## Algebraic Expressions \& Natural Language

The figure below illustrates how algebraic expressions can be developed from natural language descriptions. Develop algebraic expressions for each of the following. You may refer to the table on the last page to see correlation between terms and mathematical operations. Write your answers on a separate sheet of paper.


1. Work $(W)$ is the product of the force $(F)$ and the distance $(d)$ through which the force is applied.
2. The coefficient of friction $(\mu)$ is equal to the ratio of the force of friction $\left(F_{f r}\right)$ to the normal force $\left(F_{N}\right)$.
3. The density $(d)$ is the ratio of the mass $(m)$ to the volume $(V)$.
4. Force $(F)$ is equal to the product of mass $(m)$ and acceleration (a).
5. The final velocity $\left(v_{f}\right)$ is equal to the sum of initial velocity $\left(v_{i}\right)$ and the product of acceleration (a) and the difference in time $(t)$.
6. Pressure $(P)$ is the ratio of force $(F)$ to area $(A)$.
7. The ratio of the height $\left(h_{i}\right)$ of an image to the height of its object $\left(h_{o}\right)$ is equal to the ratio of the distance from the lens to the image $\left(d_{i}\right)$ and the distance from the lens to the object $\left(d_{0}\right)$.
8. The change in Gibbs free energy $(G)$ is equal to the change in enthalpy $(H)$ minus the product of the temperature ( $T$ ) and the change in entropy $(S)$.
9. The force between two point changes $(F)$ is equal to the product of the proportionality constant $(k)$ and the two charges $\left(Q_{1}, Q_{2}\right)$ divided by the square of the distance $(d)$ between them.
10. The energy of a photon $\left(E_{p}\right)$ is equal to the product of Planck's constant $(h)$ and the frequency $(f)$.

This next activity is designed to provide practice translating relationships from algebra to natural language. You need not be familiar with any of the following equations, but you will need to make logical inferences when translating them. Don't panic if these equations are new to you. The algebraic principles are the same even though the scientific principles vary. For each equation, there are two statements in natural language: one is correct, and the other is incorrect. Interpret the algebraic expressions, make logical inferences about variable names, and circle the correct statements. (In most instances variable symbols are the first letter of the variable they represent)

| 1 | $a_{e r}=\frac{v_{f}-v_{i}}{t_{f}-t_{i}}$ | (a) As the difference in velocity between final and initial times <br> increases, acceleration decreases. <br> (b) Average acceleration is determined by dividing the difference <br> of final and initial velocities by the difference of final and initial <br> times. |
| :--- | :---: | :--- |
| 2 | $E=m c^{2}$ | (a) A little bit of matter represents a huge amount of energy. <br> (b) As the mass increases, the energy decreases. |
| 3 | $T=2 \pi \sqrt{\frac{l}{g}}$ | (a) The period of a pendulum (T) is independent of the mass of <br> the pendulum. <br> (b) The period of the pendulum decreases as the length increases. |
| 4 | $F=G \frac{m_{1} m_{2}}{d^{2}}$ | (a) The force of gravity between two objects is proportional to the <br> product of their masses. <br> (b) The force of gravity between two objects decreases as the <br> cube of distance between their centers of mass. |
| 5 | $E=h f$ | (a) The energy of a wave is directly proportional to its frequency. <br> (b) Energy is an order of magnitude greater than frequency. |
| 6 | $P=\frac{F \Delta d}{\Delta t}$ | (a) Power is equal to the quantity of force and distance divided by <br> time. <br> (b) Power is the product of force and distance traveled, divided by <br> the change in time. |
| 7 | $F \Delta t=m \Delta v$ | (a) The force of an impact increases if the mass increases while <br> the change in time and velocity are held constant. <br> (b) The product of force and time is the same as the quotient of <br> mass and velocity. |
| 8 | $V=\frac{4}{3} \pi r^{3}$ | (a) If the radius of sphere is tripled, volume increases 27 fold. <br> (b) The volume of a sphere is the sum of 4/3 and the product of pi <br> times the radius cubed. |
| 9 | $d=\frac{m}{V}$ | (a) Density is independent of volume and mass. <br> (b) Density is the ratio of mass to volume. |
| 10 | $\frac{A_{\text {sompr }}}{V=\frac{4 \pi r^{2}}{\left(\frac{4}{3} \pi r^{3}\right)}}$(a) The surface area to volume ratio of a sphere is quotient of 3 <br> and the radius. <br> (b) The surface area to volume ratio of a sphere increases with <br> increasing radius. |  |

Table 14.1 Terms in Word Problems That Imply Specific Mathematical Operations

| + | - | $\times$ | $\div$ |
| :--- | :--- | :--- | :--- |
| add | change in | debt | by |
| addition | decreased by | by a factor of | divide |
| also | deduct | double | each |
| and | delete | fold | half of |
| combined | difference of | multiply | into |
| exceeds | diminish | of | over |
| increased by | less | percent of | product of |
| including | lose | quart | quadruple |
| increment | negative | repeat | per |
| more | remove | times | percent |
| more than | subtract | triple | quarter of |
| plus | twice ${ }^{\text {a }}$ |  |  |

${ }^{\text {a }}$ Indicates a specific form. For example, twice indicates a multiplication by two.

