YEAR 12 PHYSICS. ASSIGNMENT #2. Due Monday 4th November.

Q1. Determine:- a) the speed [in m s^{-1}];
b) the centripetal acceleration [in m s^{-2}] of:-

i/ the hour hand of a watch (12 mm long);
ii/ the tip of a helicopter rotor (propeller), 2.75 m from the rotational axis, if it rotates at 1500 R.P.M. (revolutions per minute);
iii/ a satellite, which revolves once around the Earth every 24.0 hours, with an average orbital radius of 4.2×10^4 km;
iv/ the outermost edge of a 30-cm diameter record, rotating at 33.33 R.P.M.

Q2. A frictionless puck of mass 0.40 kg revolves in a horizontal circle on an air table. It is tied to a fixed point by means of a 0.16-m length of fine thread, that breaks if the strain exceeds 12.1 N. Calculate:-

a) the maximum centripetal acceleration acting on the puck;
b) the maximum speed at which the puck can move without breaking the thread;
c) its rotational period.

Q3. A 5000-kg satellite revolves around the Earth at a height of 420 km above the surface. Given that the radius of the Earth is 6380 km, its mass is 6.0×10^{24} kg, and that G, the gravitational constant, is 6.668×10^{-11} N m^2 kg^{-2} :-

a) use Newton's law of gravitation, $F_G = \frac{G m_1 m_2}{r^2}$ to find the force acting on the satellite;
b) determine the centripetal acceleration of the satellite;
c) use the formula $a_c = \frac{v^2}{r}$ to calculate the satellite's orbital speed;
d) find the satellite's orbital period [in seconds].

Q4. a) Earth takes one year [= 3.156×10^7 s] to orbit the Sun, with an average orbital radius of 1.50×10^{11} m. Find its average orbital velocity.
b) Hence determine the average centripetal acceleration acting on the Earth.
c) Use this to show that the mass of the Sun is 2.00×10^{30} kg.
d) The orbital period of Jupiter around the Sun is 11.9 Earth years [= 3.755×10^8 s]. Use Kepler's law to work out Jupiter's average orbital radius.
e) Hence find the orbital speed of Jupiter.