5th June '08

PHYS-141
Homework Solutions.
Homework – 1

#5 :

Radius of Sphere-1 : $R_1 = 4.50\,cm$.

Let the Radius of Sphere-2 be R_2 cm.

R_2 is unknown and is to be found.

Given that the rock from which these two spheres are cut-out is UNIFORM, we conclude that they both have the same density.

Let that density be ρ gm/cm^3.

$$\text{Mass} = \text{density} \times \text{Volume} \Rightarrow \text{Mass} = (\text{density})(\text{Volume}) \text{ gm}$$

Also given that : Mass of Sphere-2 (M_2) is five times greater than M_1.

$$\therefore \frac{M_2}{M_1} = 5 .$$

$$\therefore \quad M_2 = \rho \cdot \left(\frac{4}{3} \cdot \pi R_2^3\right) \cdot \frac{gm}{cm^3} \cdot cm^3$$

$$M_1 = \rho \cdot \left(\frac{4}{3} \pi R_1^3\right) \frac{gm}{cm^3} \cdot cm^3$$

$$\therefore \quad \frac{M_2}{M_1} = 5 \Rightarrow \frac{\rho \cdot \frac{4}{3} \pi R_2^3}{\rho \cdot \frac{4}{3} \pi R_1^3} = 5 \Rightarrow \frac{R_2^3}{R_1^3} = 5$$

$$\therefore \boxed{R_2 = \sqrt[3]{5} \cdot R_1}$$

Use the value $R_1 = 4.5$ cm to compute R_2.

$$R_2 = 7.69 \text{ cm.}$$

(#9.) Newton's law of Gravitation:

$$F = \frac{G M m}{r^2}.$$

Units of Force: $kg \cdot m/s^2$

" " Mass: kg.

" " Distance: m.

$$\therefore \quad \{F\} = \frac{\{G\} \cdot \{M\} \cdot \{m\}}{\{r^2\}}$$

$$kg \cdot \frac{m}{s^2} = \frac{\{G\} \cdot (kg)^2}{m^2}$$

$$\therefore \boxed{\{G\} = \frac{m^3}{(kg)\, s^2}} \rightarrow \text{S.I. units of } G.$$

#12 Dimensions of the auditorium:

$$40.0\ m \times 20.0\ m \times 12.0\ m.$$

$\therefore$ Volume $= V = 40.0 \times 20.0 \times 12.0\ m^3$

Density of air $= \rho = 1.20\ kg/m^3$

(a) Volume of the room in Cubic feet.

$V =$ ~~96000 m^3~~ $9.60 \times 10^3\ m^3$ [each multiplican has 3 sig. figs]

$= $ ~~9600~~ $9.60 \times 10^3 \cdot (3.281\ ft)^3$

$$\boxed{1\ m = 3.281\ ft}$$

$\therefore V = 9.60 \times 10^3 \times (3.281)^3 (ft)^3 = 3.39 \times 10^5\ (ft)^3$.

(b) Weight of air in pounds:

Mass of air = Volume × density

$= 9.60 \times 10^3\ m^3 \times 1.20 \times \frac{kg}{m^3}$

$= 9.60 \times 1.20 \times 10^3\ kg.$

$= 9.60 \times 1.20 \times 10^3 \cdot (0.454)\ lbs$

$= 5.23 \times 10^3\ lbs.$

#14

It takes 7.00 min to fill a 30.0 gal gasoline tank.

(a): Rate at which tank is filled → in gal/s

∴ 30.0 gal in (7.00 × 60) sec.

∴ 30.0 gal in 420 sec.

∴ Flow rate = $\frac{30.0\ gal}{420.\ sec} = 7.14 \times 10^{-2}\ \frac{gal}{sec}$

(b) What is this rate in m^3/s ?

$1\ gal = 231\ (in)^3 = (231)(2.54\ cm)^3 = (231)(2.54)^3 \times 10^{-6}\ m^3$

∴ Volume flow rate

$$= 7.14 \times 10^{-2} \frac{gal}{sec} = 2.70 \times 10^{-4} \frac{m^3}{s}.$$

#21.

Volume of paint = $V = 3.78 \times 10^{-3}\ m^3$.

Area of paint = $A = 25.0\ m^2$.

What is the thickness = t ?

$$V = A \cdot t$$

$$\therefore \quad t = \frac{V}{A} = \frac{3.78 \times 10^{-3}\ m^2}{25.0\ m^2}$$

$$t = \frac{3.78}{25.0} \times 10^{-2}\ m$$

$$t = 1.51 \times 10^{-4}\ m.$$

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28 Total amount of money = $ 1 billion

$= 1 \times 10^9$ dollars.

Time to count one dollar bill = 1 sec.

∴ To count 10^9 bills, we require 10^9 sec.

If we have 8 hours a day for sleeping and eating, we have the rest of 16 hours for counting.

* No. of seconds in a day = ~~24(hr) × 60(min) × 60 sec~~

24 hr = 24 × 60 min = 24 × 60 × 60 sec

= 86,400 sec.

∴ In 16 hours, we have: $\frac{16^{2}}{24_{3}} \times 86{,}400^{28800} = 57{,}600$ sec

∴ If we need N days to finish counting,

$$(N)(57600) = 1 \times 10^{9}$$

$$\therefore N = \frac{1 \times 10^{9}}{57{,}600} = 17{,}400 \text{ days.}$$

This is a really long time! More than 40 years!

#31 How many significant figures in the following?

(a) 78.9 ± 0.2

As both numbers have 1 decimal place each, the final answer will have 1 decimal place.

Therefore: $78.9 + 0.2 = 79.1$ } 1 decimal place.
$78.9 - 0.2 = 78.7$ }

3 sig. figs in total.

(b) 3.788×10^{9} ⟶ 4 sig. figs.

(c) 2.46×10^{-6} ⟶ 3 sig. figs.

(d) $0.0053 = 5.3 \times 10^{-3}$ ⟶ 2 sig. figs.

Note: a decimal number should be brought to an exponential form as above to decide on the number of significant digits.

#33 (a) $756 + 37.2 + 0.83 + 2.5 = ?$

Rule: When adding a set of numbers, the final result should have the same number of DECIMAL PLACES as in the number which has the fewest decimal places.

We add up all the numbers first to get the result 796.53. But 756 has NO DECIMAL PLACE

∴ 796.53 is rounded off to 797.

∴ $756 + 37.2 + 0.83 + 2.5 = 797.$

(b) 0.0032×356.3

Rule: In multiplication of two numbers, the product should have the same number of SIGNIFICANT DIGITS

as that of the number with the fewest SIGNIFICANT FIGURES.

$\therefore \quad 0.0032 = 3.2 \times 10^{-3} \longrightarrow$ 2 sig. figs.

$356.3 \longrightarrow$ 4 sig. figs

$\therefore \quad 356.3 \times 0.0032 = 356.3 \times 3.2 \times 10^{-3} = \underline{1.1} \longrightarrow$ 2 sig figs

(C): $5.620 \times \pi = ?$

π is an irrational number. So, it has ~~a~~ a non-terminating ~~fraction~~ decimal as its value whereas, 5.620 has 4 ~~deci~~ significant figures.

$\therefore$ $5.620 \times \pi$ has 4 sig. figs.

$5.620 \times 3.142 = 17.656 \longrightarrow \underline{17.66}$.