Name: ______________________ Period: _____

11-2 Density and Design

Notes

Using a yardstick, work with a partner to measure the length and the width of the classroom. Record your measurements below. Use these measurements to find the area of the classroom.

Length: 353.5 in

Width: 369.75 in

Area: $lw = (353.5)(369.75) = 130706.63 \text{ in}^2$ (907.69 ft^2)

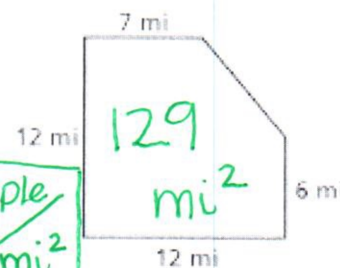
Count the number of people in the classroom. How much area can each person take up if the area is divided equally? 22 people

$\frac{\text{area}}{\text{people}}$ OR $\frac{\text{people}}{\text{area}}$ $\frac{22}{907.69} = 0.024$ people/ft²

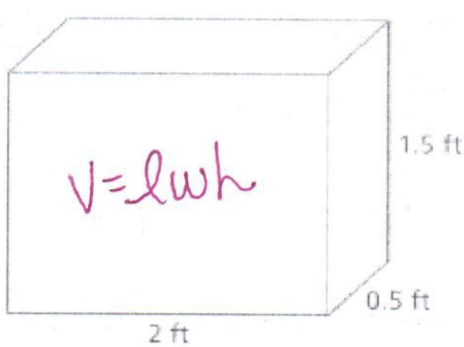
$\frac{907.69}{22} = 41.3 \text{ ft}^2/\text{person}$

Population Density: $\frac{\text{population size}}{\text{area / volume}}$

#1: The population of a nearby county is 92,024. The dimensions of the county are shown at the right. What is the population density?



$PD = \frac{\text{pop}}{\text{area}} = \frac{92{,}024 \text{ people}}{129 \text{ mi}^2} = \boxed{713.4 \text{ people}/\text{mi}^2}$



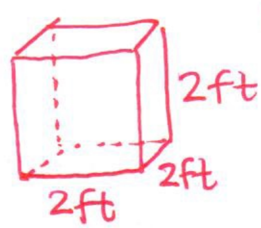
$V = (2)(\frac{1}{2})(1.5)$

$= 1.5 \text{ ft}^3$

#2: The aquarium to the left can accommodate medium-size fish.

a) What is the population density of the aquarium if it holds two fish? $PD = \frac{\text{pop}}{\text{volume}} = \frac{2 \text{ fish}}{1.5 \text{ ft}^3} = \boxed{1.33 \text{ fish}/\text{ft}^3}$

b) An aquarium in the shape of a cube has 2 ft edges. If this aquarium has the same population density as the aquarium in part (a), how many medium size fish can it hold?



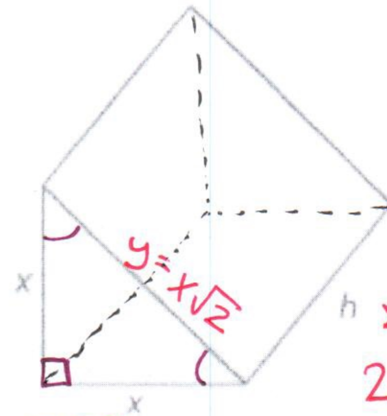
$V = 8 \text{ ft}^3$

$8 \cdot 1.33 = \frac{\text{fish}}{\cancel{8 \text{ ft}^3}} \cdot \cancel{8}$

$\boxed{\# \text{ of fish} = 10.67}$

Design:

A company wants to manufacture blocks of cheese in the shape of triangular prisms with isosceles triangles as bases. Each block of cheese will have a volume of 250 cubic centimeters. The company wants to choose the dimensions so that the cheese's surface area is minimized to reduce the amount of packaging needed. What dimensions should the company choose for the blocks of cheese? Round your answer to the nearest tenth.



