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Physics 590
Dr. Larry Gladney & Bill Berner
Week 1, Homework 2

I should have used a different method.

1.2.1

Assumptions & Parameters:

- *My measuring tool, a 12" ruler, is accurate*
- *Measurements are rounded to the nearest whole centimeter*

Body Part	Dimensions (cm)	Formula & Thinking	Volume (cm^3)
Head Including ears	r = 7	$V_{sphere} = 4/3 \cdot \pi \cdot r^3$ $V_{sphere} = 4/3 \cdot \pi \cdot 7^3$	1,436.76
Arms From wrist to shoulder	r = 3 h = 46	$V_{cylinder} = 4/3 \cdot \pi \cdot r^2 \cdot h$ $V_{cylinder} = 4/3 \cdot \pi \cdot 7^2 \cdot 46$	2,601.24
Hands Both together, forming a rough rectangular prism	l = 16 w = 3 h = 5	$V_{rectangle} = l \cdot w \cdot h$ $V_{rectangle} = 16 \cdot 3 \cdot 5$	240
Body From shoulder to lower hip	l = 32 w = 13 h = 47	$V_{rectangle} = l \cdot w \cdot h$ $V_{rectangle} = 32 \cdot 13 \cdot 47$	19,552
Legs From lower hip to ankle	r = 6 h = 66	$V_{cylinder} = 4/3 \cdot \pi \cdot r^2 \cdot h$ $V_{cylinder} = 4/3 \cdot \pi \cdot 6^2 \cdot 66$	7,464.42
Feet Both together, forming a rough rectangular prism	l = 20 w = 7 h = 9	$V_{rectangle} = l \cdot w \cdot h$ $V_{rectangle} = 20 \cdot 7 \cdot 9$	1,260
		Estimate of the volume of my body:	32,554.42 cm^3

The volume of my body is about 3.6 x 10^4 cm^3.

1.2.2

Assumptions & Parameters:

- *My measuring tool, a tape measurer, is accurate*
- *Measurements are rounded to the nearest whole foot*
- *Emptying the bag of grass is included in the estimated time: it takes my friend, Heather, about 25 minutes to mow her backyard that is 30 x 60', or 1800 sq ft*
- *An American football field is 360' x 160', including end zones and from one coaching box to the opposite coaching box*

Area	Dimensions (ft)	Area (ft^2)	Estimated Time to Mow	Estimated Area mowed per minute (ft^2)
Backyard	30 x 60	1,800	25 minutes	72
Football Field	160 x 360	57,600	800 minutes or 13 hours and 20 minutes	72

It would take about 13 hours for a person to mow a football field using an ordinary home lawn mower.

1.2.3

Assumptions & Parameters:

- *There are 1.1 million households*
- *There are 2 cars per American household*
- *Tread's depth is 1 cm*
- *The 1-cm tread wears away after 50,000 miles or in about 5 years*
- *All tires wear at the same rate or 1 cm in 5 years*
- *Each year, all tires wear 1/5 cm*
- *Average tire that Americans own are like my Corolla: 29 cm in diameter and 15 cm wide.*
- *Space between the treads are not accounted for*
- *Rubber that is worn on roads such as screech marks are not accounted for*

This is an inaccurate number to use

Finding length of tire when flattened	Finding volume of tread of 1 tire	Finding the mass of the tread of 1 tire
D = 29 cm – 2 cm (tread on each side, one end to opposite end) C = π d C = π 27 C = 84.82 cm = length of rubber when flattened	L = C = 84.82 cm W = 15 cm H = thread depth = 1cm $V_{rectangle} = l \cdot w \cdot h$ $V_{rectangle}$ = 84.82 x 15 x 1 $V_{rectangle}$ = 1,272.34 cm^3 $V_{rectangle}$ = 0.8482 x 0.15 x 0.01 m $V_{rectangle}$ = 1.2723 x 10^{-3} m^3 In 1 year, tire wears 1/5 of 1.2723 x 10^{-3} m^3	D = m/v D_{rubber} = 1200 kg/m^3 D_{rubber} = 1200 kg / 1m^3 $\frac{1200kg}{1\ m^3} = \frac{kg}{1.2723 \times 10^{-3}\ m^3} =$ $\frac{(1200\ kg)\ (1.2723 \times 10^{-3}\ m^3)}{1\ m^3} =$ 1.52676 kg of tread per tire

Every 5 years, the amount of tire worn is:
(1.1 x 10^6 households) x (2 cars / household) x (4 tires / car) x (1.52676 kg tread / tire) = 13,435,488 kg of tread

Each year, the amount of rubber worn is:
1/5 of 13,435,488 kg of tread → 13,435,488 kg ÷ 5 = 2,687,097.6 kg

About 2.687 x 10^6 kg of rubber is put into the air in the United States every year.

My calculations were incorrect because of one minor error in notation.

1.2.4

Assumptions & Parameters:

- *The density of a rock is 3 kg/l or 3 kg/1000cm³*
- *The density of aluminum is 2.70 g/ml*
- *The density of gold is 19.3 g/ml*
- *D = m/v*
- *1 ton is equivalent to about 907.18 kg*

$$D_{Rock} = \frac{3\text{ kg}}{1} = \frac{3\text{kg}}{1000\text{ cm}^3} = \frac{0.003\text{ kg}}{\text{cm}^3}$$

$$\frac{0.003\text{ kg}}{\text{cm}^3} \times \frac{1\text{ Ton}}{907.18\text{ kg}} = 3.306951211 \times 10^{-6}\text{ T/cm}^3$$

$$\frac{3.306951211 \times 10^{-6}\text{ T}}{\text{cm}^3} = \frac{1\text{ T}}{X\text{ cm}^3}$$

$$X = 302{,}393.3334\text{ cm}^3$$

$V_{sphere} = 4/3 \cdot \pi \cdot r^3$
$r^3 = V / (4/3 \cdot \pi)$
$r^3 = 302{,}393.3334\text{ cm}^3 / (4/3 \cdot \pi)$
$r^3 = 72{,}191.09065\text{ cm}^3$
$r = 41.63844808\text{ cm}$

The volume of a rock that weighs one ton is about 3×10^5 cm³ with a radius of about 4×10^1 cm.

1.2.5

Assumptions & Parameters:

- *The universe is now 13.7 billion years old*
- *The universe has been expanding constantly at the speed of light, 2.998×10^8 m/s*
- *The radius of the universe is 13.7×10^9 light years now*

Speed of light = 2.998×10^8 m/s

2.998×10^8 m/s x 3600 s /hour x 24 hours/day x 365 days/year = 9.4544928×10^{15} m/year

Speed of light = 9.4544928×10^{15} m/year

Light travels in 13.7 billion years:
9.4544928×10^{15} m/year x 13.7 billion years = $1.295265514 \times 10^{26}$ m
Therefore, the universe's radius is $1.295265514 \times 10^{26}$ m.

(If the universe is assumed to be 10 billion years old, then 9.4544928×10^{15} m/year x 10 billion years = 9.4544928×10^{25}m; and the universe's radius is 9.4544928×10^{25}m. In this case, the volume of the universe would be $3.540000437 \times 10^{78}$ m³ or 3.540×10^{78} m³.)

Finding the volume of the universe:
$V_{sphere} = 4/3 \cdot \pi \cdot r^3$
$V_{sphere} = 4/3 \cdot \pi \cdot (1.295265514 \times 10^{26}\text{ m})^3$
$V_{sphere} = 9.110807615 \times 10^{78}\text{ m}^3$
$V_{sphere} = 9.111 \times 10^{78}\text{ m}^3$

The volume of the universe is about 9.111×10^{78} m³.