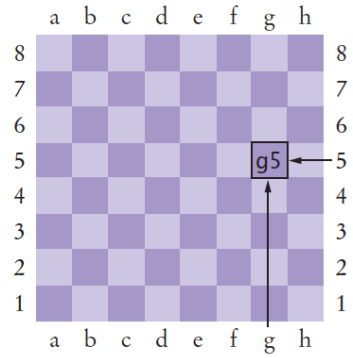
Class 3. Challenge problems

1. **Chess board Black/White or Dark/Light**:



Each square on a chess board can be described by a letter and number, such as g5 in the example. Take in a user input such as 'g5' and let them know whether their desired square is colored black(dark) or white(light).

You can even practice input validation on this problem. Think about when you would return an error message to the user!

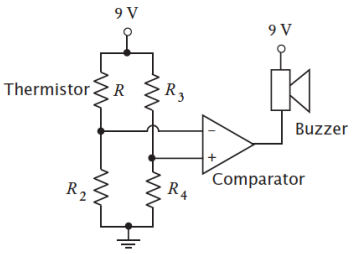
2. **Scheduling program:** Suppose this program will be used by academic advisors or accountants, or any job that requires meeting customers/students by appointment. This program will check whether two appointments overlap. (For simplicity, you can use military time (with hours 0–24) if you want)
Come up with an algorithm to determine whether an appointment with start time `start1` and end time `end1` overlaps with the appointment with start time `start2` and end time `end2`.
Then write a program that takes in two appointment times (let the user know what format you want) and print out whether they can or cannot schedule both appointments.

3. For sciency folks, **astronaut escape velocity:**
(From Horstmann, Java Early Objects)
The average person can jump off the ground with a velocity of 7 mph without fear of leaving the planet. However, if an astronaut jumps with this velocity while standing on Halley's Comet, will the astronaut ever come back down?
Create a program that allows the user to input a launch velocity (in mph) from the surface of Halley's Comet and determine whether a jumper will return to the surface. If not, the program should calculate how much more massive the comet must be in order to return the jumper to the surface.

Escape velocity is $v_{escape} = \sqrt{\frac{2GM}{R}}$, where $\mathrm{G} = 6.67\mathrm{x}10^{-11}\, Nm^2/kg^2$ is the gravitational constant, $\mathrm{M} = 1.3\mathrm{x}10^{22}\, kg$ is the mass of Halley's comet and $\mathrm{R} = 1.153\mathrm{x}10^{6}\, m$ is its radius.

4. Another science application: **Estimating crop damage from frost** (From Horstmann, Java Early Objects)
Crop damage due to frost is one of the many risks confronting farmers. The figure below shows a simple alarm circuit designed to warn of frost. The alarm circuit uses a device called a thermistor to sound a buzzer when the temperature drops below freezing. Thermistors are semiconductor devices that exhibit a temperature dependent

resistance described by the equation: $R = R_0 e^{\beta(\frac{1}{T}-\frac{1}{T_0})}$, where R is the resistance (in Ω) at the temperature T, in K (Kelvin) R_0 is the resistance at the temperature T_0 in K. β is a constant that depends on the material used to make the thermistor.



The circuit is designed so that the alarm will sound when

$$\frac{R_2}{R + R_2} < \frac{R_4}{R_3 + R_4}$$

The thermistor used in the alarm circuit has R_0 = 33,192 Ω at T_0 = 40 °C, and β = 3,310 K. (Temperature in K is obtained by adding 273°C to the temperature in °C.) The resistors R2, R3, and R4 have a resistance of 156.3 kΩ = 156,300 Ω. Write a program that prompts the user for a temperature in F and prints a message indicating whether or not the alarm will sound at that temperature.

5. Suppose you are a manager of a restaurant and you want to suggest a tip according to the service your customers receive. Write a program that calculates a tip according to the customer's satisfaction as follows:

- Ask for the diners' satisfaction level using these ratings:
  1 = Totally satisfied, 2 = Satisfied, 3 = Dissatisfied.
- If the diner is totally satisfied, calculate a 20 percent tip.
- If the diner is satisfied, calculate a 15 percent tip.
- If the diner is dissatisfied, calculate a 10 percent tip.
- Report the satisfaction level and tip in dollars and cents.

(Horstmann, Early Objects)

6. A minivan has two sliding doors. Each door can be opened by either a dashboard switch, its inside handle, or its outside handle. However, the inside handles do not work if a **child lock switch** is activated. In order for the sliding doors to open, the **gear shift** must be in Park (P), and the **master unlock switch** must be activated. Your task is to simulate a portion of the control software for the vehicle. The input is a sequence of values for the switches and the gear shift, in the following order:

- Dashboard switches for left and right sliding door, child lock, and master unlock (in that order) (0 for off or 1 for activated)
- Inside and outside handles on the left and right sliding doors (0 or 1)
- The gear shift setting (one of P N D 1 2 3 R).

(e.g.) A typical input would be 0 0 0 1 0 1 0 0 P. The numbers in order mean the following:

- 0 0: dashboard switches for both left and right sliding doors are 'off'
- 0: Child lock is 0 (off) so inside handles wouldn't work
- 1: Master unlock is activated
- 0: Inside handle on left door is 'off'
- 1: Outside handle on left door is 'on' (activated)
- 0 0: Inside/outside handles on right door are both 'off'
- P: Gear is in park

Since the gear shift is in park AND the master unlock switch is activated, when the outside handle on left door is activated, the left door would open.

Print "left door opens" and/or "right door opens" as appropriate. If neither door opens, print "both doors stay closed".