**Modeling and Equation Solving**

Scientists and engineers have always used mathematics to model the real world and thereby to unravel its mysteries. A mathematical model is a mathematical structure that approximates phenomena for the purpose of studying or predicting their behavior. We will be concerned primarily with three types of mathematical models: numerical models, algebraic models and graphical models. Each type of model gives insight into real-world problems, but the best insights are often gained by switching from one kind of model to another.

Numeric Model

Perhaps the most basic kind of math model is the numerical model, in which numbers or data are analyzed to gain insights into phenomena. A numerical model can be as simple as the major league baseball standings or as complicated as the net-work of interrelated numbers that measure the global economy.

Example 1: Tracking the minimum wage

|  |  |  |
| --- | --- | --- |
| Year | Minimum Hourly wage (MHW) | Purchasing power in 1996 dollars |
| 1995 | 0.75 | 4.39 |
| 1960 | 1.00 | 5.30 |
| 1965 | 1.25 | 6.23 |
| 1970 | 1.60 | 6.47 |
| 1975 | 2.10 | 6.12 |
| 1980 | 3.10 | 5.90 |
| 1985 | 3.35 | 4.88 |
| 1990 | 3.80 | 4.56 |
| 1995 | 4.25 | 4.38 |
| 2000 | 5.15 | 4.69 |
| 2005 | 5.15 | 4.15 |

The numbers in this table show the growth of the minimum hourly wage (MHW) from 1995 to 2005. It also shows the MHW adjusted to the purchasing price of 1996.

1. In what 5 year period did the actual MHW increase the most?
2. In what year did a worker earning the MHW enjoy the greatest purchasing power?
3. A worker on minimum wage in 1980 was earning nearly twice as much as a worker on minimum wage in 1970, and yet there was great pressure to raise the minimum wage again. Why?

Example 2: Analyzing Prison Populations

|  |  |  |  |
| --- | --- | --- | --- |
| Year | Total | Male | Female |
| 1980 | 316 | 604 | 12 |
| 1985 | 480 | 459 | 21 |
| 1990 | 740 | 699 | 41 |
| 1995 | 1085 | 1021 | 64 |
| 2000 | 1382 | 1290 | 92 |

This table shows the growth in the number of prisoners incarcerated in state and federal prisons from 1980 to 2000. Is the proportion of female prisoners over the years increasing?  
Algebraic Models

An Algebraic model uses formulas to relate variable quantities associated with the phenomena being studied. The added power of an algebraic model over a numeric model is that is can be used to generate numerical values of unknown quantities by relating them to known quantities.

Example 3: Comparing Pizzas

A pizzeria sells a rectangular 18” by 24” pizza for the same price as its large round pizza (24” diameter). If both pizzas are of the same thickness, which option gives the most pizza for the money?

Now work Problems Page 81 #11,12, 19-22

**Graphical Methods**

A graphical model is a visible representation of a numerical model or an algebraic model that gives insight into the relationships between variable quantities.

Example 4: Visualizing Gravity Experiments

Galileo spent a god deal of time rolling balls down incline planes carefully recording the distance they traveled as a function of elapsed time. His experiments are commonly repeated in physics classes today so it is easy to reproduce a typical table of Galilean data.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Elapsed time (seconds) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Distance traveled (inches) | 0 | 0.75 | 3 | 6.75 | 12 | 18.75 | 27 | 36.75 | 48 |

What graphical model fits the data? Use calculator and regression models to solve.

Example 5: Redo Prison