9 **(a)** Fig. 9.1 shows a metal wire held taut between a knife edge X and a smooth pulley P. The wire passes between opposing poles of permanent bar magnets.

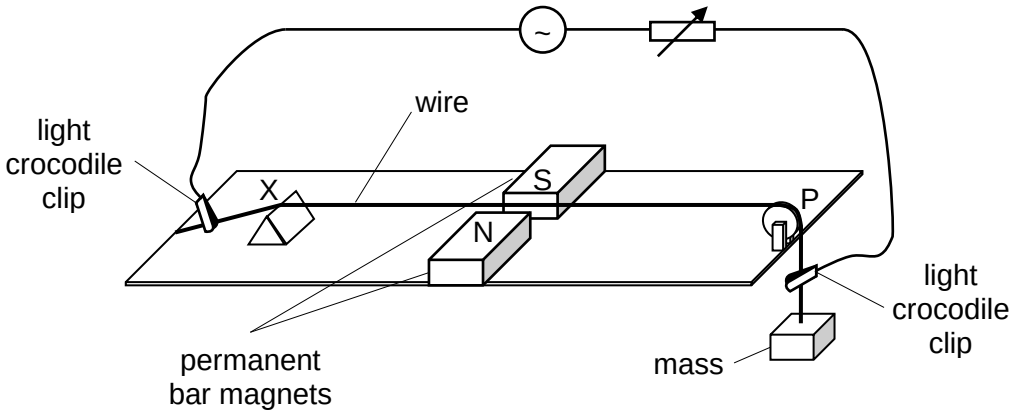

Fig. 9.1

(i) The wire vibrates when a sinusoidal alternating source is connected across the wire.

Explain how these vibrations are created.

.....

.....

.....

.....

.....

..... [2]

(ii) When the frequency of the alternating source is 50 Hz and the distance XP is 40 cm, a fundamental stationary wave is observed between XP.

1. Calculate the speed of the wave in the wire.

speed = ……. m s^{-1} [1]

2. Explain, with reference to the formation of a stationary wave, what is meant by the speed calculated in **(a)(ii)1**.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

3. State and explain how the amplitude of the vibration would change if X is shifted closer to P.

.....

.....

.....

..... [2]

4. Determine the next 2 higher frequencies that will produce stationary waves when XP remains 40 cm apart.

frequencies = ……. Hz, ……. Hz, [1]

(b) The decay of a radioactive nuclei is random and spontaneous. In a radioactive decay, the activity of the atoms at time t is given by

$$A = A_0 \exp(-\lambda t)$$

where A_0 is the activity at the start of the decay and λ is the decay constant.

As part of monitoring of a particular disposal site where nuclear waste in the form of a particular radioactive isotope is disposed, the activity on-site is recorded on a yearly basis from 1990 through to 2003. A significant reduction in activity was recorded in 1998, as shown in Fig. 9.2.

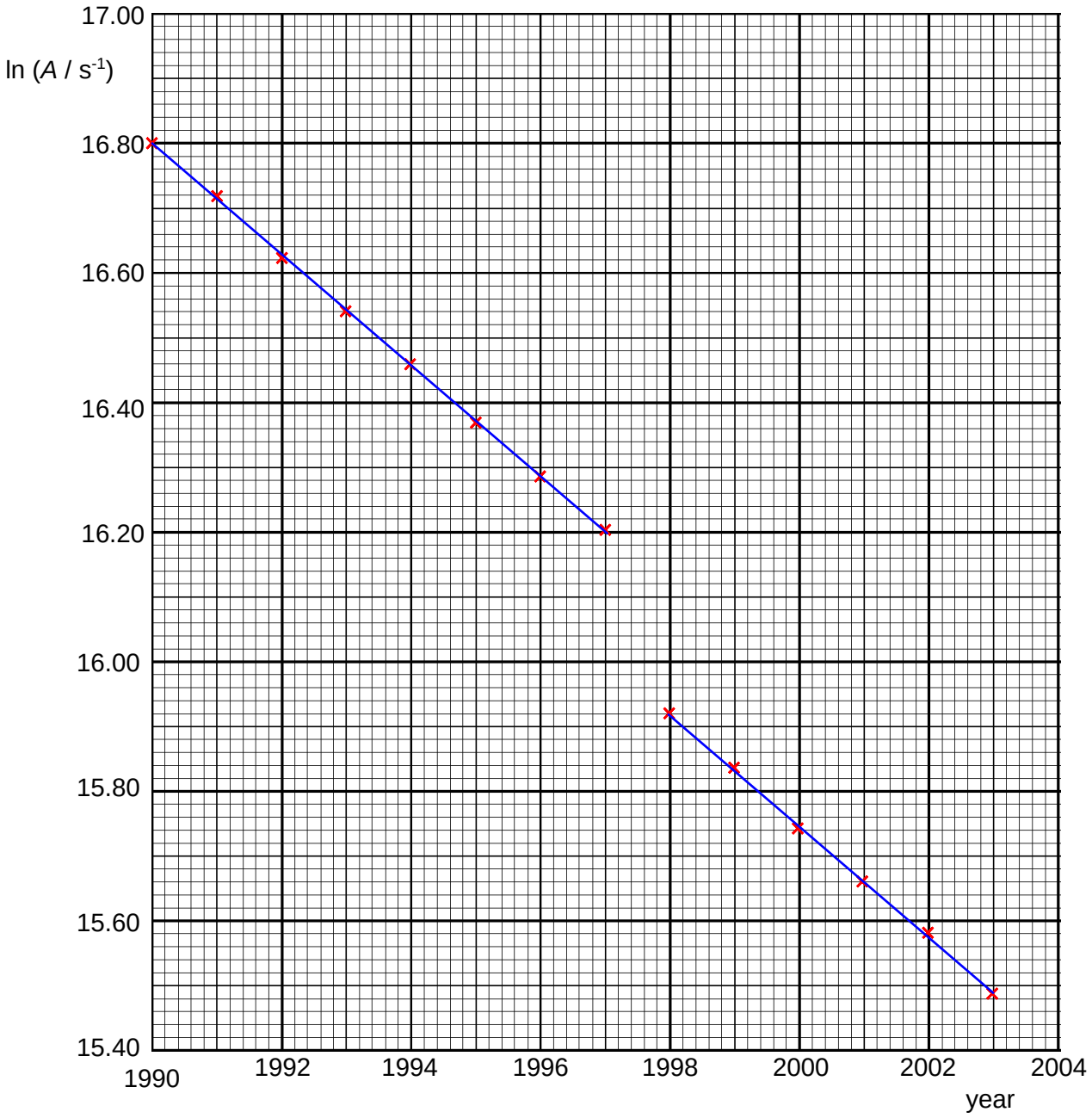

Fig. 9.2

(i) Use Fig. 9.2 to determine the decay constant λ of the radioactive isotope.

λ = ... s^{-1} [2]

(ii) Hence or otherwise, find the half-life of the radioactive isotope.

half-life = ... years [2]

(iii) Use Fig. 9.2 to show that the number of undecayed nuclei present in the year 1997 is 4.00×10^{15}.

(iv) It is alleged that some of the radioactive waste material was stolen between 1997 to 1998.

Estimate the number of radioactive nuclei that was stolen.

number = ... [2]

(v) Explain why the two sections of the graph before and after the alleged theft, are parallel.

.....

.....

.....

..... [2]

[Total: 20]