9 Solve the following numerical problems.

a. the weight of a piece of stone when fully immersed in water is 20N. If it displaces 5N of water, what will be weight of the stone in air?

→ Sol-n

Given,

weight of stone fully immersed in water ($W_2$) = 20N

upthrust (water displaced's weigh) (U) = 5N

weight of stone in Air ($W_1$) = ?

Now,

we know that,

$U = W_1 - W_2$

or $5 = W_1 - 20$

$W_1 = 25N$

weight of stone in Air will be 25N.

b. In a hydraulic press, area of the large piston is $40cm^2$ whereas the area of small piston is $8cm^2$. what weight can be balanced in the large piston if 200N effort is applied on small piston?

→ Sol-n

Area of large piston ($A_2$) = $40cm^2$

Area of small piston ($A_1$) = $8cm^2$

Force applied on small piston ($F_1$) = 200N

Force obtained on large piston ($F_2$) = ?

Now,

we know that,

From pascal's law

$$P_1 = P_2$$

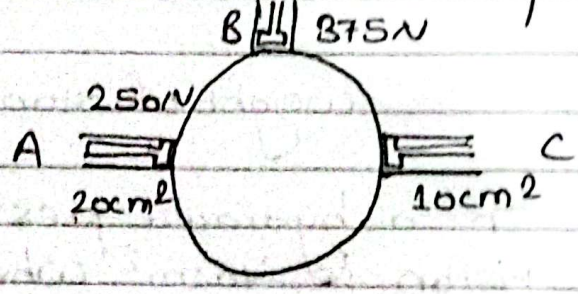
$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

or, $\frac{200}{8} = \frac{F_2}{40}$

or, $F_2 = 1000N$

Thus, weight of 1000N can be balanced on large piston.

c. Pistons A, B and C of the apparatus given are frictionless. What is the Area of the piston B? what force is exerted on the piston C?




Soln

Given

piston A Area $(A_A) = 20cm^2$

piston A Force $(F_A) = 250N$

Piston B Area $(A_B) = ?$

Piston B Force $(F_B) = 375N$

Piston C Area $(A_C) = 10cm^2$

Piston C Force $(F_C) = ?$

Now,

From pascal's law

$$\frac{F_1}{A_1} = \frac{F_2}{A_2} = \frac{F_3}{A}$$

$$\frac{F_A}{A_A} = \frac{F_B}{A_B} = \frac{F_C}{A_C}$$

or, $\frac{250N}{20cm^2} = \frac{375N}{A_B} = \frac{F_C}{10cm^2}$

Now,

$$\frac{250}{20} = \frac{375}{A_B}$$

$$A_B = \frac{375 \times 20}{250}$$

$$A_B = 30cm^2$$

Also,

$$\frac{250}{20} = \frac{F_C}{10}$$

$$F_C = \frac{250 \times 10}{20}$$

$$F_C = 125N$$

Thus, Area of piston B is $30cm^2$,
Force exerted on piston C is 125N.

d. A pressure of 50,000 N/m² has been developed in liquid used in a hydraulic lift of a house. If the area of cross-section of the piston used to lift the load is 0.1m². Calculate the weight that lift can raise.

→ Soln Gr

Given,

pressure developed in hydraulic lift (P) = 50,000
Area of piston (A) = 0.1m²
Force or weight that can be lifted (F) = ?

Now,

We know that,

$P = \frac{F}{A}$

$50,000 = \frac{F}{0.1}$

$F = 5000\ N$.

Thus, weight of 5000N can be lifted.

e. A piece of stone with volume 400cm³ and density 7800 Kg/m³ is immersed completely in water. If the density of water is 1000 Kg/m³, calculate the weight of stone in air. What is upthrust of water?

→ Soln

Given

Volume of piece of stone (V) = 400cm³ = 0.0004m³
density of stone (ds) = 7800 Kg/m³
density of water (dw) = 1000 Kg/m³
weight of stone in Air (w) = ?

upthrust of water (U) = ?

Now

we know, that

weight of stone in Air = $d_s \times g \times V$

$= 7800 \times 10 \times 0.0004$

$= 31.2N$

[since stone is fully immersed water displaced and stone have same]

Also,

upthrust due to water U = $d_w \times g \times V$

$= 1000 \times 10 \times 0.0004$

$= 4N$

Thus,

weight of stone in Air is 31.2N.

upthrust of water is 4N

1 The cross-sectional areas of small and big pistons of a hydraulic lift are in the ratio 1:6. If an effort of 500N is applied through small piston, what weight will be lifted by the large piston?

Soln

Given,

Ratio of Areas of small and big piston $\left(\frac{A_1}{A_2}\right) = 1:6$

Force applied on small piston $(F_1) = 500N$

Force obtained on large piston $(F_2) = ?$

Now,

We know that,

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$F_2 = F_1 \times \frac{A_2}{A_1}$$

$$F_2 = F_1 \times \frac{1}{\frac{A_1}{A_2}}$$

$$F_2 = 500 \times \frac{1}{\frac{1}{6}}$$

$$F_2 = 5000 \times 6$$

$$F_2 = 3000N$$

Thus, weight of 3000N can be lifted by large piston.

g weights of stone in three different mediums air, water and salt solutions are as follows:

| medium | weight |
|---|---|
| A | 10N |
| B | 15N |
| C | 12N |

i. which medium is Air and which one is water? why?

Soln

medium B is Air due to less upthrust by Air causing highest weight of stone

medium C is water because of ~~upthrust~~ ~~no~~ Stone's weight being lesser than medium B and higher than medium A, medium A being most dense will have most upthrust making stone's weight lightest

ii. what is upthrust given by water and salt solution to the stone?

upthrust given by water = weight of stone in Air - weight of stone in water

= 15 - 12

= 3N

upthrust given by salt solution = weight of stone in Air - weight of stone in salt solution

= 15 - 10

= 5N