**12** In 2011, a tsunami was caused by a massive earthquake centred some distance off the coast of Japan. The tsunami caused a cooling system failure at the Fukushima Nuclear Power Plant. This resulted in a nuclear meltdown and radioactive materials were released into the surroundings.

(a) A reservoir beside one of the reactor buildings contained a large volume of water. In 2013, this water was found to have an extremely high concentration of caesium-137.
Caesium-137 is a radioactive isotope of caesium.

(i) Complete the nuclear equation for the decay of caesium-137.

$$^{137}_{55}\text{Cs} \rightarrow \text{.....}^{\text{.....}}_{\text{.....}}\text{Ba} + \text{.....}^{\text{.....}}_{\text{.....}}\beta^{-} + {}^{0}_{0}\overline{\nu}_{e}$$

**(2)**

(ii) An activity of $2.35 \times 10^{12}$ Bq per $m^3$ of water in the reservoir was measured. It is suggested that a safe level for the activity of all water in the reservoir would be 100 Bq.

Calculate the time in years for the caesium-137 to decay to a safe level.

volume of water in reservoir = 5000 $m^3$
half-life of caesium-137 = 30 years

**(4)**

Time = ..... years

(b) The most common radionuclide amongst the fission products in the fuel was iodine-131, which decays with a half-life of 8.0 days to form a stable isotope of the gas xenon.

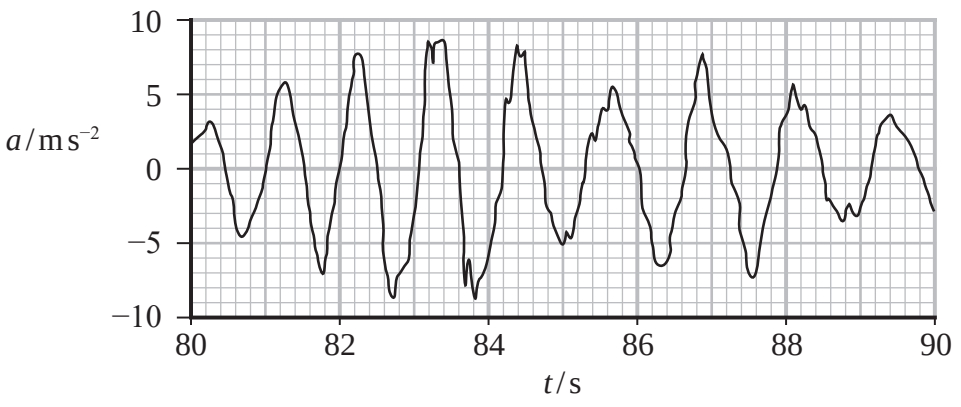
Deduce whether enough xenon would have collected in 32 days to exert a pressure of $1.0 \times 10^5$ Pa in a volume of 450 $m^3$. Assume that no gas escapes.

temperature = 20 °C
initial number of iodine nuclei = $1.25 \times 10^{28}$

**(6)**

(c) Buildings in nearby Tohoku University suffered structural damage during the 2011 earthquake.

The graph shows how the acceleration of one of the buildings, measured on the 9th floor, varied with time during the earthquake.




(Source: https://www.sciencedirect.com/science/article/pii/S0038080612001035)

At the time it was reported that during the earthquake the 9th floor of the building displaced by more than 30 cm from its normal position.

Assess the accuracy of this report.

**(5)**

**(Total for Question 12 = 17 marks)**