AH Physics Homework One

1. A student carries out an Ohm's Law experiment and finds the current to be (5.75 ± 0.2)A when the voltage is (230 ± 6)V. What is the value of the resistance in this experiment? Display your answer as (resistance ± uncertainty) Ω.

2. An object is propelled at $26ms^{-1}$ at an angle of 30^o to the horizontal. Calculate:-
   a) the vertical component of its initial velocity
   b) the maximum height reached
   c) the time of flight to the maximum height
   d) the horizontal component of its initial velocity
   e) the horizontal distance covered for the whole flight

3. The equation of motion of an object is given by

$$s = 5t + 2t^2$$

If the object starts from rest and travels 7m. State expressions for the object's velocity and acceleration. How long does the object take to travel the 7m?

AH Physics Homework Two

1. Calculate the relativistic mass of a particle (rest mass $1.87 \times 10^{-27}kg$) travelling at 0.3c.
2. The rest mass of a football is 1.2kg. At what speed would the football be travelling to have a mass of 2.0kg?
3. The relativistic energy of an electron is $4.5 \times 10^{-13}J$. Calculate its relativistic mass.
4. The high energy proton is accelerated until it has a mass that is four times its rest mass. At what speed is the proton travelling? What is the relativistic energy of the proton?

AH Physics Homework Three

1. A disc is slowed uniformly at $5.0rads^{-1}$ for 4.0s. The initial angular velocity is $200rads^{-1}$.
   a) Determine the angular velocity at the end of the four seconds.
   b) What is the angular displacement in this time?

2. If the orbital radius of the Moon is 3.8×10^5km, and its period is 28days, calculate its angular velocity and its tangential velocity.

3. An object is moving in a circle of radius 0.25m with a constant angular velocity of $6.4rads^{-1}$. Through what distance does the object travel in 2.0s?

4. A spinning disc slows down from $4.5rads^{-1}$ to $1.8rads^{-1}$ in 5.0s. If the radius of the disc is 0.2m, find the tangential acceleration of a point on the circumference of the disc

AH Homework Four

1. A sphere of mass 0.20kg is rotating in a circular path at the end of a string 0.8m long. The other end of the string is fixed. The period of the motion is 0.25s.
Calculate the tension in the string. (Assume the motion is a horizontal circle)

2. A ball of mass 2.0kg is attached to a string 1.6m long and made to travel in a vertical circle. The ball passes the highest point with a speed of $5.0ms^{-1}$.
a) What is the tension in the string at the highest and lowest points?
b) What is the least speed the ball could have to complete a vertical circle?

3. A conical pendulum is created by a mass on the end of a piece of string. When the pendulum makes a circle of radius 40cm, the angle between the string and the vertical is 57^0. At what angular velocity is the mass being rotated?

AH Homework Five

1. Calculate the tangential speed of the Earth at the equator. Assume the Earth is a sphere of radius 6.4×10^6m. (You should know how long it takes the Earth to spin once on its axis!)

2. What is the moment of inertia of the Earth if its mass is 6.0×10^{24}kg. ($I_{sphere} = 0.4mr^2$)

3. A flywheel has a moment of inertia of $1.2kgm^2$. The flywheel is acted on by a torque of magnitude 0.80Nm.
(a) Calculate the angular acceleration produced.
(b) The torque acts for 5.0s and the flywheel starts from rest. Calculate the angular velocity at the end of the 5.0s.

4. A heavy drum has a moment of inertia of $2.0kgm^2$. It is rotating freely at $10revs^{-1}$ and has a radius of 5.0m. A constant frictional force of 5.0N is then exerted at the rim of the drum.
(a) Calculate the time taken for the drum to come to rest.
(b) Calculate the angular displacement in this time.

AH Homework Six

1. Explain why the moment of inertia of hollow cylinder is greater the moment of inertia of a solid cylinder of the same mass and radius.

2. A bicycle wheel (mass 2.0kg and radius 0.5m) is mounted so that it can rotate horizontally. Assume the mass of the spokes is negligible
(a) Calculate the moment of inertia of the wheel system.
(b) A constant driving force of 20N is applied to the rim of the stationary wheel.
    (i) Calculate the magnitude of the driving torque on the wheel.
    (ii) Calculate the angular acceleration of the wheel.
(c) After a period of 5.0s, calculate:
    (i) The angular displacement,
    (ii) The angular momentum of the wheel.
    (iii) The kinetic energy of the wheel

3. A very light but strong disc is mounted on a free turning axis. A mass of 0.20kg is placed at a radius of 0.40m and the arrangement is set rotating at $1.0 revs^{-1}$. (The moment of inertia of the disc can be considered to be negligible.)
(a) Calculate the angular momentum of the 0.20kg mass.
(b) The mass is pushed quickly into a radius of 0.20m. Calculate the new angular velocity of the mass in $rads^{-1}$.

AH Homework Seven

1. Calculate the gravitational force of attraction between the proton and the electron in a hydrogen atom. Assume the electron is describing a circular orbit with a radius of 5.3×10^{-11} m.
(mass of proton = 1.67×10^{-27} kg; mass of electron = 9.11×10^{-31} kg).

2. What is meant by the following terms:-
- Gravitational potential
- Conservative field

3. Determine the potential energy between the planet Saturn and its rings.
Assume the rings have a mass of 3.5×10^{18} kg and are concentrated at an average distance of 1.1×10^{8} m from the centre of Saturn. The mass of Saturn is 5.72×10^{26} kg.

4. During trial firing of the Pioneer moon rocket(mass 1900kg), it reached an altitude of 125000km above the surface of the Earth. If the Earth's atmosphere extends to a height of 130km above its surface, how much gravitational potential energy did the rocket gain when it left Earth's atmosphere? What was the rocket's speed on re-entry to the Earth's atmosphere?

AH Homework Eight

1. Show that an alternative expression for the escape velocity from a planet may be given by:

$$v_e = \sqrt{2gr}$$

where the symbols have there usual meanings.

2. Calculate the escape velocity from a star of mass 2.0×10^{27}kg and radius 20,000km. What is the name given to this type of object in space?

3. A central force is required to keep a satellite in orbit. Derive the expression for the orbital period in terms of the orbital radius.

4. Show that a satellite orbiting the Earth at height of 400km has an orbital period of 93minutes. (You should know the mass and radius of the Earth!)

AH Homework Nine

1. The motion of an object performing SHM can be defined by the equation:-

$$y = A\cos\omega t$$

Derive the expression for the velocity of the object, clearly stating the initial conditions of the motion.

2. An object moves with a SHM of 10Hz and amplitude of 20mm. Calculate the accelerations and the velocities for the equilibrium and extreme points.

3. In SHM at which point does the maximum value of kinetic energy occur?

4. In SHM at which point does the maximum value of potential energy occur?

5. A 500g block is performing SHM with an angular frequency of 6.28rads^{-1}. What is the potential energy of the system when the displacement of the block is 4cm?