \frac{\text{Density of X}}{8.34 \text{ lb/gal}}$$

$$11.7 \frac{\text{lb}}{\text{gal}} = \text{Density of X}$$

9. $$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}}$$ ← have this in gpm, so find volume in gallons

Volume = 0.785(diameter^2)(height)
Volume = (0.785)(0.5 ft)(0.5 ft)(316 ft)
Volume = 62.015 ft^3

↑ convert to gallons

cont.

9. $62.015\ ft^3 \left| \frac{7.48\ gal}{1\ ft^3} \right| = 463.87\ gal$

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}}$$

$$= \frac{463.87\ gal}{31\ gpm}$$

$$= 15\ min$$

10. $13.2\ psi \left| \frac{1\ ft}{0.433 psi} \right| = 30.5\ ft$

11. $62\ psi \left| \frac{1\ ft}{0.433 psi} \right| = 143.2\ ft$

12. $\text{Velocity} = \frac{\text{Flow}}{\text{Area}}$

③ Flow ← convert gpm to cfs so units will cancel

① Velocity ← this is in ft/s

② Area ← find this in ft^2

$10\text{-inch} \left| \frac{1\ ft}{12\text{-in}} \right| = 0.83\ ft$

$\text{Area} = (0.785)(\text{diameter})^2$

$\text{Area} = (0.785)(0.83\ ft)(0.83\ ft)$

$\text{Area} = 0.54\ ft^2$

$$\frac{550\ \text{gal}}{\text{min}} \left| \frac{1\ \text{min}}{60\ \text{sec}} \right| \frac{1\ \text{ft}^3}{7.48\ \text{gal}} = 1.225\ \text{cfs}$$

$$\text{Velocity} = \frac{\text{Flow}}{\text{Area}}$$

$$\text{Velocity} = \frac{1.225\ \text{cfs}}{0.54\ \text{ft}^2}$$

$$\text{Velocity} = 2.27\ \text{ft/s}$$