Problem 1 Solutions:
  a) \[ \text{Total volume} = \text{Volume of the rectangular solid} + \text{Volume of the triangular solid} \]
     \[ \text{Vol} = (48 \times 84 \times 106) + 0.5 \times (16 \times 106) \times 84 = 498624 \text{ cubic inches}. \]
  b) \[ 498624 \text{ cubic inches times } 2.54^3 = 8170983.4 \text{ cubic cm which is } 2206155.18 \text{ g or approximately } 48,593.95 \text{ lb}. \]

Problem 2A Solutions:
  a) \[ \text{Handrails: } 2 \times (13 + 42.5) = 111" \text{ or } 9.25 \text{ ft, which is almost } 1.2 \text{ pieces of } 8\text{ft (2x4s)}. \]
     Step: Since each step is 48 inches wide(4ft) we need 32 ft which is 4 pieces of 8ft (2x6s).
     Posts: \[ 30.5 \times 8 = 244 \text{ inches or approximately } 20.33 \text{ ft. This will require } 2.5 \text{ pieces of } 8\text{ft (2x4s)}. \]
     So, overall, for the handrails and the posts we can use 4 pieces of (2x4s) and 4 pieces of (2x6s) for the steps.
  b) \[ 2 \times 4\text{s: } 4 \times $3.07 = $12.28. \text{ For the } 2 \times 6\text{s: } 4 \times $5.27 = $21.08. \text{ So, for the materials (wood) total = } $33.36 \text{ plus tax (7%) = } $35.7. \text{ This total is just for the material not including nails, concrete for the base, labor or the rest of the wood for the structure!} \]

Problem 2B Solutions:
\[ \frac{35000 \text{ gal}}{1} \times \frac{3.79 \text{ L}}{1 \text{ gal}} \times \frac{1000 \text{ mL}}{1 \text{ L}} \times \frac{1 \text{ cm}^3}{1 \text{ mL}} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{1 \text{ g}}{1 \text{ m}^3} = 132.65 \text{ grams of methylparaben} \]

Problem 3 Solutions:
  a) Yosef’s optimum stride length would be 208” using a 2.6 multiplier.

Problem 4 Solutions:
  a) 10
  b) 10
  c) 11
  d) 0.4
  e) 0.52
  f) No
  g) 100 inches or 8 feet and 4 inches
  h) For the bottom staircase, \[ \tan \theta = 5/12.5 \text{ or } \theta \cong 21.8^\circ \text{ and for the top staircase, } \tan \theta = 6/11.5 \text{ or } \theta \cong 27.55^\circ \]

Problem 5 Solutions:
  a) \[ 4 \text{ (sides) } \times 3.5 \times 40 = 560 \text{ in}^2 \]
  b) Square Pyramid

Problem 6 Solutions:
Total Volume = \( V_1 + V_2 \)
  a) \[ V_1 = \frac{1}{3} \times 41 \pi \times (33^2 + 24.75 \times 33 + 24.75^2) = 108,124.00 \text{ in}^3 \]
     \[ V_2 = \frac{1}{3} \times 6 \pi \times (60^2 + 60 \times 33 + 33^2) = 530,765.8 \text{ in}^3 \]
     Total volume = 108,124 in\(^3\) + 530,765.8 in\(^3\) = \text{638,889.8 in}^3 \]
  b) 369.73 cubic ft
  c) Four
Problem 7A Solutions:
Based off of the pictorial representation of the bike rack and the placing of the axes the bike rack best represents a cosine function (see image below). Currently there are 11 slots, which would fit 11 bikes and adding an extra loop would add 2 more slots making it 13.

![Cosine Function Image](https://www.desmos.com/)

Problem 7B Solutions:
The volume of one post is $5^2 \pi (30) + 4^2 \pi (4) = 814 \pi = 2557 \text{ in}^3 = .0419 \text{ m}^3$, it weighs 222 lb. rounded to the nearest pound. You would need 6 first graders that weighed 40 lb. to outweigh the post.

Problem 8 Solutions:
There is no definitive solution. This is about creativity and thought.

