5 — Gravitational Potential Energy

1. What is the GPE relative to 0 at ∞ of a 1000 kg car: on the earth’s surface, at height of 1re, at 2re and 10re?

2. A rocket with a speed of 1800 m/s at the earth’s surface aims straight up. If it turns its engine off and there is no friction, to what maximum altitude can it reach?

3. At what speed must a rock be launched from the surface of the moon to get to a maximum height of 1rm, 2rm?

4. A 3500 kg rocket from the shuttle is dropped from a stationary height of 500 km. It hits the earth at a speed of 400 m/s. How much energy is lost to friction with the atmosphere?

5. A 1500 kg spaceship is stationary over the moon with a radius of 1.5 rm. It hits the surface of the moon. How much kinetic energy does it have and at what speed does it have just before it hits the surface?

6 — Mechanical Energy and Escape Velocity

6. What is the kinetic and total mechanical energy of a 500 kg satellite in orbit of the earth with a radius of: 1.1re, 2re, 5re, 10re, in geo-synchronous orbit?

7. A 1500 kg spaceship is in orbit of the moon with a radius of 1.5 rm. It hits the surface of the moon. How much kinetic energy does it have and at what speed does it have just before it hits the surface?

8. The Mir orbital station fell to the earth from an orbital height of 400 km. If it lost 85% of its Kinetic Energy it would have had if there was no energy lost to friction, how fast is it moving just as it hits the earth’s surface?

9. What is the escape velocity from the surface of the: earth, moon, sun?

10. What is the escape velocity of the earth from the orbit of the moon?

11. What is the escape velocity of the sun from the orbit of the earth?

12. For a space probe launched from the earth that is to escape the solar system, what is the major gravity well to escape?

13. What is the extra energy needed to allow a satellite to escape the earth if: it is in orbit at r =1000 km or, it is stationary at r=1000km. Explain the difference.

14. A comet enters the solar system, orbits the sun, and leaves again. When it is near the sun, its Ep (relative to zero at infinity) plus its Ek is found to be less than zero. Will the comet ever return ?

15. To "escape" from the surface of a planet depends on which values?

16. A rocket has a mass of 2.5 x 103 kg. What is its escape velocity from the surface of a planet having a mass of 6.1 x 1024 kg, and a radius of 4.2 x 106 m?

17. The star ship Enterprise discovers a small moon orbiting an unknown planet. The moon orbits at a mean distance of 3.6 x 108 m and has a period of 21.0 days. If the stars hip establishes an orbit of 8.0 x 107 m around the planet, what is the minimum escape velocity needed by the Enterprise so it can continue to seek out new life?

18. Find the largest radius that would allow the earth to become a black hole. (Hint: no light can escape from a black hole)

1. –6.24x1010J, -3.13x1010J, -2.08x1010J, -6.25x109J.

2. 1.7x105m.

3. 1680m/s, 1944m/s.

4. 2.1 x109 J.

5

6. ±1.42x1010J, ±7.81x109J, ±3.13 x109J, ±1.56 x109J, 2.36 x109J.

7. 2.84 x109J, 1940m/s.

8. 3150m/s.

9. 1.1 x104m/s, 2.4 x103m/s, 6.2 x105m/s.

10. 1.4 x103m/s. 11. 4.2 x104m/s.

13. 2.7 x107J, 5.4 x107J. 14. Yes,

15. radius, mass. 16. 1.4 x104m/s.

17. 3.74 x103m/s, 18. 8.9mm.