

2nd section A test for Clockwork Universe: Time 30 minutes

1. Choose the correct value from the list below for the energy stored in a 100 μF capacitor with a p.d. of 25 V across it.

0.0025 J

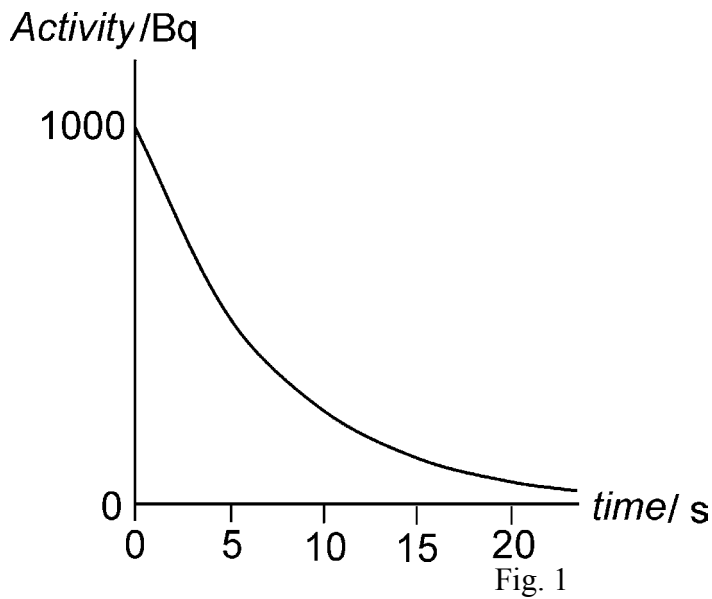
0.031 J

0.063 J

2.5 J

energy =J
[1]

2. The graph in Fig. 1 shows the decay curve for a sample of radioactive nuclei decaying to form stable nuclei.



- (a) Show that the decay constant λ is about 0.14 s^{-1} .

- (b) Show that the sample originally contained about 7000 radioactive nuclei.

[2]

[2]

3. The graph in Fig. 3 shows the displacement-time graph for a 0.50 kg mass attached to a spring.

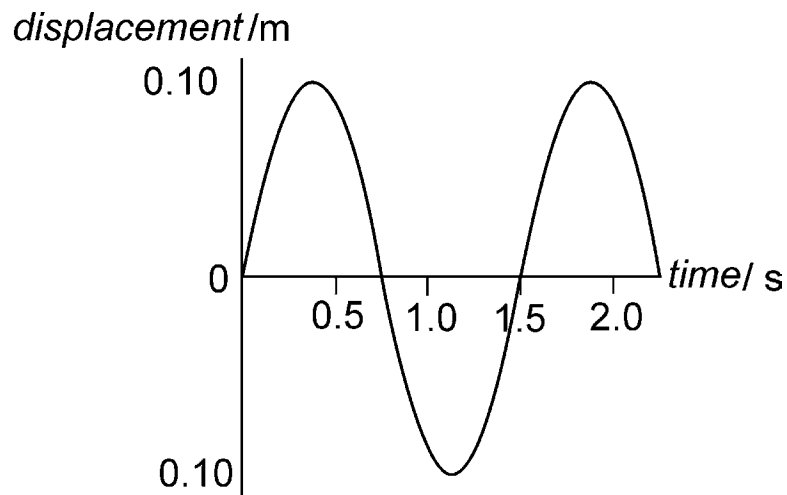


Fig. 3

- (a) State the period of oscillation of the mass-spring system.

period = s [1]

- (b) Calculate the spring constant k of the spring.

$k = \dots\dots\dots$ unit [3]

- (c) Without calculating any values, sketch on Fig. 3 above the acceleration-time graph for this oscillation.

