# Solution Manual for Fluid Mechanics 1st Edition by Hibbeler ISBN 0132777622 9780132777629

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**1–1.** Represent each of the following quantities with combinations of units in the correct SI form, using an appropriate prefix: (a) GN • mm, (b) kg / mm, (c) N /ks, (d) kN / ms.

SOLUTION

a) GN· mm = (10')N(1O)m = 10'N·m=kN·m **Ans.**

b) kg/mm=(10')g/(1O)m =10'g/m=Gg/m **Ans.**

d) kN/ms = (10')N/(1O)s = 10'Ns =GN/s **Ans.**

**Ans:**

**a)** kN • m
**b)** Gg /m
**c)** pN / s2
**d)** GN /s

**1–2.** Evaluate each of the following to three significant figures, and express each answer in SI units using an appropriate prefix: (a) (425 mN), (b) $(67300\ \text{ms})^2$. (e) [723(10)] mm

## SOLUTION

a) $(425\ \text{mN})^2 = [425(10)\text{N}] = 0.181\ \text{N}$ **Ans.**

b) $(67\ 300\ \text{s}) = [67.3(10)(10)\text{s}] = 4.53(10)\text{s}$ **Ans.**

e) $[723(10)]/\text{mm} = [723(10)][(10)\text{m} = 26.9\ \text{m}$ **Ans.**

**Ans:**
**a)** 0.181 N
**b)** 4.53(10')s
**c)** 26.9 m

**1–3.** Evaluate each of the following to three significant figures, and express each answer in SI units using an appropriate prefix: (a) 749 m/63 ms, (b) (34 mm)(0.0763 Ms)/263 mg, (c) (4.78 mm)(263 Mg).

## SOLUTION

a) 749 m/63 ms = 749(1O)m/63(1O)s = 11.88(1O)m/s
= 119 mm/s **Ans.**

b) (34 mm(0.0763 Ms)/263 mg = [34(1O7)m][0.0763(1O)s]/[263(10)(10)g]
= 9.86(10°) m·s/kg = 9.86Mm·s/kg **Ans.**

e) (4.78 mm)(263 Mg) = [4.78(10) m][263(1O)g]
= 1.257(1O) g·m = 1.26Mg·m **Ans.**

**Ans:**
**a)** 11.9 mm/s
**b)** 9.86 Mm·s/kg
**e)** 1.26 Mg·m

**1-4.** Convert the following temperatures: (a) 2OC to degrees Fahrenheit, (b) 500 K to degrees Celsius, (c) 125F to degrees Rankine, (d) 215F to degrees Celsius.

## SOLUTION

a) $T_e = \frac{5}{9}(T_r - 32)$

2Or = }C - 32 **Ans,**

$T_r = 68.0F$

b) $T_e = T_e + 273$ **Ans.**

500K = $T_e$ + 273

$T_c$ = 227Cc

e) $T = T_e + 460$ **Ans.**

$T_e$ = 125F + 460 = 585R

) $T_e = \frac{5}{9}(T_r - 32)$ **Ans.**

$T_c$ = ¾(21s°F – 32) = 102°c

**1–5.** Mercury has a specific weight of 133 kN/m' when the temperature is 2OC. Determine its density and specific gravity at this temperature.

## SOLUTION

$y = pg$

$133(10^3)\ N/m^3 = \rho_m (9.81\ m/s^2)$

$\rho_m = 13558\ kg/m^3 = 13.6\ Mg/m^3$ **Ans.**

$S = \frac{\rho_e}{\rho_w} = \frac{13558\ kg/m^3}{1000\ kg/m^3} = 13.6$ Ans.

**Ans:**
$\rho_e = 13.6\ Mg/m^3$
$S_e = 13.6$

**1-6.** The fuel for a jet engine has a density of $1.32\ slug/ft^3$. If the total volume of fuel tanks *A* is $50\ ft^3$, determine the weight of the fuel when the tanks are completely full.


## SOLUTION

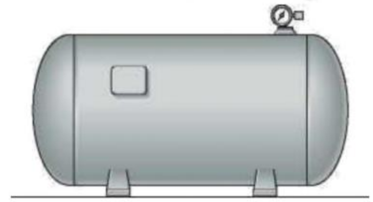
The specific weight of the fuel is

$\gamma = \rho g = (1.32\ slug/ft^3)(32.2\ ft/s^2) = 42.504\ lb/ft^3$

Then, the weight of the fuel is

$W = \gamma V = (42.504\ lb/ft^3)(50\ ft^3) = 2.13(10^3)\ lb = 2.13\ kip$ **Ans.**

**Ans:**
$y = 42.5 lb/ft$
$W = 2.13 kip$



**1–7.** If air within the tank is at an absolute pressure of 680 kPa and a temperature of 7OC, determine the weight of the air inside the tank. The tank has an interior volume of 1.35 m.

