Algebra Review

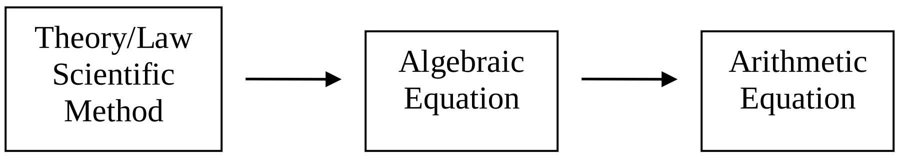
C1WS2K

By: Dr. Robert Belford

Algebra Review

1. Logic of Partial Credit and Importance of Showing Work:

What is the final temperature if a 1 g piece of aluminum at 80 deg C is dropped into 1 mL of water at 20 deg C in a thermally isolated system. The heat capacity of aluminum is 0.902J/(G-K)



1. First Law of Thermodynamics: Energy Lost by Hot Object = Energy Gained by Cold

Do you know what is going on? How to set up the equation?

$$-q_h = q_c$$

Do you know the algebraic equations which describe the process?

$$-m_h c_h(T_F-T_H) = m_c c_c(T_F-T_c)$$

Can you solve the algebraic equation to answer the question?
Can you substitute the numerical values into the algebraic equation?
Can you do the arithmetic?

There is more to grading a question like this than just giving credit for the final answer. So it is important to show work, and some instructors will give no credit if the work is not shown.

2. Algebra Review

Lets look at the equation $Q = mc(T_F-T_I)$.

To a chemist this is a sentence and it says that they heat gained or lost by a substance (Q) is equal to the temperature change times the heat capacity of that substance. The heat capacity is described by the mass (m)of the substance times it's specific heat capacity (c) and the temperature change is described by T_F-T_I (T_F is the final temperature and T_I is the initial temperature). Each of these algebraic symbols (variable) Q, m, c, T_F and T_I represent a measurable property of the matter and knowing 4 of these you can determine the other. So you need to be able to algebraically rearrange this sentence in a way which solves for any of the variables.

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Lets start by looking at an equivalence statement

We can say: A = B (algebraically)

or

6 calories = 6 calories (arithmetically)

Let's look at Mathematical Operations which Maintain the Equivalence Statement

First Operation: Adding same value to both sides maintains the Equality

Starting with the equivalence statement

6 calories = 6 calories

we can add 4 calories to both side and maintain the equality

6 calories + 4 calories = 6 calories + 4 calories

Which becomes

10 calories = 10 calories ,

so although the values have changed, they are still equivalent

Algebraically, if: A = B

Then A+C = B+C

Second Operation: Subtracting same value from both sides maintains the Equality

Starting with the equivalence statement

6 calories = 6 calories

we can subtract 4 calories to both side and maintain the equality

6 calories - 4 calories = 6 calories - 4 calories

becomes

2 calories = 2 calories,

so although the values have changed, they are still equivalent

so algebraically, if A = B

then A-C = B-C

<u>Third Operation:</u> Multiplying same value to both sides maintains the Equality

Note multiplication is the repetition of addition. 3x6 means add 6 to itself 3 times, that is: 3 x 6 = 6+6+6=18. So A x C means add C to itself A times.

We often omit the "x" sign, or use parenthesis.

so the algebraic equation $Q=mc(T_F-T_I)$

means Q equals m x c x (T_F-T_I)

Starting with the equivalence statement

6 calories = 6 calories

we can multiply both sides by 3 and maintain the equality

3(6 calories) = 3(6 calories)

Which becomes

18 calories = 18 calories ,

so although the values have changed, they are still equivalent

Algebraically, if: A = B

Then CA = CB

<u>Fourth Operation</u>: Dividing both sides by the same value maintains the equality.

Division is the inverse of multiplication

6/3 = ? means what times itself 3 times equals 6

or 6/3=2 as 2x3=6 (or 2+2+2 =6)

Starting with the equivalence statement

6 calories = 6 calories

we can divide both sides by 3 and maintain the equality

(6 calories)/3 = (6 calories)/3

Which becomes

2 calories = 2 calories ,

so although the values have changed, they are still equivalent

Algebraically, if: A = B

Then A/C = B/C

<u>Fifth operation:</u> Since division is the inverse of multiplication we divide and multiply any number or algebraic term by the same value and not change that number or term

Look at the number 6

We can multiply it by 3 and divide it by 3

$6 \times 3 = 18$

$18/3 = 6$

so $6(3/3) = 6$

Algebraically,

$A(C/C) = A$

so if $A = B$

Then, $A = B(C/C)$

<u>Sixth Operation</u>: Commutative Property of Multiplication

$4 \times 2 = 2 \times 4$

or $8=8$

algebraically $A \times B = B \times A$

<u>Seventh Operation</u>: Associative Property of Multiplication

$2(3 \times 4) = (2 \times 3)4$

becomes $2(12) = 6 \times 4$

or $24 = 24$

algebraically $A(B \times C) = (A \times B)C$

<u>Eighth Operation</u>: Distributive Property of Multiplication

$4(6+3) = (4 \times 6) + (4 \times 3)$

or $4 \times 9 = 24 + 12$

or $36 = 36$

algebraically

$A(B+C) = AB+BC$

Exponentiation

Exponentiation is the repetition of multiplication (as multiplication is the repetition of addition) Two cubed means 2^3

$$2^3 \text{ means } 2x2x2 = 2x4 = 8$$

algebraically A^n means A x A x A n times

Roots of Number
This is the inverse of exponentiation

The cube root of a number is a number when multiplied by itself three times equals that number.

$$\sqrt[3]{8} = 8^{1/3} = 2$$
$$\textit{because } 2^3 = 8$$

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1. PV = nRT, solve for R (Ideal Gas Law)

$$R = \frac{PV}{nT}$$

2. $E = \frac{hc}{\lambda}$ solve for λ (Energy of a photon)

$$\lambda = \frac{hc}{E}$$

3. $Q=mc(T_F-T_H)$, solve for T_F (relation between temperature change and heat transfer)

$$T_F = \frac{Q + mcT_I}{mc} = \frac{Q}{mc} + T_I$$

4. $E = R\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$, solve for n_f (Bohr Eq.)

$$n_f = \sqrt{\frac{1}{\frac{1}{n_i^2} - \frac{E}{R}}}$$

5. $-m_h c_h(T_F-T_H) = m_c c_c(T_F-T_c)$, solve for T_F (Application of First Law)

$$T_F = \frac{m_C c_C T_C + m_H c_H T_H}{m_C c_C + m_H c_H}$$