PHYSICS 12 GRAVITATION WORKSHEET 2

1. The starship Enterprise discovers a small moon orbiting an unknown planet at a distance of 3.6×10^8 m with a period of 21 days.
   a) What is the mass of the planet?
   b) If the Enterprise establishes a stable orbit of 8.0×10^7 m around the planet, what is the starship's orbital speed?

2. Relative to '0' at infinity, what is the gravitational potential energy of the moon because of the presence of: a) the Earth? b) the Sun?

3. Suppose NASA has built a tower of negligible mass on a tiny round asteroid. There is a platform on top of the tower which is 200 m above the asteroid's surface. The asteroid's radius is also 200 m and its mass is 1.4×10^{10} kg.
   a) What is the E_p (relative to '0' at infinity) of a 60 kg astronaut standing on the asteroid?
   b) How much work would the 60 kg astronaut do in climbing from the surface of the asteroid to the platform?

4. How much gravitational potential energy does a 325 kg satellite gain when it is lifted from the surface of the Earth into an orbit 3.75×10^7 m from the Earth's center?

5. A 150 kg satellite in space is sitting 200 km above Earth's surface (assume it is <u>not</u> orbiting the Earth). How much work is required to move the satellite to 1500 km away from the Earth's surface?

6. A satellite of mass 20.0 kg is in an elliptical orbit around the Earth. At **perigee** (the point *nearest* the Earth) the satellite is 8.00×10^3 km from the Earth's center, travelling at 8.26×10^3 m/s. Conversely, at **apogee** (the point *furthest* from Earth) the satellite is 1.60×10^4 km from the Earth's center, with a speed of 4.29×10^3 m/s. Calculate the potential, kinetic, and total energy of the satellite at: a) perigee and b) apogee.

7. A 1.00×10^3 kg satellite orbiting at 3.00×10^8 m from the Earth's center encounters a mishap and falls to the Earth.
   a) Calculate: i) the speed, ii) the kinetic energy, iii) the potential energy and iv) the total energy of the satellite *before* it starts to fall.
   b) How much kinetic energy does the satellite have when it strikes the ground?
   c) With what velocity does it strike the ground?

8. A space capsule having a mass of 9.0×10^2 kg is projected vertically upwards from the Earth's surface with an initial kinetic energy of 7.0×10^9 J. With no air resistance, determine the maximum distance from the center of the Earth attained by the capsule.

9. Calculate the surface escape velocities for the following: a) moon b) Earth

10. A rocket has a mass of 2.5×10^3 kg. What is its escape velocity from the surface of a planet having a mass of 6.1×10^{24} kg and a radius of 4.2×10^6 m?

11. A 10 kg satellite is in a circular orbit about the Earth at an altitude of 200 km. Calculate:
a) the potential energy (with respect to 0 at infinity) of the satellite.
b) the kinetic energy of the satellite.
c) the additional energy required to move it out to infinity.

12. A comet enters the solar system, orbits the Sun, and leaves again. When it is near the Sun,
its $\mathbf{E_p}$ (relative to 0 at infinity) plus its $\mathbf{E_k}$ is less than zero. Will the comet ever return? Explain.

1. a) 8.4×10^{24} kg b) 2.7×10^{3} m/s 2. a) -7.63×10^{28} J b) -6.47×10^{31} J 3. a) -0.28 J b) 0.14 J 4. 1.69×10^{10} J 5. 1.5×10^{9} J 6. a) -9.97×10^{8} J, 6.82×10^{8} J, -3.15×10^{8} J b) -4.99×10^{8} J, 1.84×10^{8} J, -3.15×10^{8} J
7. a) i) 1.15×10^{3} m/s ii) 6.65×10^{8} J iii) -1.33×10^{9} J iv) -6.65×10^{8} J b) 6.19×10^{10} J c) 1.11×10^{4} m/s
8. 7.3×10^{6} m 9. a) 2.37×10^{3} m/s b) 1.12×10^{4} m/s 10. 1.4×10^{4} m/s
11. a) -6.06×10^{8} J b) 3.03×10^{8} J c) 3.03×10^{8} J 12. E_k can't overcome E_p, so v < escape velocity, $\therefore$ yes