

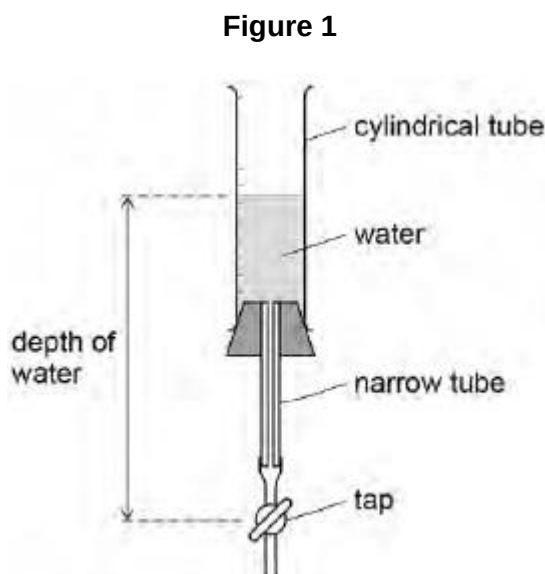
Name of the Student: _____

Max. Marks : 19 Marks

Time : 19 Minutes

Q1.

Figure 1 shows how radioactive decay of one nuclide can be modelled by draining water through a tap from a cylindrical tube.

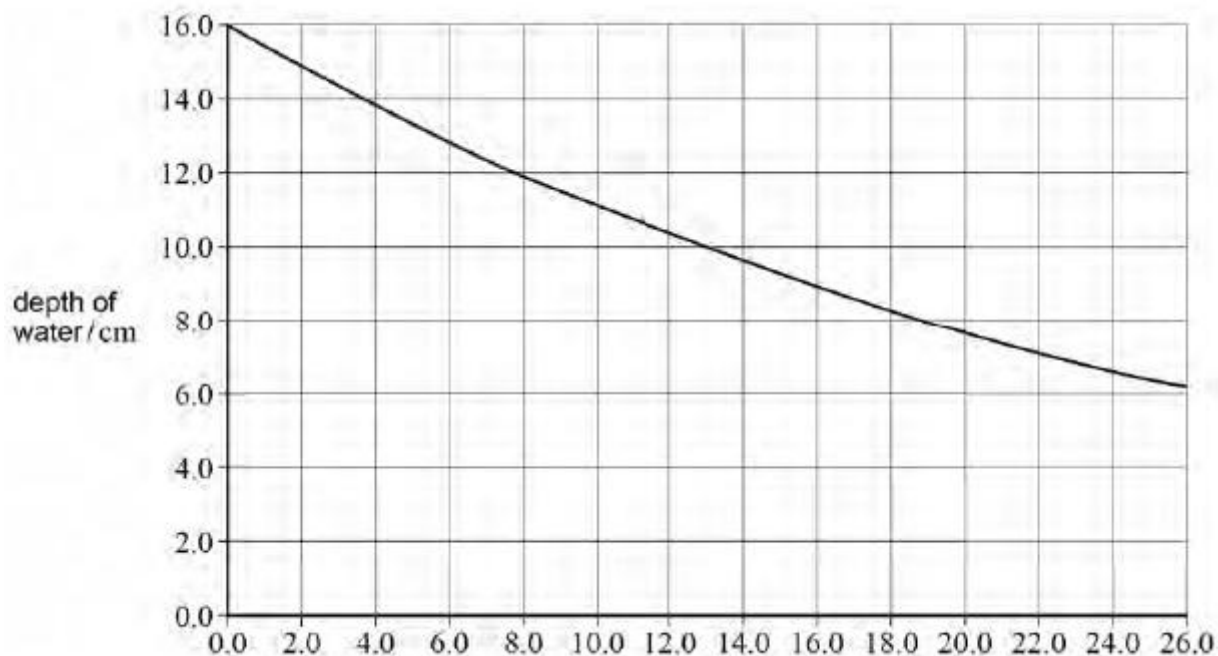


The water flow-rate is proportional to the pressure of the water. The pressure of the water is proportional to the depth of the water. Therefore the rate at which the depth decreases is proportional to the depth of the water.

Before the tap is opened the depth is 16.0 cm

The tap is opened and the depth is measured at regular intervals. These data are plotted on the graph in **Figure 2**.

Figure 2



- (a) Determine the predicted depth of water when the time is 57 s

depth = _____ cm

(1)

- (b) Suggest how the apparatus in **Figure 1** may be changed to represent a radioactive sample of the same nuclide with a greater number of nuclei.

