Test # 3 Momentum and Energy

Review

1. **ρ = mv** is a property of matter based on an object’s mass and velocity (kg m/s)
2. **F =Δ ρ/t** force is the change in momentum over time. (N)
3. **J = Δρ** Impulse is the change in momentum (kg m/s)

**J = Ft** (N s)

**J= ρf - ρi**

1. Conservation of Momentum ~ if there is no unbalanced force on a system or object momentum is conserved.

**ρf =ρi**

1. Two dimensional cases of conservation of momentum (both x and y directions are conserved)
   1. objects colliding and sticking together
   2. Stationary objects exploding
   3. Objects colliding and bouncing apart
2. Work

**W = F.d**

**W = Fdcosθ** (J)

Work is done when a force acts on an object causing it to move.

Zero work is done when

1. No distance is moved (pushing a wall)
2. No force is applied but the object still moves (drifting in space)
3. There is a 90o angle between the force and distance (orbits, carrying a tray forward)
4. Energy = Work

Energy of movement is kinetic energy **Ek = mv2/2**

Energy of gravitational potential **Eg = mgΔh** near the surface or **Eg = -GMm/r** far off surface

Energy of elastic potential **Ee = kx2/2** where k is the spring constant (x is negative for compression, positive for extension and **Fe = -kx**)

1. Power is the rate of change of work.

**P = W/t** or **P = E/t** (Watts = W)

1. Conservation of Energy – the total energy of a closed system is conserved but the types of energies making up the total can vary.

**ETi = ETf**

**ET = Ek + Eg**

1. Elastic vs Inelastic Collisions

Elastic Collisions momentum and kinetic energy are conserved and no deformation occurs.

Inelastic Collisions momentum is conserved but kinetic energy is not due to deformation.

Special case of an elastic collision ~ head on collision with one object initially stationary

**v2f = v1o +v1f**

**v2f = 2m1v1o/(m1 + m2)**

**v1f = (m1 – m2)v1o/(m1+m2)**

**if m1 = m2 then v1f = 0 and v2f = v1o**

**if m1>m2 then v1f = + and v2f = +**

**if m1<m2 then v1f = - and v2f = +**

To employ the special case formulas to a scenario with both objects moving change your frame of reference so one object goes to zero velocity. Just be sure to change back at the end.

1. Gravitational Potential Energy and Gravity

**Eg = -GMm/r**  (negative because trying to get out of the gravity well)

**ΔEg = GMm(1/r1 – 1/r2)** (moving from one position r1 to another r2) (both measured from centre of earth)

To escape the earth from the surface Ek > Eg and **vesc= (2GM/r)1/2**

If ET = 0 (Meaning Ek = Eg) will escape with no residual speed left. Drift off.

If ET > 0 (Meaning Ek> Eg) will escape with speed remaining and will speed away.

1. Orbital Speed and Binding Energy

When in orbit Ek < |Eg| at the radius.

In orbit **Ek = ½|Eg| = ½ GMm/rorbit**

To escape from orbit you need the other half of the Ep which is called the binding energy

**EB = ½|Eg| = Ek**

**Vorbitalescape = (GM/rorbit)1/2**

1. Ballistics Pendulum

**V1o = (M+m/m)(2gh)1/2**

1. Simple Harmonic Motion

Motion that is cyclic and repetitive ~ know stages of SHM

Damping 3 cases with examples ~ critical, over and under

**Review Questions**

pg 219 # 37, 39, 41, 46, 56

pg 274 # 24, 30, 34, 38, 39, 43, 48, 64

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