gravity - practice problems

1. An asteroid in the main belt has an average orbital distance of 2.25 AU from the Sun. Using Kepler's simple relation, find its orbital period in years.

2. A comet takes 8 years to orbit the Sun. Using Kepler's simple relation, find its average orbital distance in AU.

3. Planet A orbits at 1 AU and planet B orbits at 4 AU. How many times longer is planet B's orbital period?

4. Two 100 000 kg pieces of mining equipment are parked 20 m apart, measured from center to center. Each machine is much taller than a person, but model them as point masses. What is the gravitational force between them?

5. A 1200 kg satellite is 400 km above Earth's surface, about the altitude of some low Earth orbit spacecraft. Find the force of gravity on the satellite. Use Earth's mass as 5.97 × 10 24 kg and Earth's radius as 6.37 × 10 6 m.

6. A 75 kg astronaut feels a 300 N gravitational force from Earth. How far is the astronaut from Earth's center? Use Earth's mass as 5.97 × 10 24 kg.

7. A 75 kg person stands on Earth. Earth pulls on the person, and the person pulls on Earth with the same size force. Find the person's acceleration and Earth's acceleration from this gravitational force. Use Earth's mass as 5.97 × 10 24 kg and Earth's radius as 6.37 × 10 6 m.

8. Mars has mass 6.42 × 10 23 kg and radius 3.39 × 10 6 m. Its sky often looks dusty orange, but the surface gravity comes from mass and radius. Find the gravitational acceleration at the surface of Mars.

9. Find the gravitational acceleration 400 km above Earth's surface. Use Earth's mass as 5.97 × 10 24 kg and Earth's radius as 6.37 × 10 6 m.

10. At what altitude above Earth's surface is gravitational acceleration one-fourth of its surface value? Use Earth's radius as 6.37 × 10 6 m.

11. A spacecraft moves from a distance of 3 Earth radii from Earth's center to 6 Earth radii from Earth's center. What happens to the gravitational force from Earth?

12. Two 5.0 × 10 4 kg asteroids are 30 m apart. What is the gravitational force between them?

13. A 70 kg rover part is weighed on Mars. Use the surface gravity you found for Mars, 3.73 m/s^2. What is its weight on Mars?

14. A rock is dropped from rest near the surface of Mars. Assume the gravitational acceleration stays constant at 3.73 m/s^2 for the short fall. How fast is the rock moving after 6 s?

15. Two asteroids have masses of 100 000 kg and 200 000 kg. Their centers are 5 m apart. What is their gravitational potential energy?

16. The two asteroids from the last problem are slowly pulled from 5 m apart to 20 m apart. How much work must be done to separate them that far?

17. A 500 kg probe starts at rest 20 000 km above Earth's surface and falls to 10 000 km above Earth's surface. Ignoring air resistance and engines, how much kinetic energy does it gain? Use Earth's mass as 5.97 × 10 24 kg and Earth's radius as 6.37 × 10 6 m.

18. In the last problem, what is the probe's speed after falling to 10 000 km above Earth's surface?

19. A 1000 kg payload is lifted from Earth's surface to a circular-orbit altitude of 400 km. Ignoring the rocket's wasted energy, how much work is needed just to increase the payload's gravitational potential energy? Use Earth's mass as 5.97 × 10 24 kg and Earth's radius as 6.37 × 10 6 m.

20. Find the minimum escape speed from Earth. Use Earth's mass as 5.97 × 10 24 kg and Earth's radius as 6.37 × 10 6 m.

21. Find the minimum escape speed from the Moon. Use the Moon's mass as 7.35 × 10 22 kg and its radius as 1.74 × 10 6 m.

22. A small asteroid has mass 8.0 × 10 15 kg and radius 500 m. Find its surface gravity and escape speed.

23. A probe starts from rest at a distance of 2 Earth radii from Earth's center and falls to Earth's surface. Ignoring atmosphere and Earth's rotation, how fast is it moving when it reaches the surface? Use Earth's mass as 5.97 × 10 24 kg and Earth's radius as 6.37 × 10 6 m.

24. A 900 kg spacecraft is at a distance of 2 Earth radii from Earth's center. Find the gravitational acceleration there and the gravitational force on the spacecraft. Use Earth's mass as 5.97 × 10 24 kg and Earth's radius as 6.37 × 10 6 m.

25. Halley's Comet has an orbital period of about 75 years. If Kepler's simple relation is used as an average model for its orbit around the Sun, what is its average distance from the Sun in AU?

26. Earth is 1.496 × 10 11 m from the Sun. Use the Sun's mass as 2.00 × 10 30 kg and Earth's mass as 5.97 × 10 24 kg. Find the gravitational force on Earth from the Sun, then find Earth's acceleration toward the Sun.