Conceptual Questions

1. Imagine 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]

   A. 1/100 as much. B. 10 times as much. C. 100 times as much.
   D. 1000 times as much. E. None of these.

2. A spacecraft on its way from Earth to the Moon is pulled equally by Earth and Moon when it is [2]

   A. closer to the Earth's surface. B. closer to the Moon's surface.
   C. half way from Earth to Moon. D. At no point, since Earth always pulls more strongly.

3. If the Sun collapsed to become a black hole, Planet Earth would [3]

   A. continue in its present orbit. B. fly off in a tangent path.
   C. likely be sucked into the black hole. D. be pulled apart by tidal forces.
   E. Both C and D.

4. A (theoretical) hole is dug down through the centre of the Earth and out to the other side. What would be your motion if you were to jump into the hole? Explain.
5. 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. [4]
6. The Sun's gravitational pull on the Earth is much larger than the Moon's, yet the moon is mainly responsible for the tides. Explain [*Hint: Consider the difference in gravitational pull from one side of the Earth to the other.*][5]

Problems

7. An object of mass 40.0 kg rests on the surface of a planet with a mass of 8.2×10^{22} kg and radius 3.6×10^{5} m.
   a) Calculate the force of gravity acting on the object.
   b) Determine the gravitational field strength "g" at the planet's surface.
   c) Calculate the force of gravity acting on the object if it is placed at a position 6.4×10^{5} m above the planet's surface.

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[1] 60 Questions – Basic Physics, Paul G . Hewitt, #15
[2] 60 Questions – Basic Physics, Paul G . Hewitt, #18
[3] 60 Questions – Basic Physics, Paul G . Hewitt, #53
[4] Almeida, F., Physics Department, Victoria Park C.I.
[5] Physics 6th Edition, Giancoli, Chapter 5 Questions, #14

8. An object of mass 50.0 kg rests at the surface of a planet with a mass of 6.2×10^{20} kg and a radius of 3.8×10^{4} m. What would the object weigh at an altitude equivalent to the planet's radius?
9. Your friend explains that astronauts feel weightless while in orbit around the Earth because gravity is really weaker up there in outer space, but is it? Find out yourself by calculating the gravitational field strength of the Earth 380 km above its surface (the orbital altitude of the International Space Station) as a percentage of the gravitational field strength at its surface (9.8 N/kg). [6]
10. The gravitational field strength on the surface of Mars is 3.7 N/kg.
    a) What would a person weigh on Mars if this person weighs 637 N on Earth?
    b) What is the mass of Mars if its radius is 3.4×10^{6} m?
11. The gravitational field strength on the surface of some celestial object is 1.6 N/kg and its radius is 1.7×10^{6} m.
    a) How much would a 60.0-kg astronaut weigh in orbit at an altitude of 2.0×10^{2} km?
    b) If a rock, thrown vertically upward from the Earth's surface, achieves a maximum height of 5.1 m, how high will it reach above the surface of the celestial object if thrown in the same way?
12. A person stands on a set of bathroom scales (on the Earth) which have been calibrated in Newtons. The scales read 500 N (Assume three significant digits).
    a) What would the reading be if the same person stood on the scales on a planet where the gravitational field strength is 14 N/kg?
    b) If this planet had a mass of 7.0×10^{24} kg, what would its radius be?
13. A 3.0-kg object is dropped from 4.0 m above the lunar surface and reaches the ground 2.24 s later.
    a) What is the value of the force of gravity exerted by the Moon on the object?
    b) 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?
14. The Earth is the densest planet in the solar system. If it had the density of the least dense planet in the solar system, Saturn ($\rho = 0.70$ g/cm^3), how large, compared to its current size (as a percentage), would the Earth need to be for us to still experience the same gravitational field strength on its new surface? [7]

[6] Physics 6th Edition, Giancoli, Chapter 5 Problems, #38 - modified
[7] Almeida, F., Physics Department, Victoria Park C.I.