Problem 9 Solutions:
\[
\text{a) } \frac{\$65000}{1} \times \frac{1 \text{kWh}}{\$0.06} \times \frac{1 \text{ year}}{5782 \text{kWh}} = 187.363 \text{ years. So, roughly 187.4 years.}
\]
\[
\text{b) } 1554 \times 36 = 55944 \text{ square inches. 5782 kWh divided by 55944 means each square inch of the panel produces .103 kWh of energy annually or 103 watts/yr.}
\]

Problem 10 Solutions:
\[
\text{a) Area of one block = 64 square inches.}
\]
\[
\text{Total area in square ft} = (64 \times 10384)/144 = 4615.11
\]
\[
\text{Number of cans of paint} = 4615.11/20 = 230.76 \text{ (round up to 231 cans).}
\]
\[
\text{b) } 231 \times \$6.25 = \$1443.75.
\]

Problem 11 Solutions:
\[
\text{a) } 63 \text{ in.} - 24 \text{ in.} = 39 \text{ in. or 3.25 ft. So the incline of theta can be found by doing arcsin(3.25/30) = 6.2 degrees.}
\]
\[
\text{b) To find the slope: } 3.25^2 + x^2 = 30^2. \text{ Solving for } x, \text{ we get } x = 29.82 \text{ ft (357.84 inches). The slope is } 3.25/x \text{ so the slope = 0.109.}
\]
\[
\text{c) The area of the triangle is } \frac{1}{2} (3.25 \text{ ft})(29.82 \text{ ft}) = 48.46 \text{ ft}^2 \text{ or 6978.24 in}^2.
\]
\[
\text{d) The area of the entire ramp is the area of the triangle and the area of the two adjacent rectangles. Total area = (30x63 in}^2 + 24x357.84 \text{ in}^2 + 6978.24 \text{ in}^2 ) = 17,456.4 \text{ in}^2.
\]
\[
\text{e) 360}
\]
\[
\text{f) 2142}
Problem 12 solutions:

a) The volume of the rotunda is \( \pi (16)^2 (125) = 100,531 \) cubic feet. The volume of a book is \( 8 \times 12 \times 2 = 192 \) cubic inches. \( \frac{192 \text{ in}^3}{1} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{1 \text{ ft}}{12 \text{ in}} = 0.111 \) cubic feet. If the volume of the rotunda is 100,531 cubic feet and each book is 0.111 cubic feet it would take \( \frac{100,531}{0.111} \approx 905,685 \) books rounded up to fill the rotunda.

b) Yes, there are enough books in the library to fill the rotunda.

c) \( \frac{939291}{18000} = 52.18 \) so each student would have to carry roughly 52 to 53 books to move the entire library.

Problem 13 Solutions:

a) 54 degrees
b) 108 degrees
c) 11 children

Problem 14 Solutions:

a) \( \frac{30 \text{ Min}}{1} \times \frac{60 \text{ sec}}{1 \text{ Min}} \times \frac{12 \text{ m}^3}{1 \text{ m}} \times \frac{100 \text{ cm}}{1 \text{ m}} \times \frac{100 \text{ cm}}{1 \text{ m}} \times \frac{1 \text{ mL}}{1 \text{ cm}^3} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.001 \text{ g}}{1 \text{ L}} = 2.160 \text{ g} \)

b) \( \frac{4 \text{ L}}{1} \times \frac{0.001 \text{ g}}{1 \text{ mL}} \times \frac{1 \text{ mL}}{1 \text{ cm}^3} \times \frac{1 \text{ cm}^3}{1 \text{ m}^3} \times \frac{1 \text{ L}}{1000 \text{ mL}} = 0.4 \text{ mg} \)

c) No. The fish is moved away from you by the water faster than it can swim.

Problem 15 Solutions:

a) 22.5 degrees
b) Since one revolution of the blade = circumference, it goes 69\( \pi \) inches in 1 revolution times 990 rpm gives 214602” per minute and dividing by 12 gives you 17883.5 feet per minute.

Problem 16 Solutions:

a) if the base is 36”x36” and the height is 93.5”, then the line from the tip of the pyramid down the side to the middle of the base is \( \sqrt{(18)^2 + (93.5)^2} \), which is approximately 95” so the surface area is \( .5(36 \text{ base})(95 \text{ height of slant})(4 \text{ sides}) \) or 6840 sq. inches or 47.5 square feet (1 sq ft = 144 sq in).

b) \( 93.5/69.2 = 1.35 \approx 1 = 0.35 \times 100 = 35\% \) taller than the average American male.