

**Section A test for Clockwork Universe: Time 30 minutes**

1. The graph in Fig. 1b shows the decay curve obtained from the circuit of Fig. 1a

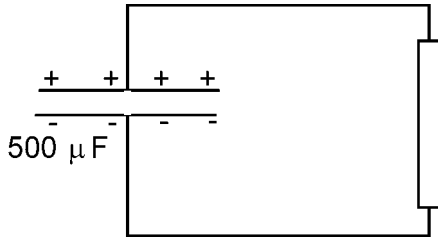


Fig. 1 a

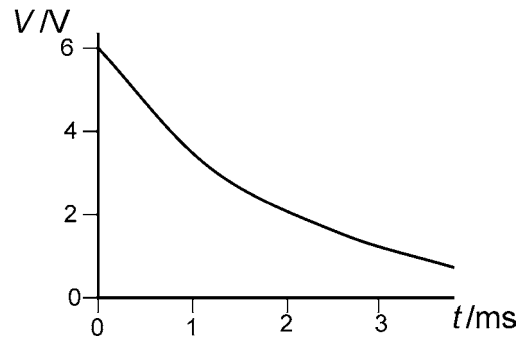


Fig. 1b

- (a) Calculate the charge on the capacitor at the time  $t = 0$ .

[3]

- (b) Calculate the energy stored in the capacitor at time  $t = 0$ .

[2]

- (c) Show that the resistor has a resistance of about  $4 \Omega$ .

[2]

- (d) Calculate the current flowing at time  $t = 0$ .

[2]

2. Fig. 2 shows a satellite orbiting the Earth at a distance of  $1.0 \times 10^7$  m from the centre of the Earth.

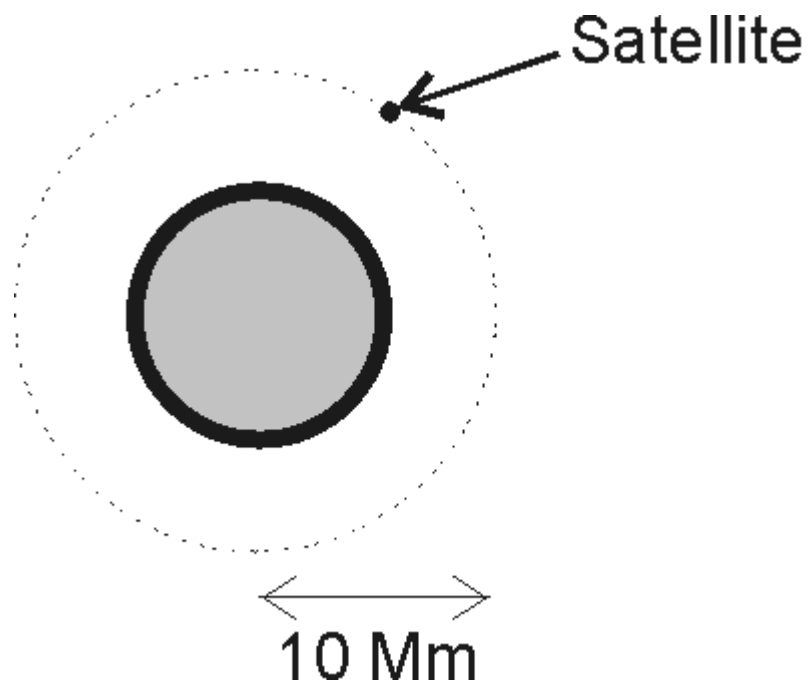


Fig. 2

- (a) Draw an arrow on the satellite in Fig. 2 to indicate the direction of the resultant force acting upon it.
- (b) Show that the gravitational field strength  $g$  at the satellite is about  $4 \text{ N kg}^{-1}$ . [1]  
 $G = 6.7 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$   
Mass of Earth,  $M_E = 6.0 \times 10^{24} \text{ kg}$

3. A balloon has a volume of  $2.4 \times 10^{-3} \text{ m}^3$  at a pressure of  $1.0 \times 10^5 \text{ Pa}$  and a temperature of  $300 \text{ K}$ .

(a) Show that the balloon contains about  $0.1 \text{ mol}$  of gas.  
 $R = 8.3 \text{ J mol}^{-1} \text{ K}^{-1}$

[2]

(b) Calculate the volume on the balloon if it is left in a freezer at  $260 \text{ K}$ , the pressure remaining constant at  $1.0 \times 10^5 \text{ Pa}$ .

[2]

4. A mole of helium is at a pressure of  $5.0 \times 10^6 \text{ Pa}$  and occupies a volume of  $0.02 \text{ m}^3$ . Calculate the r.m.s. speed of the molecules.

$$m_{\text{He}} = 6.7 \times 10^{-27} \text{ kg}$$

[3]

5. A ball of mass 0.020 kg hangs on a rubber cord of spring constant  $3.0 \text{ N m}^{-1}$ . Calculate the period of oscillation when the ball is pulled down and released.

[2]

6. Here is a list of different energies (measured in J).

$10^{-18}$              $10^{-19}$              $10^{-20}$              $10^{-21}$

Which of the energies is closest to:

- (a) the average energy of a gas molecule at room temperature (300 K)?

- (b) the average energy of a gas molecule in the Sun's photosphere (at a temperature of 6000 K).? .....[1]

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

7. Here are four different (correct) pieces of astronomical evidence.

- A Distant galaxies are receding at higher speeds than closer ones
- B The entire sky is full of microwave radiation at a temperature of about 3 K
- C The ratio of hydrogen to helium in the universe is about 3:1 by mass
- D The mass of the universe, from gravitational observations, is much greater than the mass predicted from visible stars and galaxies.

Which **one** of these is **not** evidence for the Hot Big Bang theory?

Answer ..... [1]