Magnetic forces and Kinetic Energy.

Like gravity, the motion that a charged particle will take in a magnetic field will depend on the kinetic energy of the particle – in other words, the particle's mass and speed. Scientists often measure a charged particle's energy, **E**, in terms of its' voltage' rather than in the more common units of 'ergs' or 'joules'. In this exercise, we will look at the speeds of various types of charged particle. The formula that relates the speed of an electron in a plasma cloud, **V**, in kilometers per second, to its energy, **E**, in units of volts, is given by:

$$V = 590\sqrt{E}\ \frac{kilometers}{second}$$

Use the above formula to complete the following table, and round all answers to **two significant figures** (i.e 1,570 = 1,600).

Object	Energy	Speed (km/s)
Ionosphere	10 Volts	
Plasmasphere	100 Volts	
Lightning	5,000 Volts	
Aurora Current	6,000 Volts	
Ring Current	70,000 Volts	

Question 1 – If the radius of Earth is 6,400 kilometers, what is its circumference?

Question 2 – How long would it take an ionosphere particle to travel once around Earth?

Question 3 – How long would it take an auroral current particle to go once around Earth?

Question 4 – How long would it take a ring current particle to go once around Earth?

Question 5 - If a solar storm produced a ring current disturbance over California, how long would the disturbance take to travel eastward to New York located about 4,300 kilometers away?

Answer - Extra Credit Problem

Example for Row 1:

$V = 590 (10 \text{ volts})^{1/2} = 590 \times 3.1 = 1{,}800$ km / sec.

Object	Energy	Speed (km/s)
Ionosphere	10 Volts	1,800
Plasmasphere	100 Volts	5,900
Lightning	5,000 Volts	42,000
Aurora Current	6,000 Volts	46,000
Ring Current	70,000 Volts	160,000

Question 1 – If the radius of Earth is 6,400 kilometers, what is its circumference?
Answer: 2π (6400 km) = 40,000 km.

Question 2 – How long would it take an ionosphere particle to travel once around Earth?
Answer: T = (40,000/1900) = 21 seconds!

Question 3 – How long would it take an auroral current particle to go once around Earth?
Answer: T = (40000/46000) = 0.86 seconds.

Question 4 – How long would it take a ring current particle to go once around Earth?
Answer: T = (40000/160000) = 0.25 seconds.

Question 5 - If a solar storm produced a ring current disturbance over California, how long would the disturbance take to travel eastward to New York located about 4300 kilometers away?
Answer: About (4300/160000) = 0.027 seconds