YEAR 12 PHYSICS. ASSIGNMENT #3. Due Monday 8th November.

Q1. (a) Define what is meant by a gravitational field.
(b) What is a gravitational field line of force?
(c) Neatly sketch the gravitational field surrounding:
(i) the Moon; (ii) the Earth / Moon system.
(d) What are the units of gravitational field strength?
(e) What is the strength of the Earth's gravitational field on the surface of Earth?
(f) What is the mass of a 90-kg astronaut on the Moon's surface, where the acceleration due to gravity is one-sixth of that on the Earth's surface?
(g) The acceleration due to gravity on the surface of Venus is 8.9 m s^{-2}. What would be the weight of a 120-kg rock at rest on the ground on Venus?

Q2. (a) "If a missile were launched directly upwards from any site on the Earth, depending upon the launch velocity it would either fall back to Earth or leave the Earth behind. It could not be put into orbit around the Earth in this way." Briefly discuss this statement.
(b) Identify the four phases of a rocket flight, from the take-off to the release of a satellite into a "parking orbit" around the Earth. Briefly explain what is happening in each phase.
(c) *Use a table to* describe at least three differences between a parking orbit and a geosynchronous orbit.
(d) What is the difference between a geostationary orbit and a geosynchronous orbit?
(e) Determine the radius of a geosynchronous orbit.
(f) Calculate the orbital velocity of a satellite in a geosynchronous orbit.

Q3. (a) Determine the (defined) gravitational P.E. of a 10 000-kg satellite in a circular low-Earth parking orbit 370 km above the surface [take Earth's radius to be 6380 km].
(b) Calculate the orbital velocity of this satellite.
(c) Given that kinetic energy, $E_K = \frac{1}{2} m v^2$, what is the kinetic energy of the satellite?
(d) Determine the (defined) gravitational P.E. of the 10 000-kg satellite in a geostationary orbit 35 800 km above the surface.
(e) Work out its orbital velocity, and hence its kinetic energy.
(f) What is the *total* mechanical energy of the satellite in each of these orbits? – [care! remember the sign of the energies in each case!]

Q4. (a) Explain carefully the procedure required for the Space Shuttle to "wait" for a satellite in an orbit with the same radius to "catch up" to it, if the Space Shuttle is one kilometre in front.
(b) A spacecraft is to be sent from the Earth to Mars. Describe precisely how the spacecraft is manoeuvred from its orbit around the Earth to begin the voyage to Mars.
(c) Identify the difference when a spacecraft is instead sent to an inner planet such as Mercury.
(d) By considering the motion of a spacecraft as it approaches a planet from the point of view of that planet, then of the Sun, explain the "sling-shot effect", or "gravitational assist".