SMTE Key Ideas

KSB 1: SURFACE AREA AND VOLUME CALCULATIONS

Students will know that:

Volume is a measure of filling an object and surface area is a measure of wrapping an object.

To demonstrate their understanding, students will:

1. Given representations of three dimensional (3D) shapes, students will compare and contrast volume and surface area. (Qs.1, 2)
2. Given the outside dimensions and the mathematical formulas for the volume of each shape, correctly calculate the volume of four geometric shapes: a cube, a sphere, a square-based pyramid, and a cylindrical prism. (Qs. 7, 8, 9, 10)
3. Given the outside dimensions and the mathematical formulas for surface area for each shape, correctly calculate the surface area of four geometric shapes: a cube, a hemisphere, a square-based pyramid, and a cylindrical prism. (Qs. 5, 6)
4. Given two dimensional nets reflecting a variety of geometric shapes, convert the nets to three dimensional models. (Qs. 3-5)

KSB 2: CONDUCTIVE HEAT FLOW

KSB 2A: Students will know that:

Heat (q) flows from hot (T_h) to cold (T_c) through a material by conduction.

To demonstrate their understanding, students will:

Given an object with a temperature difference from one side to the other, students will describe that as the temperature difference (ΔT) increases, the conductive heat flow (q) increases.(Q.11)

KSB 2B: Students will know that:

Since heat is transferred from a hot temperature (T_h) to a cold temperature (T_c) through a flat surface, reducing the amount of surface area reduces heat transfer.

To demonstrate their understanding, students will:

Given objects with different surface areas (everything else being equal) the student will analyze how surface area affects conductive heat flow. (Q.12)

KSB 2C: Students will know that:

Different materials conduct heat at different rates depending upon their thermal conductivity. Thermal conductivity is symbolized by the letter (*k*).

To demonstrate their understanding, students will:

A. Given a list of materials with different k values, students will differentiate those that are good insulation materials from those that are not. (Q. 13)
B. Given a heat source and two objects of the same dimensions made from different materials, students will be able to evaluate how different materials affect conductive heat flow. (Q.14,16)

KSB 2D: Students will know that:

As the thickness of a material increases, the heat flow through it decreases.

To demonstrate their understanding, students will:

Given different thicknesses of the same material (everything else being equal) students will analyze how thickness affects conductive heat flow. (Q.17)

KSB 2E: Students will know that:

The formula that relates heat flow (q) to its determining factors is $q = kA (T_h - T_c)/L$

To demonstrate their understanding, students will:

Given the heat flow formula and a standard calculator, students will correctly formulate an outcome based upon manipulation of the variables in the formula.(Q. 18)

KSB 3: RELATIONSHIP BETWEEN K VALUE AND R VALUE

KSB 3: Students will know that:

A. k value and R value are both measures of a material's resistance to heat flow. k value relates only to the type of material where R value also takes into account the material's thickness (L).
B. Since R value takes thickness (L) into account, yet is related to k value, **R, L, and k can be expressed in a relationship**. The R value of a material equals its thickness / its k value (**R=L/k).**
C. The total R value (R_t) of a system of materials is the sum of each of the individual R values ($R_t = R_1 + R_2 + R_3 + R....$).

To demonstrate their understanding, students will:

1. Given information about k value and R value, students will describe the similarities and differences between them. (Q. 19-25)
2. Given information about the relationship between k value, R value, and thickness of a material, students will analyze a variety of materials to determine differences in k and R value. (Q.26)
3. Given k values and thicknesses for several different materials, students will calculate the R value of each material using the formula R = L/k. (Q. 27-31)
4. Solve for heat loss using the formula **$Q = A (\Delta T) / R$** given surface area, R value, and ΔT. (Q.33)
5. Given individual R values of several materials, students will determine the total R value of a system made from layers of those materials by summing the individual R values. (Q. 32)

KSB 4: STRUCTURAL DESIGN

KSB 4A: Students will know that:

Dead loads, live loads, and wind loads are among those that have to be taken into consideration when designing a structure.

To demonstrate their understanding, students will:

1. Given information about dead and live loads, students will define dead load as a load of constant magnitude (such as the weights of the materials of construction) and live load as a load that changes in magnitude and/or location (such as people in a building, or cars on a bridge). Q.34, 35, 36, 38)
2. Given a representation of wind blowing against a tower on a foundation that supports a platform with a filled water tank upon it, students will correctly label dead loads and live loads.
3. After engaging in an activity that shows the effect of wind on a structure (such as playing a game that illustrates how wind affects a structural shape, or seeing a video of “Galloping Gertie,” the Tacoma Narrows Bridge Collapse), students will recognize that wind loads have to be considered in designing a structure in addition to “dead loads” and “live loads.” (Q.37)

KSB 4B: Students will know that:

Structural integrity refers to the ability of individual structural members that comprise the structure (and their connections) to perform their functions under loads.

To demonstrate their understanding, students will:

Given a representation of a structure that supports a load, students will recognize that a lack of structural integrity would affect the structure's ability to stand up under load. (Qs.39, 40)

KSB 4C: Students will know that:

Selecting materials involves making tradeoffs between qualities.

To demonstrate their understanding, students will:

After explaining that structural integrity depends upon the ability of individual structural members that comprise the structure to perform their functions under loads, students will explain how selecting materials for a structural project involves making tradeoffs between competing qualities such as its strength, cost, availability, and the ease of working with the material.(Q.42, 43)

KSB 4D: Students will know that:

The overall stability of a structure ~~and its foundation~~ refers to its ability to resist overturning and lateral movement under load.

To demonstrate their understanding, students will:

1. Given the challenge to improve the structural stability of a structure students will select improvements that will help the structure resist overturning and lateral movement under load. (Q. 45). See reworded test item as well.
2. After investigating the shape of 3 D structures, students will evaluate the wind load effect on these shapes. (Q.44)

KSB 4E: Students will know that:

Structural design is influenced by climate and location, function, appearance, and cost.

To demonstrate their understanding, students will:

After reviewing images or models of a variety of structures built for different purposes in different geographic areas (deserts, mountains, icy climates) students will describe how structural design is influenced by function, appearance, cost, and climate/location.

Multiplayer Learning Objectives

Prerequisite

Learns must individually complete knowledge and skill builder singleplayer levels that are focused on surface area and volume of geometric shapes; conductive heat flow; k and R value; and structural design.

Purpose

8th Grade Technology Education (or ETE) learners will:

A. Develop an appreciation for the use of STEM skills applied in a "real-life" context.
B. Apply individual KSB skills situated in a complex design problem scenario.
C. Develop an appreciation for team work in solving a complex design problem.
D. Develop an understanding of the Informed Design Process.

Learning Objectives

Working in teams of four on an emergency shelter design challenge problem, the learner will:

1. Consider more than one shelter design before making their final choice of shape and size.
2. Determine and defend the choice of shape of the shelter design.
3. Demonstrate that their shelter meets design specifications.
4. Calculate the surface area and volume of the shelter.
5. Calculate the minimum R value of the shelter exterior
6. From a variety available, select the most appropriate materials for the shelter exterior to that will provide the necessary insulation.
7. Determine and defend the choice of framing for their shelter design that will provide the necessary structural integrity.
8. From a variety available, select the most appropriate materials for the shelter framing that will provide the necessary structural strength.
9. Determine, through use of mathematical modeling, if their shelter design will limit heat loss (in BTU/hour) to less than the heat generated by the body heat of the shelter inhabitants
10. Communicate their achievements to an interested audience