PREPARATORY TOPICS

Part 1: Formulas and Principles of Geometry, and Dimensional Analysis

Follow all instructions and show your answer in the space provided.

1. Formulas and Principles of Geometry.
   (a) Length $p$ of the perimeter of a rectangle with base $b$ and height $h$.
   (b) Length $d$ of the diagonal of a rectangle with base $b$ and height $h$.
   (c) Length $c$ of the circumference of a circle with radius $r$.
   (d) Area $A$ of a circle with radius $r$.
   (e) Area $A$ of a rectangle with base $b$ and height $h$.
   (f) Area $A$ of a region with uniform cross-sectional length $l$ and height $h$.
   (g) Area $A$ of a parallelogram with base $b$ and height $h$.
   (h) Area $A$ of a triangle with base $b$ and height $h$.
   (i) Surface area $S$ of a rectangular solid with length $l$, width $w$ and height $h$.
   (j) Surface area $S$ of a right circular cylinder with radius $r$ and height $h$.
   (k) Surface area $S$ of a sphere with radius $r$.
   (l) Volume $V$ of a sphere with radius $r$.
   (m) Volume $V$ of a rectangular solid with length $l$, width $w$ and height $h$.
   (n) Volume $V$ of a solid with uniform cross-sectional area $A$ and height $h$.
   (o) Volume $V$ of a parallelopiped with length $l$, width $w$ and height $h$.
   (p) Volume $V$ of a right circular cylinder with radius $r$ and height $h$.
   (q) Volume $V$ of a general cone with base area $A$ and height $h$.
   (r) Volume $V$ of a right circular cone with radius $r$ and height $h$.
   (s) Volume $V$ of a pyramid with height $h$ and a square base of side $s$. 
2. Make a labeled drawing and give a formula for the area $A$ of a sector of a circle of radius $r$ and central angle $\theta$.

3. Two boats nearly collide on a lake—one heading due north at 20 mph and the other east at 25 mph. Make a labeled drawing and give a formula in terms of time $t$ in hours for the distance $d$ in miles between the boats.

4. Make a labeled drawing and give a formula in terms of height alone for the surface area of an unopened 1000 $cm^3$ can of soup.
5. Use Dimensional Analysis to determine which of the formulas could be correct. \( V \) is a volume, \( A \) is an area, \( x, y, \) and \( z \) are lengths, \( v \) is a velocity (dimensions \( L/T \)), \( a \) is an acceleration (dimensions \( L/T^2 \)), and \( t \) is a time. The other quantities are dimensionless.

(a) \[ A = \frac{xy^2 + 2z^3}{x + y + z} \]

(b) \[ t = \frac{\pi A}{xv} \]

(c) \[ V = \frac{v^3}{3a} \]

(d) \[ x = vt + at^2 \]

(e) \[ y = vat^3 \]

6. Suppose the displacement \( s \) of a particle is related to time \( t \) according to the equation \( s = ct^4 - d/t \). What are the dimensions of the constants \( c \) and \( d \)?

7. Suppose that two quantities \( A \) and \( B \) have different dimensions. Which of the following arithmetic operations could be physically meaningful? Explain.

(a) \( A+B \)

(b) \( A/B \)

(c) \( B-A \)

(d) \( AB \)