Homework 2 Key

1.

A. The Basics

a 4.6 billion years

b 4.6 billion years

c when it last solidified

d 0-3.9 billion years

e 0-200 million years

f. Working

g. Oceanic crust subducts in less than 200 Mya, but continental crust floats on mantle essentially forever.

B. Layering

a

$$Average\_density = Total\_Mass / Total\_Volume = \rho_{earth}$$

$$= 6 \times 10^{24} kg / (4/3\pi(6{,}370 km)^3)$$

$$= 5.54 kg / km^3$$

The correct units are either kg/m^{3}or gm/cc...

$$= 5.542 kg / km^3 \times (1 km / 1000 m)^3$$

$$= 5542 kg / m^3$$

$$= 5542 kg / m^3 \times (1000 g / kg) \times (1 m / 100 cm)^3$$

$$= 5.542 gm / cc$$

b

$M_{earth} = M_{core} + M_{mantle}$

$$\rho_{earth} \times Volume_{earth} = \rho_{core} \times Volume_{core} + \rho_{mantle} \times Volume_{mantle}$$

$$Volume_{mantle} = Volume_{earth} - Volume_{core}$$

$$\rho_{earth} \times Volume_{earth} = \rho_{core} \times Volume_{core} + \rho_{mantle} \times (Volume_{earth} - Volume_{core})$$

$$(\rho_{earth} - \rho_{mantle}) \times Volume_{earth} = (\rho_{core} - \rho_{mantle}) \times Volume_{core}$$

$$Volume_{core} = (\rho_{earth} - \rho_{mantle}) \times Volume_{earth} / (\rho_{core} - \rho_{mantle})$$

$$4/3\pi r_{core}^{3} = (\rho_{earth} - \rho_{mantle}) / (\rho_{core} - \rho_{mantle}) \times 4/3\pi r_{earth}^{3}$$

$$r_{core} = r_{earth} \times \sqrt[3]{(\rho_{earth} - \rho_{mantle}) / (\rho_{core} - \rho_{mantle}) \times 4/3\pi}$$

We calculated ρ_{earth} in the part "a". Plugging in the numbers and taking the cube root...

2715 km

The accepted figure, http://geomag.usgs.gov/intro.php, is 1215 km for the inner core and 3485 km for the outer core. So this value is reasonable.

2.

a. Sea floor spreading at a ridge.
b. Zero
c. South-East
d. Subduction
e. Normal
f. Approximately 3 Mya
g. Vancouver Island is about 450 km long. From the figure, the perpendicular distance of point A to the ridge is about 20% of the length of the island, or about 90 km. Thus the half spreading speed is about 90 km*10^3 m/km * 10^2 cm/m / 3 * 10^6 year = 3 cm/year.

h. Using http://jules.unavco.org/VoyagerJr with the help on

http://www.dpc.ucar.edu/VoyagerJr/JVV_Jr/help/helpvel.html

I find the Pacific plate speed relative to the Juan de Fuca plate is about 5 cm/year, so the half spreading rate at the ridge is 2.5 cm/yr. The estimate from the map is accurate (with in 20%).

i. The spreading rate may not have been constant in speed or direction.
j. In Cascada the Juan de Fuca plate is subducting under the North America plate. In Southern California there is no subduction. Subduction leads to volcanoes as the plate melts releasing hot steam (from dissolved seawater) and gases that rise up through the over burden and create stratovolcanoes. The strain accumulated as subduction proceeds is much larger than the stick slip faulting of SoCal, and the resulting rupture would be offshore, parallel to the coast, and close to shore, so there will be little time to evacuate from what could be a huge tsunami.