

### Conceptual Questions

- Imagine you're standing on the surface of a shrinking planet. If it shrinks to one-tenth its original diameter with no change in mass, on the shrunken surface you'd weigh
  - 1/100 as much.
  - 10 times as much.
  - 100 times as much.
  - 1000 times as much.
  - None of these.
- A spacecraft on its way from Earth to the Moon is pulled equally by Earth and Moon when it is
  - closer to the Earth's surface.
  - closer to the Moon's surface.
  - half way from Earth to Moon.
  - At no point, since Earth always pulls more strongly.
- If the Sun collapsed to become a black hole, Planet Earth would
  - continue in its present orbit.
  - fly off in a tangent path.
  - likely be sucked into the black hole.
  - be pulled apart by tidal forces.
  - Both C and D.
- A hole is dug down through the centre of the Earth and out to the other side (theoretically, of course, as this would be physically impossible). What would be your motion if you were to jump into the hole? Explain.
- The gravitational field strength caused by the Earth on its surface is approximately 9.8 N/kg. At what location would the gravitational field strength caused by the Earth be equal to 0 N/kg? Explain.

### Problems

- An object of mass 40.0 kg rests on the surface of a planet with a mass of  $8.2 \times 10^{22}$  kg and radius  $3.6 \times 10^5$  m.
  - Calculate the force of gravity acting on the object.
  - Determine the gravitational field strength "g" at the planet's surface.
  - Calculate the force of gravity acting on the object if it is placed at a position  $6.4 \times 10^5$  m above the planet's surface.
- An object of mass 50.0 kg rests at the surface of a planet with a mass of  $6.2 \times 10^{20}$  kg and a radius of  $3.8 \times 10^4$  m. What would the object weigh at an altitude equivalent to the planet's radius?

8. You are explaining why astronauts feel weightless while orbiting in the space shuttle. Your friends respond that they thought gravity was just a lot weaker up there. Convince them and yourself that it isn't so by calculating the acceleration of gravity 250 km above the Earth's surface in terms of  $g$ .
9. The gravitational field strength on the surface of Mars is 3.7 N/kg.
- What would a person weigh on Mars if this person weighs 637 N on Earth?
  - What is the mass of Mars if its radius is  $3.4 \times 10^6$  m?
10. The gravitational field strength on the surface of the Moon is 1.6 N/kg. The radius of the Moon is  $1.7 \times 10^6$  m.
- How much would a 60.0-kg astronaut weigh in orbit around the Moon at an altitude of  $2.0 \times 10^2$  km above the lunar surface?
  - If an object is thrown vertically upward from the lunar surface with a speed of 10 m/s, what maximum height will it reach?
11. A person stands on a set of bathroom scales which have been calibrated in Newtons. The scales read 500 N. (Assume three significant digits.)
- What would the reading be if the same person stood on the scales on a planet where the gravitational field strength,  $g$ , is 14 N/kg?
  - If this planet had a mass of  $7.0 \times 10^{24}$  kg, what would its radius be?
  - What would this person weigh at an altitude of  $2.8 \times 10^6$  m above the planet's surface?
12. A 3.0-kg object is dropped from 4.0 m above the lunar surface and reaches the ground 2.24 s later.
- What is the value of the force of gravity exerted by the Moon on the object?
  - If both the Moon's mass and radius were doubled, how long would it take the object to reach the surface if dropped from the same height?
13. A typical white-dwarf star, which was once an average star like our Sun but is now in the last stage of its evolution, is the size of our Moon but has the mass of our Sun. What is the surface gravity of this star, in  $g$ 's?