

## Project 1: Blood Alcohol Concentration Model <sup>1</sup>

### Data and Assumptions

Data are from Davis, Porta, Uhl, *Calculus & Mathematica: Derivatives* [14] ©1994 Addison Wesley Longman Inc. Reprinted by Permission of Addison Wesley Longman.

- The average human body eliminates 12 grams of alcohol per hour.
- An average college male in good shape weighing  $K$  kilograms has about  $.68K$  liters of fluid in his body. A college-age female in good shape weighing  $K$  kilograms has about  $.65K$  liters of fluid in her body. People in poor shape have less.
- One kilogram = 2.2046 pounds.
- Threshold for legal driving: If your body fluids contain more than one gram of alcohol per liter of body fluids (or 0.1 gm/100 ml which is the usual way of reporting it), then you are too drunk to drive legally in most states. Find out the level for your state and use it in this project.
- A blood alcohol concentration of 4.0 gm/l is likely to result in coma. A blood alcohol concentration of 4.5–5.0 gm/l is likely to result in death.
- Alcohol content of various beverages: see Table 1.1

Type of Drink	Grams of Alcohol
12 ounce regular beer	13.6
12 ounce light beer	11.3
4 ounce port wine	16.4
4 ounce burgundy wine	10.9
4 ounce rose wine	10.0
1.5 ounce 100-proof vodka	16.7
1.5 ounce 100-proof bourbon	16.7
1.5 ounce 80-proof vodka	13.4
1.5 ounce 80-proof bourbon	13.4

### Project

Construct the basic model from the compartmental diagram shown in Figure 1.26. Pick an appropriate time step as given. Technically this is a continuous model, but we are treating it as discrete

<sup>1</sup>This project is taken from *A Course in Mathematical Modeling* by Mooney and Swift (The Mathematical Association of America, 1999).

with a short time step. Pick a hypothetical person as given. Plot the legal driving level on the same graph along with the levels of coma and likely death. In each of the following three cases, find from the graph how long it takes before the hypothetical person can drive home legally.

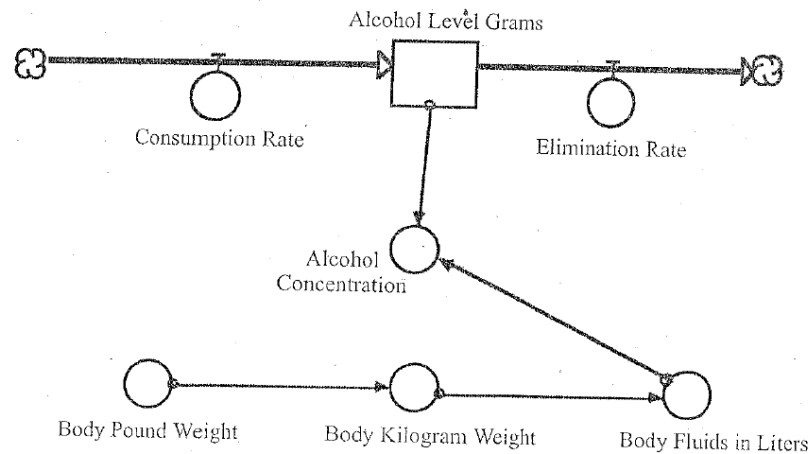


FIGURE 1.26 Compartmental Diagram for the Blood Alcohol Model.

1. Assume your hypothetical person arrives at a party and instantaneously downs a six-pack of beer. Graph alcohol concentration as a function of time.
2. Construct a more realistic manner of consuming six beers. One of many cases could be that the hypothetical person drinks two beer cans and waits for 10 minutes, drinks another set etc.
3. Try some other alcohol input functions. Here is one idea: the hypothetical person drinks 2 beers, and after 15 minutes he drinks 3 oz of 100-proof vodka. After 20 minutes drinks more (pick something realistic).

*We acknowledge a high school teacher in the TORCH program, whose name we no longer recall, for originally introducing us to the ideas of this project. The book *Calculus & Mathematics* by Davis, Porta, and Uhl has a problem on blood alcohol levels which significantly influenced this project.*