

## Earthquakes

The strength of an earthquake is measured on the Richter scale.

The energy,  $E$  (in Joules), produced by the earthquake is related to the value,  $r$ , on the Richter scale.

Details of six recent earthquakes are given below:

Earthquake	Richter value, $r$	Energy released, $E$ (J)
A. USSR (1986)	2.9	$1.02 \times 10^9$
B. England (2008)	5.3	$2.64 \times 10^{12}$
C. Greece (2008)	6.5	$2.62 \times 10^{14}$
D. Pakistan (2005)	7.4	$2.71 \times 10^{15}$
E. Peru (2007)	8.0	$4.53 \times 10^{16}$
F. Chile (2010)	8.8	$7.26 \times 10^{17}$

- (i) By choosing 2 suitable earthquakes from the above table, verify the approximate result that an increase of 2 on the Richter scale corresponds to an increase of energy by a factor of 1000.
- (ii) The exponential law connecting  $E$  and  $r$  may be written

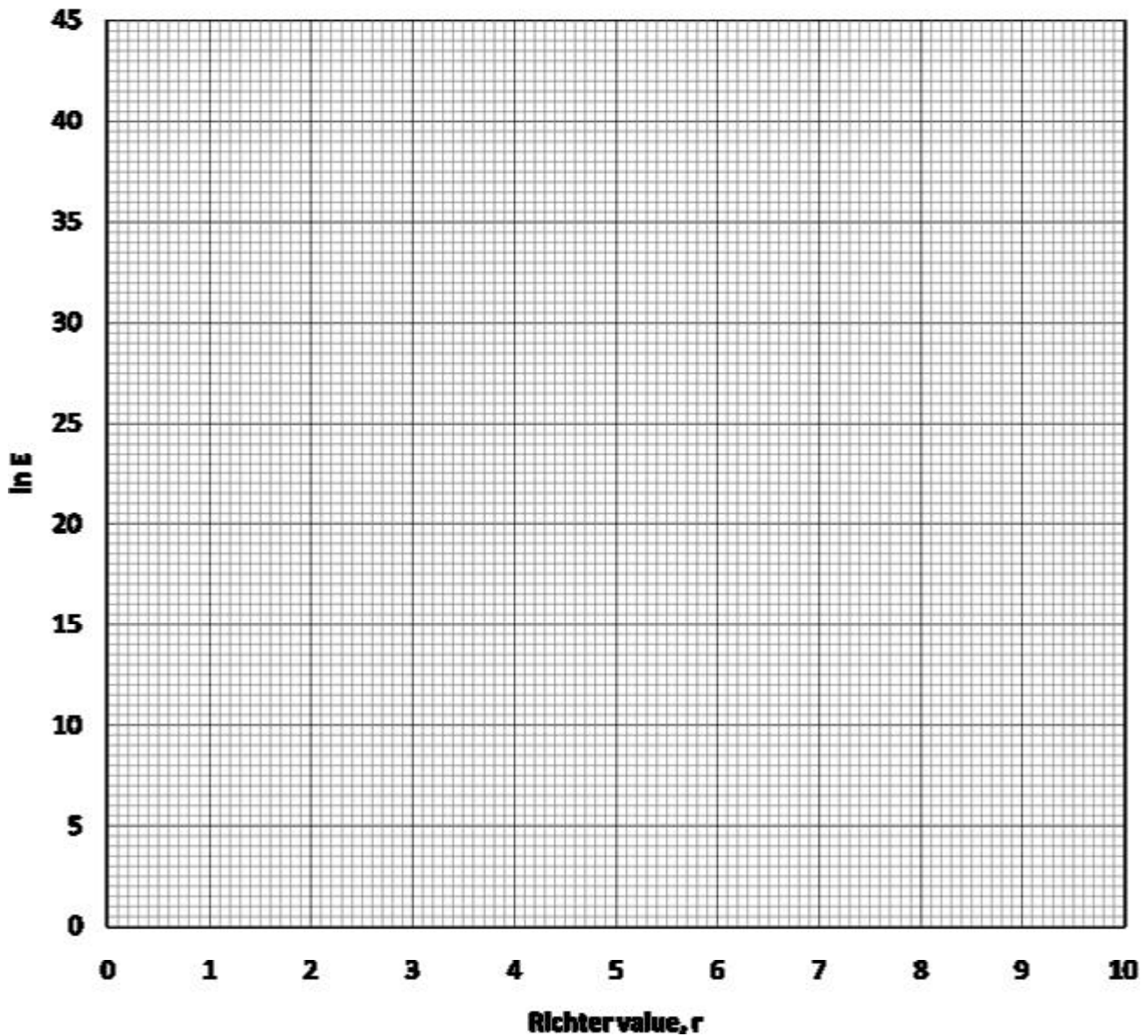
$$\ln E = \ln E_0 + kr$$

where  $E_0$  is the energy released from a seismic event corresponding to a Richter value of 0 and  $k$  is a constant.

Complete the table below:

	A	B	C	D	E	F
$r$	2.9	5.3	6.5	7.4	8.0	8.8
$\ln E$	20.7					

- (iii) Plot these values on the grid on the following page.

**Graph of  $\ln E$  against  $r$** 

- (iv) Find the value of the vertical axis intercept.
- (v) Find the value of the gradient of the graph.
- (vi) Using your answer to (v) write down the value of  $k$ .
- (vii) Using your answer to (iv) calculate the value of  $E_0$ .
- (viii) Earthquakes with a Richter value between 9.0 and 10.0 are classified as 'great'. Calculate the least energy produced by a great earthquake.