Further Mechanics

Fairlight Tuition

Sevens

www.FairlightTuition.org

Tutorials

www.youtube.com/FairlightTuition

Further Mechanics 1 [Circular Motion]

1. **Circular Motion:** Circling bodies are accelerating as they continually change direction and acceleration is a vector (the rate of change of velocity). They therefore experience an external resultant force (NII) directed radially inwards towards the centre of the circle (i.e. the force and velocity vectors remain perpendicular).

2. **Circling:** A body describes a circle when the radial resultant force acting on it is equal to the required centripetal force value.

3. **Spiralling:** A body spirals outwards when the radial resultant force acting on it is less than the required centripetal force value (i.e. the radius of curvature of its path will increase).

4. **Centripetal equations:** Acceleration: $a_c = \frac{v^2}{r}$ $\left[= r\omega^2\right]$

   Force (= *ma*): $F_c = \frac{mv^2}{r}$ $\left[= mr\omega^2\right]$

5. **Angular velocity** (ω) radians per second [rad s^{-1}] + direction

6. **Angular velocity equations:** $\omega = \frac{v}{r}$ $\left[= 2\pi f\right]$ $\left[= \frac{2\pi}{T}\right]$

7. **Work and circular motion:** A radial resultant force does no work on a circling body as the force and displacement vectors remain perpendicular and hence there is no displacement in the direction of this force (W = $\Sigma Fx = \Sigma F(0) = 0$).

Further Mechanics 2 [Oscillations : Equations]

1. **Phase difference:** $\Delta\phi = \frac{2\pi\Delta t}{T}$

2. **Instantaneous displacement:** $x = A\cos(2\pi ft)$

3. **Instantaneous velocity:** $v = \pm 2\pi f(A^2 - x^2)^{\frac{1}{2}}$

4. **Instantaneous acceleration:** $a = -(2\pi f)^2 x$

5. **Maximum acceleration:** $a_{max} = (2\pi f)^2 A$

6. **Mass-Spring system:** $T = 2\pi\left(\frac{m}{k}\right)^{\frac{1}{2}}$

7. **Simple pendulum system:** $T = 2\pi\left(\frac{l}{g}\right)^{\frac{1}{2}}$

Further Mechanics 3 [Oscillations : Concepts]

1. **Simple Harmonic Motion:** The acceleration of a simple harmonic oscillator is directly proportional to its displacement from (and remains directed towards) its equilibrium position ($[F \propto]\ a \propto -x$).

2. **The sum of** kinetic and potential energy components remains constant in an un-damped simple harmonic system (due to the Principle of Conservation of Energy).

3. **Damped Harmonic Motion:** A retarding force removes energy from the oscillator, causing a progressive reduction in its amplitude (period is unaffected unless damping is heavy).

4. **Critical damping:** A retarding force returns the oscillator to its equilibrium position in the shortest time without overshooting (such as needles of ammeters and voltmeters).

5. **Free oscillations:** The system oscillates with its natural (or resonant) frequency.

6. **Forced oscillations:** The system (the driven oscillator) is made to oscillate at the applied frequency of a periodic external force (the driving oscillator), which supplies energy to the system at regular intervals.

7. **Resonance:** The applied frequency is equal to the natural frequency of the driven oscillator but ½ π radians out of phase. The periodic force of the driving oscillator is therefore exactly in phase with the velocity of the driven, transferring maximum energy from the driver and causing maximum amplitude in the driven.