Moving and Shaking

Piri's pager vibrates on his belt.

> Looks like we've got a 6.6 in Hawke's Bay.
> Let's scramble, Shakers!

They fly over the devastation.
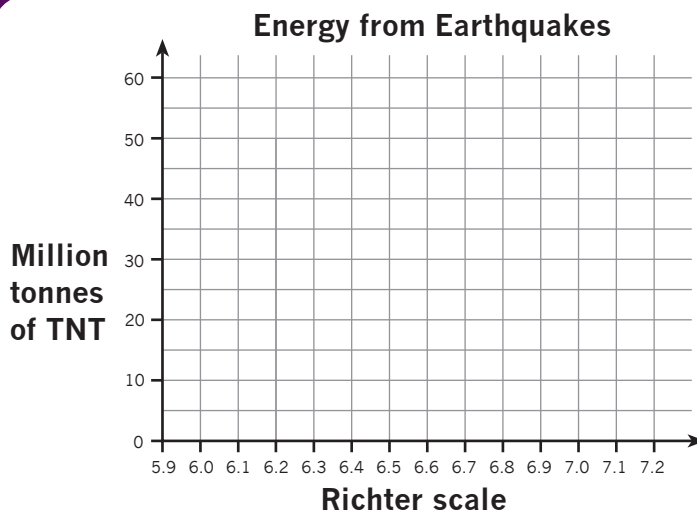Arun is amazed by the extent of the damage.

> Hey, that's way more damage than that 6.1 we went to in Japan last month!

> Yes, a 6.6 is a much bigger earthquake than a 6.1.
> That's the way the Richter scale works.

Later, when the emergency is over and they are back at the Counter Catastrophe base, Piri explains to Arun that the Richter scale is exponential. As the size of the earthquake goes up, the actual energy released goes up by huge amounts.

> You can measure the amount of energy that is released by comparing it to the energy released by trinitrotoluene (TNT), which, as you know, is a powerful explosive.

1. a. Copy this graph and mark in the points shown in the table.

Energy from Earthquakes

Million tonnes of TNT (vertical axis, 0 to 60)

Richter scale (horizontal axis, 5.9 to 7.2)

Richter scale	Tonnes of TNT in millions
6.0	1.0
6.1	1.3
6.2	1.8
6.3	2.6
6.4	3.7
6.5	5.0
6.6	6.8
6.7	9.3
6.8	12.6
6.9	17.8
7.0	32.0

  b. Approximately how many tonnes of TNT do 5.9 and 7.1 on the Richter scale equate to?

2. Piri shows Arun a table for higher numbers on the Richter scale and explains some related terms.

One thousand is 1 000 or 10^3 as a power of 10.
One million is 1 000 000 or 10^6 as a power of 10.
One billion is 1 000 million, and a trillion is a million million.

Richter scale	Tonnes of TNT
7.5	160 million
8.0	1 billion
8.5	5 billion
9.0	32 billion
10.0	1 trillion

Wow!
The effect of the exponential growth is amazing!

a. Write 160 million as a numeral.

b. Write one billion and one trillion as numerals and as powers of 10.

3. Piri tells Arun that the closer a populated area is to the epicentre of an earthquake, the more damage there is. He gives Arun this information:

- The 1994 Los Angeles earthquake, a major disaster, was a 6.6 and was centred 40 kilometres from the city.

- A 6.5 earthquake in Arthur's Pass in 1994 was felt as violent shaking in Christchurch, 110 kilometres away.

- New Zealand's most disastrous earthquake, in Napier in 1931, was 7.9 on the Richter scale. It was centred 45 kilometres away from Napier.

About how many tonnes of TNT do you think the Napier earthquake was equivalent to?