PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Spring Semester 2016**

College of Sciences

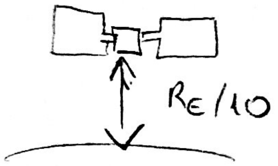
Section 1 **Quiz 12** **May 6, 2016**

Closed book. Duration: 10 minutes

Name: **Student ID:** **Signature:**

A satellite with mass m_s is in a circular orbit at a height $R_E/10$ above the Earth's surface. How much additional work should be done to make the satellite escape from the Earth? Express your answer in terms of G (gravitational constant), R_E (radius of the Earth), m_s (mass of the satellite), and M_E (mass of the Earth).

Circular orbit



$$\frac{\cancel{m_s} v^2}{\cancel{\frac{11R_E}{10}}} = \frac{\cancel{m_s} M_E G}{\left(\frac{11R_E}{10}\right)^{\cancel{2}}}$$

$$v^2 = \frac{10 M_E G}{11 R_E}$$

$$E_{mechanical,1} = \frac{1}{2} m_s v^2 - \frac{M_E G m_s}{\left(\frac{11R_E}{10}\right)} = -\frac{1}{2}\frac{M_E m_s G}{\left(\frac{11R_E}{10}\right)}$$

$$E_{mechanical,1} + W = 0$$

→ since potential is defined wrt. infinity and the speed is zero when the satellite reaches infinity

$$W = +\frac{1}{2}\frac{M_E m_s G}{\left(\frac{11R_E}{10}\right)}$$

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Section 2 **Quiz 12** **May 6, 2016**

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Name: **Student ID:** **Signature:**

A rocket is launched from the surface of the Earth with an initial speed v_{in}. Find an expression for the minimum value of v_{in} such that the rocket will completely escape from the Earth. Express your answer in terms of G (gravitational constant), R_E (radius of the Earth), and M_E (mass of the Earth).

$$E_{mechanical} = 0 = K + U$$

$$U = -\frac{G m_{rocket} M_E}{R_E}$$ (potential at the surface)

$$K = \frac{1}{2} m_{rocket} v_{in}^2$$

$$\frac{1}{2} \cancel{m_{rocket}} v_{in}^2 - \frac{G \cancel{m_{rocket}} M_E}{R_E} = 0$$

$$v_{in} = \sqrt{\frac{2 G M_E}{R_E}}$$

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Section 3 **Quiz 12** **May 6, 2016**

Closed book. Duration:10 minutes

Name: **Student ID:** **Signature:**

A satellite with mass m_s is initially stationary at the surface of the Earth. How much work should be done to place this satellite to a circular orbit at a height $R_E/10$ above the Earth's surface? Express your answer in terms of G (gravitational constant), R_E (radius of the Earth), m_s (mass of the satellite), and M_E (mass of the Earth).

Circular motion
$$\frac{\cancel{m_s} v_0^2}{\frac{11R_E}{\cancel{10}}} = \frac{\cancel{m_s} M_E G}{\left(\frac{11R_E}{10}\right)^{\cancel{2}}}$$

$$v_0^2 = \frac{10 M_E G}{11 R_E}$$

$$E_{total,orbit} = K_{orbit} + U_{orbit} = \frac{1}{2} m_s v_0^2 - \frac{G M_E m_s}{\left(\frac{11R_E}{10}\right)}$$

$$E_{total,orbit} = -\frac{1}{2} \frac{G M_E m_s}{\frac{11R_E}{10}}$$

$$E_{before\ launch} = -\frac{G M_E m_s}{R_E}$$

$$W = E_{total,orbit} - E_{before\ launch} = \frac{G M_E m_s}{R_E}\left(-\frac{10}{22} + 1\right)$$

$$W = \frac{6}{11} \frac{G M_E m_s}{R_E}$$