9 Polonium-193 ($^{193}_{84}$Po) is an unstable nuclide. A nucleus of polonium-193 decays to a nucleus of lead-189 ($^{189}_{82}$Pb) by emitting an alpha-particle.

(a) Radioactive decay is both random and spontaneous.

State what is meant by:

(i) random

.....

..... [1]

(ii) spontaneous.

.....

..... [1]

(b) Define half-life.

.....

.....

..... [1]

(c) Data for the binding energy per nucleon of the particles involved in the decay of a nucleus of polonium-193 are given in Table 9.1.

Table 9.1

particle	binding energy per nucleon / eV
$^{193}_{84}$Po	7.774
$^{189}_{82}$Pb	7.826
$^{4}_{2}\alpha$	7.074

Determine the energy, in eV, released when a nucleus of polonium-193 decays into a nucleus of lead-189.

energy = ... eV [2]

(d) A pure sample of polonium-193 contains N_0 nuclei. After a time t the sample contains N nuclei of polonium-193. The variation of $\ln(N/N_0)$ with t is shown in Fig. 9.1.

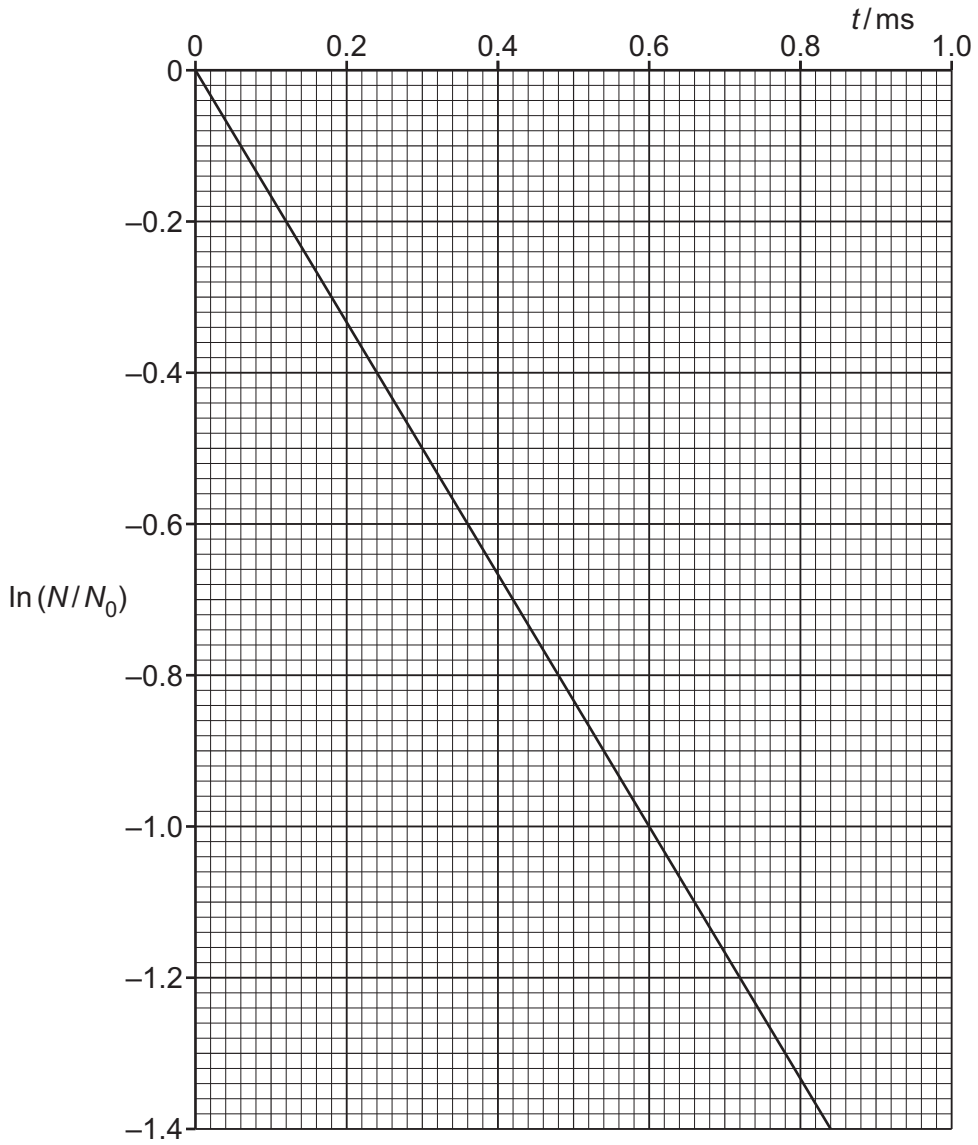

Fig. 9.1

(i) State the name of the quantity that is represented by the magnitude of the gradient of the line in Fig. 9.1.

..... [1]

(ii) Use Fig. 9.1 to determine the half-life, in ms, of polonium-193.

half-life = ... ms [2]

(e) Positron emission tomography (PET scanning) uses a radioactive tracer.

(i) State what happens to the positrons emitted by the tracer.

.....

..... [1]

(ii) Explain why a tracer with a half-life of approximately 2 hours is a suitable tracer to use.

.....

..... [1]

[Total: 10]