Subject 10

Please do not write on the exam paper.

The magnitude of most earthquakes is measured on the **Richter scale**, invented by Charles F. Richter in 1934.
The Richter magnitude is calculated from the amplitude of the largest seismic wave recorded for the earthquake, no matter what type of wave was the strongest.

The Richter magnitudes are based on a logarithmic scale (base 10).
What this means is that for each whole number you go up on the Richter scale, the amplitude of the ground motion recorded by a seismograph goes up ten times.

The magnitude of a seism of intensity I is measured on the Richter scale by : $M = \log(\frac{I}{I_0})$,

where I_0 is a reference intensity.

Using this scale, a magnitude 5 earthquake would result in ten times the level of ground shaking as a magnitude 4 earthquake (and 32 times as much more energy would be released).

(Source : http://www.geo.mtu.edu/UPSeis/intensity.html)

Nota : $\log x = \frac{\ln x}{\ln 10}$; $(y = \log 10) \Leftrightarrow (x = 10^y)$.

Questions:

a) Find out the magnitude M (on the Richter scale) of the following seism :

California (1992) : $I = 3.16 \times 10^7 I_0$.

b) The Fukushima earthquake followed by a tsunami was of magnitude 9 on the Richter scale.
Calculate $\frac{I}{I_0}$ and give an interpretation of this number.

c) The energy E (in joules) liberated at the center of the seism is related to the magnitude M by the relation : $\log E = a + bM$, where a and b are constants.

Calculate a and b knowing that a seism of magnitude 8 implies approximately 30 000 times more energy than a seism of magnitude 5, which itself liberates an energy of 0.2×10^{20} joules.