Chapter 1 (Dimension law and conversion of unit)

1- A certain brand of house paint claims a coverage of 500 ft* *2 / gal (1 ft = 30.48 cm; 1 gal = 3.78 liter). Express this quantity in m* *2/liter. (A: 12.3)

2- Speed of sound is 330 m/s. Express this in miles per hour (1 mile = 1609 m). (A: 738 miles/h)

3- The average radius of a nucleus is R = 10.0 fm. Find the density of the nucleus which has a mass of 15u [1 fm = 10**(-15) m, 1 u = 1.66* 10**(-27) kg. (A: 5.94* 10** 15 kg/m* * 3)

4- Speed of sound is 340 m/s. Express this in millimeters per nanosecond. [1 ns = 10**(-9)s] . (A: 3.40* 10**(-4) mm/ns)

5- The standard kilogram is a platinum-iridium cylinder 39 mm in height and 19.5 mm in radius. What is the density of the material? (A: 21 g/cm**3)

6- During a short interval of time the velocity v in m/s of an automobile is given by $v = at^2 + bt^3$, where the time t is in seconds. The units of a and b are respectively: (A: m/s^3; m/s^4)

7- Suppose A = BC, where A has the dimensions L/M and C has the dimensions L/T. Then B has dimension: (A: T/M)

8- Suppose $A = B^n C^m$, where A has dimensions LT, B has dimensions L^2T^{-1}, and C has dimensions LT^2. Then the exponents n and m have the values: (A: 1/5; 3/5)

Remember the following

Circumference of a circle

Area of a circle

Surface area of a sphere

Volume of a sphere

Surface area of a right circular cylinder

Volume of a right circular cylinder

length [L] m
time [T] s
mass [M] kg

① A. 500 $ft^2/gal \equiv ?(m^2/liter)$

$1\,ft = 30.48\,cm$

$1\,gal = 3.78\,liters$

$$A = 500\left(\frac{ft^2}{gal}\right)\left(\frac{30.48^2\,cm^2}{1\,ft^2}\right)\left(\frac{1\,m^2}{100^2\,cm^2}\right)\left(\frac{1\,gal}{3.78\,liters}\right)\left(\frac{3.78\,liters}{1\,gal}\right)$$

S.F: 3

$$= \frac{500 * 30.48^2 \times 3.78}{100^2 \times 3.78}\left(\frac{m^2}{liter}\right) = \boxed{12.3}$$

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② Sped of Sound $= \boxed{334}\,\frac{m}{s} \equiv ?\,\frac{miles}{hour}$ (3)

$1\,mile = 1609\,M$

$1\,h = 3600\,sec$

$$S = 334\left(\frac{m}{s}\right)\left(\frac{1\,mile}{1609\,m}\right)\left(\frac{3600\,s}{1\,h}\right)$$

$$= \frac{330 \times 3600}{1609}\left(\frac{mile}{h}\right) \equiv \boxed{738.35}$$ (3)

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③

$R = 10.0\,fm$

$1\,fm = 10^{-15}\,m$

$1\,u = 1.66 \times 10^{-27}\,kg$

$\rho = ?$

$m = 15\,u$

$$\rho = \frac{m}{V} = \frac{15(u)\left(\frac{1.66 \times 10^{-27}}{1\,u}\right)}{2357.14 \times 10^{45}}$$ (3)

$$= \frac{1.056 \times 10^{-14}}{}$$

$$= \frac{5.942 \times 10^{-27} \times 10^{45}}{1000}$$

$$= 5.94 \times 10^{15}\,\frac{kg}{m^3}$$

$$V = \frac{4}{3}\pi R^3$$

$$= \frac{4}{3}\pi (10.0)^3$$

$$= \frac{4}{3}\pi\,1000$$ (2)

$$= 2357.14\ (3)\ fm^3$$

$$= 2357.14 \times 10^{-45}\ m^3$$ (3)

(4) $S = 340 \frac{m}{s} = ? \frac{mm}{ns}$

$$S = 340 \left(\frac{1}{s}\right)\left(\frac{1000\,mm}{m}\right)\left(\frac{1}{10^9\,ns}\right)$$

$$= \frac{340 \times 1000}{10^9} = 3.40 \times 10^{-4} \left(\frac{mm}{ns}\right)$$

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(5) $h = 39\,mm$ (2)
$R = 19.5\,mm$ (5)
$m = 1\,kg$

$V = \pi R^2 h$
$= \frac{22}{7}(1.95)^2(39)\,mm^3$
$= 466.1\,(mm^3)\left(\frac{1\,cm}{10\,mm}\right)^3$
$= 466.1 \times 10^{-9}$
$= 4.66 \times 10^{-7}\,m^3$

? $\rho = \frac{m}{V}$

$= \frac{1}{4.66} \times 10^7$

$= 2.1 \times 10^4 \left(\frac{kg}{m^3}\right)$

$= 2.1 \times 10^4 \left(\frac{kg}{m^3}\right)\left(\frac{1000\,g}{1\,kg}\right)\left(\frac{1\,m^3}{10^6\,cm^3}\right)$

$= 21 \frac{g}{cm^3}$

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(6) $u = at^2 + bt^3$

$\left[\frac{m}{s}\right] = a s^2$; $\frac{m}{s} = b s^3$

$\Rightarrow a = \left[\frac{m}{s^3}\right]$; $b = \left[\frac{m}{s^4}\right]$

7) $A = BC \quad A = \frac{L}{M} \quad C = \frac{L}{T} \quad B = ?$

$\frac{L}{M}$

$\frac{m}{kg} = B \frac{m}{s}$

$B = \frac{m}{kg} \frac{s}{m}$

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8) $A = B^n C^m$

$ms = \left(\frac{m^2}{kg}\right)^n \left(\frac{m}{s^2}\right)^m = \frac{m^{2n+m}}{s^{n+2m}}$

$1 = 2n + m$
$1 = n - 2m$
$-2 = -2n + 4m$
$-1 = 5m \quad m = \frac{1}{5}$

$1 = 2n + \frac{1}{5}$
$\frac{5}{5} - \frac{1}{5} = 2n$
$\frac{4}{5} = 2n$
$\frac{2}{5} = n$

2

$ms = \left(\frac{m^2}{s}\right)^n (m\,s^2)^m$

$ms = \left(\frac{m^{2n}}{s^n}\right)\left(m^m s^{2m}\right)$

$ms = \left(m^{2n+m}\right)\left(s^{2m-n}\right)$

$1 = 2n + m$
$1 = -n + 2m$
$2 = -2n + 4m$
$3 = 5m$
$m = \frac{3}{5}$

$1 = 2n + m$
$1 - \frac{3}{5} = 2n$
$\frac{5}{5} - \frac{3}{5} = \frac{2}{5} = 2n \quad n = \frac{1}{5}$