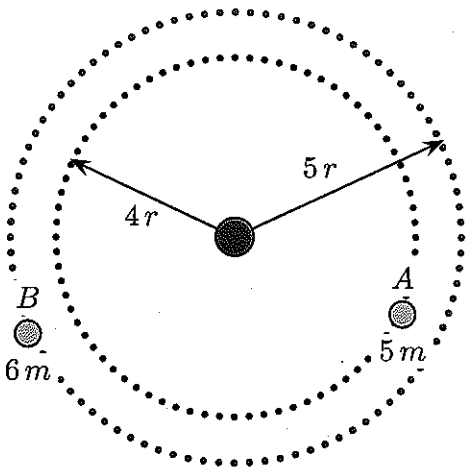
This print-out should have 15 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. The due time is Central time.

Two Satellites in Orbit 04

14:03, highSchool, multiple choice, > 1 min, wording-variable.

001

Two satellites A and B orbit the Earth in the same plane. Their masses are $5\,m$ and $6\,m$, respectively, and their radii $4\,r$ and $5\,r$, respectively.



What is the ratio of their orbital speeds?

1. $\frac{v_B}{v_A} = \sqrt{\frac{4}{5}}$
2. $\frac{v_B}{v_A} = \sqrt{\frac{5}{4}}$
3. $\frac{v_B}{v_A} = \sqrt{\frac{6}{5}}$
4. $\frac{v_B}{v_A} = \sqrt{\frac{5}{6}}$
5. $\frac{v_B}{v_A} = \sqrt{\frac{3}{2}}$
6. $\frac{v_B}{v_A} = \sqrt{\frac{2}{3}}$
7. $\frac{v_B}{v_A} = \sqrt{\frac{25}{24}}$
8. $\frac{v_B}{v_A} = \sqrt{\frac{24}{25}}$
9. None of these

Apollo Astronauts

14:03, trigonometry, numeric, > 1 min, fixed.

002

On the way to the moon, the Apollo astronauts reach a point where the Moon's gravitational pull is stronger than that of Earth's.

Find the distance of this point from the center of the Earth. The masses of the Earth and the Moon are 5.98×10^{24} kg and 7.36×10^{22} kg, respectively, and the distance from the Earth to the Moon is 3.84×10^{8} m. Answer in units of m.

003

What is the acceleration due to the Earth's gravity at this point? The value of the universal gravitational constant is 6.672×10^{-11} N $\cdot$ m^2/kg^2. Answer in units of m/s^2.

Mars in Orbit

14:05, trigonometry, numeric, > 1 min, normal.

004

The planet Mars requires 1.88 years to orbit the sun, which has a mass of 2×10^{30} kg, in an almost circular trajectory.

Calculate the radius of the orbit of Mars as it circles the sun. The gravitational constant is 6.672×10^{-11} N m^2/kg^2. Answer in units of m.

005

Calculate the orbital speed of Mars as it circles the sun. Answer in units of m/s.

Artificial Satellite in Orbit

14:03, trigonometry, numeric, > 1 min, normal.

006

An artificial satellite circling the Earth completes each orbit in 95 minutes.

What is the value of g at the location of this satellite? The mass of the earth is 5.98×10^{24} kg and the universal gravitational

constant is 6.67259×10^{-11} N $\cdot$ m^2/kg^2. Answer in units of m/s^2.

Asteroid in Orbit

14:05, trigonometry, numeric, > 1 min, wording-variable.

007

The period of the earth around the sun is 1 year and it is a distance 150 million km from the sun. An asteroid in a circular orbit around the sun is at a distance 250 million km from the sun.

What is the period T_a of the asteroid orbit? Answer in units of year.

008

What is the orbital velocity of the asteroid? Assume there are 365 days in one year. Answer in units of m/s.

Geosynchronous Satellites

14:05, trigonometry, numeric, > 1 min, normal.

009

Given: $G = 6.67259 \times 10^{-11}$ N m^2/kg^2.

A 1000 kg geosynchronous satellite orbits a planet similar to Earth at a radius 196000 km from the planet's center. Its angular speed at this radius is the same as the rotational speed of the Earth, and so they appear stationary in the sky. That is, the period of the satellite is 24 h.

What is the force acting on this satellite? Answer in units of N.

010

What is the mass of this planet? Answer in units of kg.

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14:08, trigonometry, numeric, > 1 min, fixed.

011

Find the escape speed for a rocket leaving the moon. The acceleration of gravity on the moon is 0.166 times that on earth and the moon's radius is $0.273\,R_E$. Answer in units of km/s.

Energy in Lifting 06

14:07, trigonometry, numeric, > 1 min, normal.

012

Energy is required to move a 1000 kg mass from the Earth's surface to an *altitude* h= $2R_E$ above the surface.

The acceleration of gravity is 9.8 m/s^2.

The earth has the radius R_E=6.37×10^6 m. What amount of energy is required to accomplish this move?

Hint: G and M_E can be eliminated in favor of parameter of the gravitational acceleration at the surface of the earth; *i.e.*, $g = 9.8$ m/s^2. The product GM_E may be obtained from R_E^2, the gravitational acceleration of the earth's surface. Answer in units of J.

New Satellite Orbit 02

14:09, trigonometry, numeric, > 1 min, fixed.

013

What is the kinetic energy of a satellite of mass m which is in a circular orbit of radius $3\,R_e$ about the earth?

1. $K = \dfrac{m\,v^2}{6\,R_e}$
2. $K = \dfrac{G\,M_e\,m}{3\,R_e}$
3. $K = -\dfrac{G\,M_e\,m}{3\,R_e}$
4. $K = 3\,G\,M_e\,m$
5. $K = \dfrac{m\,v^2}{3\,R_e}$
6. $K = \dfrac{G\,M_e\,m}{6\,R_e}$
7. $K = \dfrac{G\,M_e\,m}{R_e^2}$
8. $K = -\dfrac{G\,M_e\,m}{6\,R_e^2}$
9. $K = m\,g\,R_e$
10. $K = 3\,m\,g\,R_e$

014

What is the total energy of the satellite?

1. $E = -\dfrac{G M_e m}{6 R_e}$
2. $E = \dfrac{G M_e m}{R_e}$
3. $E = -\dfrac{G M_e m}{3 R_e}$
4. $E = \dfrac{G M_e m}{3 R_e}$
5. $E = 3 m g R_e + \dfrac{G M_e m}{3 R_e}$
6. $E = -\dfrac{G M_e m}{6 R_e^2}$
7. $E = 3 G M_e m$
8. $E = m g R_e + \dfrac{1}{2} m v^2$
9. $E = \dfrac{G m}{R_e}$

015

Given: The universal gravitational constant $G = 6.67 \times 10^{-11}$ N m^2/kg^2, the mass of the Earth $M_e = 5.98 \times 10^{24}$ kg and its radius $R_e = 6.37 \times 10^6$ m.

How much work must an external force do on the satellite to move it from a circular orbit of radius $2 R_e$ to $3 R_e$, if its mass is 2000 kg? Answer in units of J.