(1)

- (c) Suggest how the apparatus in **Figure 1** may be changed to represent a radioactive sample of a nuclide with a smaller decay constant.

(1)

- (d) The age of the Moon has been estimated from rock samples containing rubidium (Rb) and strontium (Sr), brought back from Moon landings.

$^{87}_{37}\text{Rb}$ decays to $^{87}_{38}\text{Sr}$ with a radioactive decay constant of $1.42 \times 10^{-11} \text{ year}^{-1}$

Calculate, in years, the half-life of $^{87}_{37}\text{Rb}$

half-life = _____ years

(1)

- (e) A sample of Moon rock contains 1.23 mg of $^{87}_{37}\text{Rb}$.

Calculate the mass, in g, of $^{87}_{37}\text{Rb}$ that the rock sample contained when it was formed 4.47×10^9 years ago

Give your answer to an appropriate number of significant figures.

mass = _____ g

(3)

- (f) Calculate the activity of a sample of $^{87}_{37}\text{Rb}$ of mass 1.23 mg

Give an appropriate unit for your answer.

activity = _____ unit _____

(3)

(Total 10 marks)

Q2.

- (a) Calculate the binding energy, in MeV, of a nucleus of $^{59}_{27}\text{Co}$.

nuclear mass of $^{59}_{27}\text{Co}$ = 58.93320 u

binding energy = _____ MeV

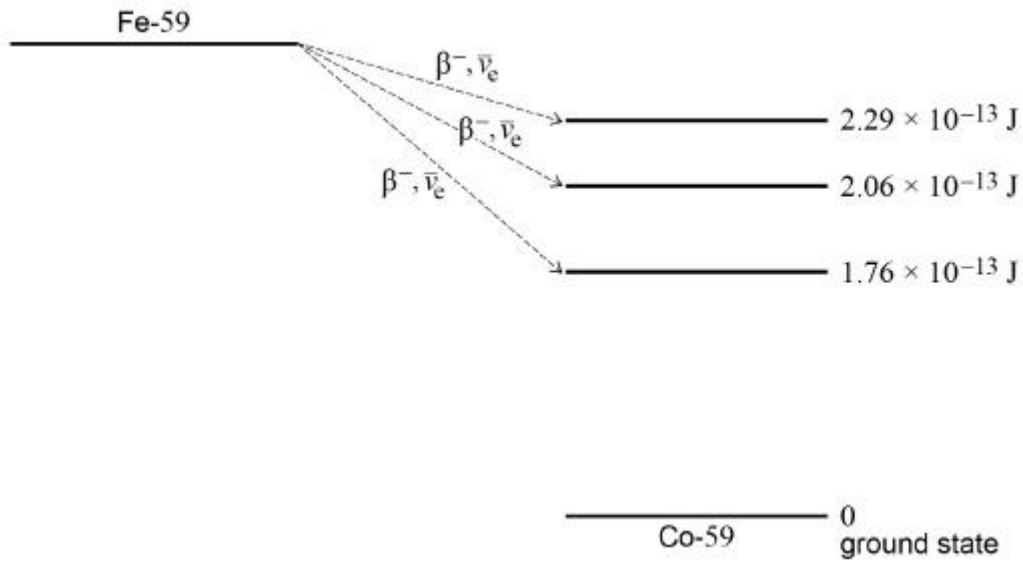
(3)

- (b) A nucleus of iron Fe-59 decays into a stable nucleus of cobalt Co-59. It decays by β^- emission

followed by the emission of γ -radiation as the Co-59 nucleus de-excites into its ground state.

The total energy released when the Fe-59 nucleus decays is 2.52×10^{-13} J.

The Fe-59 nucleus can decay to one of three excited states of the cobalt-59 nucleus as shown below. The energies of the excited states are shown relative to the ground state.



Calculate the maximum possible kinetic energy, in MeV, of the β^- particle emitted when the Fe-59 nucleus decays into an excited state that has energy above the ground state.

maximum kinetic energy = _____ MeV

(2)

- (c) Following the production of excited states of $^{59}_{27}\text{Co}$, γ -radiation of discrete wavelengths is emitted.

State the maximum number of discrete wavelengths that could be emitted.

maximum number = _____

(1)

- (d) Calculate the longest wavelength of the emitted γ -radiation.

Longest wavelength = _____ m

(3)

(Total 9 marks)