$x^2 + x^2 = y^2$

$2x^2 = y^2$

$y = \sqrt{2x^2}$

$y = x\sqrt{2}$

$V = 250\text{ cm}^3 = Bh = \frac{1}{2}xxh$

$(2)250 = (\frac{1}{2}x^2h)(2)$

$\frac{500}{x^2} = \frac{x^2h}{x^2}$ $\quad h = \frac{500}{x^2}$

$SA = 2(\frac{1}{2}x^2) + 2(xh) + 1(hx\sqrt{2})$

$= x^2 + 2xh + \sqrt{2}xh$

$= x^2 + 2x(\frac{500}{x^2}) + \sqrt{2}x(\frac{500}{x^2})$

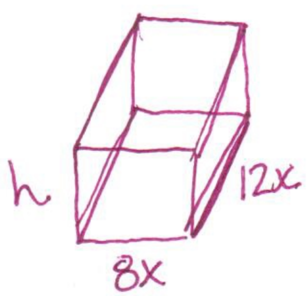
$= x^2 + \frac{1000}{x} + \frac{500\sqrt{2}}{x}$ GRAPH! min@ (9.5, 269.9)

$\boxed{x = 9.5\text{ cm}}$

$\boxed{h = 5.5\text{ cm}}$

#2: A company wants to manufacture packaging boxes in the shape of rectangular prisms. Each box will have a volume of 12,000 cubic inches. The company wants to choose the dimensions of a box with side lengths h in., $8x$ in., and $12x$ in., so that the box's surface area is minimized. What dimensions should the company choose for the boxes? Round your answer to the nearest tenth.

$V = 12{,}000\text{ in}^3$



$SA = 2(8xh) + 2(8x)(12x) + 2(12xh)$

$= 16xh + 192x^2 + 24xh$

$= 192x^2 + 40xh$

$= 192x^2 + 40x(\frac{125}{x^2})$

$= 192x^2 + \frac{5000}{x}$ GRAPH!

$V = lwh$

$= h(8x)(12x)$

$= 96x^2h$

$\frac{12000}{96x^2} = \frac{96x^2h}{96x^2}$

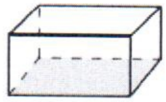
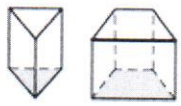
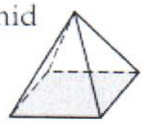
$h = \frac{125}{x^2}$

min@ (2.35, 3187.98)

so, $x = 2.35$

$8(2.35)$ $\quad 12(2.35)$ $\quad h = \frac{125}{(2.35)^2}$

$\boxed{18.8\text{in} \times 28.2\text{ in} \times 22.6\text{in}}$

Figure	Formulas for Volume (V) and Surface Area (SA)
Rectangular Prism 	$V = lwh =$ length $\times$ width $\times$ height $SA = 2lw + 2hw + 2lh$ $= 2($length $\times$ width$) + 2($height $\times$ width$) + 2($length $\times$ height$)$
General Prisms 	$V = Bh =$ area of base $\times$ height $SA =$ sum of the areas of the faces
Right Circular Cylinder 	$V = Bh =$ area of base $\times$ height $SA = 2B + Ch = (2 \times$ area of base$) + ($circumference $\times$ height$)$
Square Pyramid 	$V = \frac{1}{3}Bh = \frac{1}{3} \times$ area of base $\times$ height $SA = B + \frac{1}{2}P\ell$ $=$ area of base $+ (\frac{1}{2} \times$ perimeter of base $\times$ slant height$)$
Right Circular Cone 	$V = \frac{1}{3}Bh = \frac{1}{3} \times$ area of base $\times$ height $SA = B + \frac{1}{2}C\ell =$ area of base $+ (\frac{1}{2} \times$ circumference $\times$ slant height$)$
Sphere 	$V = \frac{4}{3}\pi r^3 = \frac{4}{3} \times \pi \times$ cube of radius $SA = 4\pi r^2 = 4 \times \pi \times$ square of radius