Motion Problems

2)A girl on a bicycle rides down a hill 600 meters. Then the girl rides up the hill 100 meters and falls off her bicycle. The entire bicycle trip lasted 50 seconds. What is the average velocity of the girl in m/s?

- **Givens**
  - D1 = 600m down
  - D2 = 100m up
  - T = 50 sec
- **Unknown**
  - Velocity
- **Equation**

$$\bar{v} = \frac{displacement}{time} = \frac{x_2 - x_1}{t_2 - t_1}$$

- **Substitute**
  - 600 m -100m = 500m / 50 sec
- **Solve**
  - Velocity = 10 m/s down

3) In 1960, U.S. Air Force Captain Joseph Kittinger broke the records for the both the fastest and the longest sky dive…he fell an amazing 19.5 miles! (Cool facts: There is almost no air at that altitude, and he said that he almost didn't feel like he was falling because there was no whistling from the wind or movement of his clothing through the air. The temperature at that altitude was 36 degrees Fahrenheit *below* zero!) His average speed while falling was 254 miles/hour. How much time did the dive last in minutes?

- **Givens**
  - D = 19.5 mi
  - Speed = 254 mi/hr
- **Unknown**
  - Time
- **Equation**
  - Time = d / v
- **Substitute**
  - 19.5 mi / 254 mi/hr
- **Solve**
  - .077 hrs x 60min/1hr = 4.6 min

4) The Voyager I spacecraft was launched 40 years ago. Since that time the spacecraft has had an average speed of about 31,000 miles/hour. Assuming Voyager I has traveled in a straight line, how far has it traveled in 40 years? Give your answer in meters. (1 year = 365 days, 1 mi = 1609.34 m)

- **Givens**
  - speed = 31,000 mi/hr
  - Time = 40 yrs x 365days/1yr x 24hr/1day = 350,400 hrs
- **Unknown**
  - Distance
- **Equation**
  - Distance = speed x time
- **Substitute**
  - 31,000mi/hr x 350,400hr
- **Solve**
  - 1.086×10^{10} mi x 1609.34m/1mi = 1.75×10^{13} m

5) A runner accelerates from a velocity of 5 miles/hour east until reaching a velocity of 10 miles/hour east in 20 seconds. What was the runner’s acceleration?

- **Givens**
  - Vi = 5 mi/hr east (+)
  - Vf = 10 mi/hr east (+)
  - T = 20 sec
- **Unknown**
  - acceleration
- **Equation**
  - Acceleration = (Vf-Vi) / time
- **Substitute**
  - (10 – 5 mi/hr) / 20 sec
- **Solve**
  - .3 mi/hr/sec east

6) An engineer is designing the runway for an airport. Of the planes that will use the airport, the lowest acceleration rate is likely to be 3 m/s^2. The takeoff speed for this plane will be 65 m/s. Assuming this minimum acceleration, what is the minimum allowed length for the runway?

- **Givens**
  - Vf = 65 m/s
  - Vi = 0 m/s
  - A = $3m/s^2$
- **Unknown**
  - distance
- **Equation**

$$v_f^2 = v_i^2 + 2*a*d$$

- **Substitute**
  - $(65m/s)^2 = (0m/s)^2 + 2(3m/s^2) \times d$
  - $4225m^2/s^2 = 6m/s^2 \times d$
- **Solve**
  - 704 m

7) You're driving along a dark stretch of highway with a speed of 25 m/s. Suddenly, you see that a bridge has been washed out ahead. You apply the brakes of your car, and come to a stop in a time of 4.0 seconds. Determine the acceleration and stopping distance of the car.

- **Givens**
  - Vi = 25 m/s
  - Vf = 0 m/s
  - T = 4 sec
- **Unknown**
  - Acceleration
  - Distance
- **Equation**
- Acceleration = (Vf-Vi) / time

$$d = \frac{v_i + v_f}{2} * t$$

- **Substitute**
  - A = (0-25 m/s) / 4 sec
  - D = ((25 + 0m/s) / 2) x 4sec
- **Solve**
  - A = -6.25 m/s^2
  - D = 50 m