Gravitation Problem Set 04

IB/HP Physics

1. At the center of our galaxy there is a super massive black hole (SMBH) with a mass of 4.1 million solar masses or 8.2x1036kg. What is the strength of its gravitational field where we are, 26,000 light years away? [1 light year = 9.46x1015m] Show your work.
2. A) A test mass of 13kg experiences a force of 100N a distance x from body A. What is the gravitational field strength of body A at distance X? Show your work.

B) What is the weight of 20kg object at the same distance from object A? Show your work.
3. A) The Kepler Space telescope orbits the Sun at about the same distance as does the Earth; 1.48x1011m. With a mass of 1040kg what is the force of the Sun’s gravity on Kepler? Show your work.

B) What is Kepler’s centripetal acceleration? Show your work.

C) What is Kepler’s orbital velocity (v)? Show your work.

D) What is Kepler’s kinetic energy? Show your work.

E) What is Kepler’s gravitational potential energy? What theorem tells us this?

F) Do part E again, but this time find the Sun’s gravitational field strength at Kepler’s orbital distance then find GPE using mgh.
4. Will it skid? You’re playing GTA5 and you take a tight corner in your Porsche 911 Turbo. The Porsche has a mass of 1200kg. The curve has a radius of 30m and is flat. You take the turn at 75km/hr (21ms-1). The coefficient of friction between your race-spec’d tires and the pavement is 0.7. Do you make it or do you slide off the road? Show your work.
5. At what angle would the road need to be banked in #4 for the car to negotiate the curve successfully?