[2]

4. A 2200 W kettle contains 2.5 kg of water. Calculate the rate at which the temperature rises.

$$c = 4200 \text{ J kg}^{-1} \text{ K}^{-1}$$

[2]

5. Fig. 4 shows gravitational equipotentials near a binary star system consisting of two stars A and B.

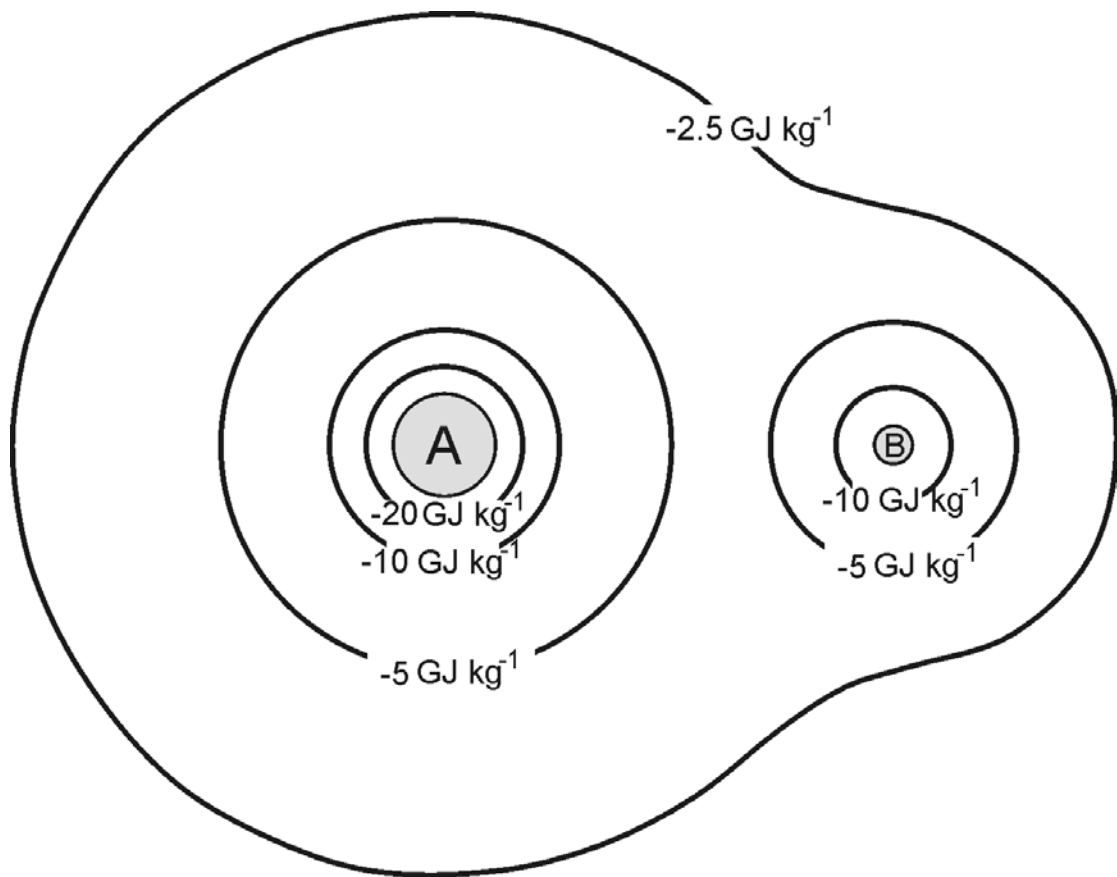


Fig. 4

- (a) Explain how the gravitational equipotentials show that the gravitational field strength becomes weaker as you move away from each star.

[2]

- (b) Estimate the energy needed to move a 100 kg mass from the surface of star A to a very great distance away.

[3]

(c) Mark with an X the point on the diagram where the resultant gravitational field strength is 0.

[1]

6. Calculate the centripetal acceleration of the Earth as it orbits the Sun.

$$\text{radius of Earth's orbit} = 1.5 \times 10^{11} \text{ m}$$

$$1 \text{ year} = 3.2 \times 10^7 \text{ s}$$

[3]

7. 0.50 mol of an ideal gas at 350 K occupy a volume of 0.40 m^3 .

(a) Show that the pressure is about 3600 Pa.

$$R = 8.3 \text{ J K}^{-1} \text{ mol}^{-1}$$

[2]

(b) Calculate the new pressure if the temperature drops to 290 K, the volume remaining constant.

[2]

8. In a hydrogen atom, the lowest possible energy state is $1.6 \times 10^{-18} \text{ J}$ below the next higher energy state.

(a) Show that the Boltzmann factor for these two energy states at a temperature of 6000 K is about 5×10^{-9} .

$$k = 1.4 \times 10^{-23} \text{ J K}^{-1}$$

[2]

(b) Explain why, at a temperature of 6000 K, only about 1 hydrogen atom in 2×10^8 will be in the higher of these two states.

[2]