## SOLUTION

From the table in Appendix A, the gas constant for air is $R = 286.9 J/kg \cdot K$.

$$p = RT$$

$$680(10) N/m = 0(286.9 J/kg \cdot K)(70° + 273)K$$

$$p = 6910 kg/m$$

The weight of the air in the tank is

$$w = og = (6910 kg/m')(9.81 m/s)(1.35 m)$$

$= 91.5$ **N** **Ans.**

**Ans:**
91.5 N

**1-8.** The bottle tank has a volume of 112 m' and contains oxygen at an absolute pressure of 12 MPa and a temperature of 30C. Determine the mass of oxygen in the tank.

## SOLUTION

From the table in Appendix A, the gas constant for oxygen is $R = 259.8 \text{ J/kg}\cdot\text{K}$.

$$p = \rho RT$$

$$12(10)\ \text{N/m} = \rho(259.81/\text{kg}\cdot\text{K})(30^\circ + 273)\text{K}$$

$$\rho = 152.44 \text{ kg/m}$$

The mass of oxygen in the tank is

$$m = \rho V = (152.44 \text{ kg/m})(0.12 \text{ m})$$

$$= 18.3 \text{ kg}$$

**Ans.**

**1–9.** The bottle tank has a volume of 0.12 $m^3$ and contains oxygen at an absolute pressure of 8 MPa and temperature of 20°C. Plot the variation of the temperature in the tank (horizontal axis) versus the pressure for 20°C ≤ $T$ ≤ 80°C. Report values in increments of $\Delta T$ = 10°C.

## SOLUTION

From the table in Appendix A, the gas constant for oxygen is $R$ = 259.8 J/(kg·K). For $T$ = (20°C + 273) K = 293 K.

$$p = \rho RT$$

$$8(10^6)\ \text{N/m}^2 = \rho[259.8\ \text{J/(kg·K)}](293\ \text{K})$$

$$\rho = 105.10\ \text{kg/m}^3$$

Since the mass and volume of the oxygen in the tank remain constant, its density will also be constant.

$$p = \rho RT$$

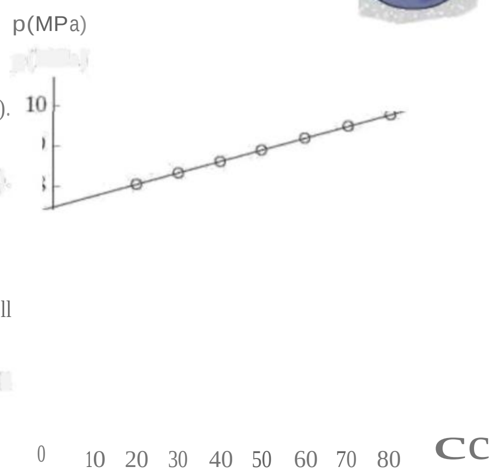
$$p = (105.10\ \text{kg/m}^3)[259.8\ \text{J/(kg·K)}](T + 273)$$

$$p = (0.02730\ T + 7.4539)(10^6)\ \text{Pa}$$

$$p = (0.02730\ T_C + 7.4539)\ \text{MPa where } T_C \text{ is in °C.}$$

The plot of $p$ vs $T_C$ is shown in *Fig. a*.

| $T_C$ (°C) | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
|---|---|---|---|---|---|---|---|
| $p$ (MPa) | 8.00 | 8.27 | 8.55 | 8.82 | 9.09 | 9.37 | 9.64 |



(a)

**Ans:**
$p = (0.0273\ T_C + 7.45)$ MPa, where $T_C$ is in °C

**1-10.** Determine the specific weight of carbon dioxide when the temperature is 100°C and the absolute pressure is 400 kPa.

## SOLUTION

From the table in Appendix A, the gas constant for carbon dioxide is $R = 188.9$ J/kg · K.

$p$

$$= \rho R T$$

$$400(10^3)\ \text{N/m}^2 = \rho(188.9\ \text{J/kg} \cdot \text{K})(100° + 273)\,\text{K}$$

$$\rho = 5.677\ \text{kg/m}^3$$

The specific weight of carbon dioxide is

$$\gamma = \rho g = (5.677\ \text{kg/m}^3)(9.81\ \text{m/s}^2)$$

$$= 55.7\ \text{N/m}^3$$ **Ans.**

**Ans:**
$55.7\ N/m^3$