Phys 140: Review for Final: First 3rd

Units 1 - 6

1. Introduction : Graphing, Excel spreadsheet modeling
2. Experimental error: significant figures, standard deviation
3. Measuring motion using logger pro: definitions of *v*, *a,* average *v* versus instantaneous *v,* displacement = area under curves
4. 1-Dimensional Motion:

Constant acceleration - kinematical equations

$$x = x_o + v_o t + \frac{1}{2}at^2$$

$$v = v_o + at$$

6. 2-Dimensional Motion:

   Direction and magnitude - vectors, projectiles, gravity

5. Forces: force body diagrams

Newton's 1st Law: objects in motion remain in motion given no external forces if viewed from an *inertial reference frame*.

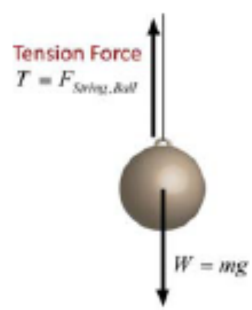
Newton's 2nd Law:

$$\boxed{\sum \vec{F}_{net} = m\vec{a}}$$

Newton's 3rd Law: for every force there is an equal and opposite one

$$F_{gravity} = G\frac{m_1 m_2}{r^2}$$

$$\vec{F}_{spring} = -k\left(\vec{x} - \vec{x}_o\right)$$



$$\vec{F}_{AB} = -\vec{F}_{BA}$$

Phys 140: Review for Final: <u>2nd Third</u>

Centripetal Acceleration

$$a_c = \frac{v^2}{R} = \omega^2 R$$

<u>Units 7, 10, 11, 8</u>

7. Centripetal force, circular motion
   Passive forces: Friction and Tension

a) Static Friction $f_s \le \mu_s N$

b) Kinetic Friction $f_k = \mu_k N$

Newton's 3rd Law

10. Work and Energy

$$W_{1\to 2} \equiv \int_{\vec{r}_1}^{\vec{r}_2} \vec{F} \cdot d\vec{l}$$

a) Net Work = Δ Kinetic Energy

b) Conservative forces

c) Non-conservative forces

$$\Delta U = U_B - U_A \equiv -W_{A\to B}$$

d) Work and Potential Energy

11. Energy and Momentum Conservation

$$W_{Non-Conservative\ Forces} = 0 \quad \Rightarrow \quad \Delta E_{Mechanical} = 0$$

When $\vec{F}_{Net,External} = 0 \quad \Rightarrow \quad \vec{P}_{Total} \equiv \sum_i \vec{p}_i = \text{Constant}$

8. 1- Dimensional Collisions: el $\Sigma K_i = \Sigma K_f$ or inelast $\Sigma K_i \neq \Sigma K_f$

a) Centre of Mass $\vec{R}_{CM} = \frac{1}{M_{Total}} \sum_{i=1}^{N} m_i \vec{r}_i$ $\quad \vec{P}_{Total} = M_{Total} \vec{V}_{CM} = 0$

Phys 140: Review for Final: Last 3rd

SR. and Units 9, 12, 13, 14

Special Relativity

- time is a parameter like mass, and position

$$t_{moving} = t_{lab}\sqrt{1-\frac{v^2}{c^2}}$$

$$\int_{t_1}^{t_2} \vec{F}_{Net}\, dt = \Delta\vec{p}$$

9. Two-Dimensional Collisions (same concepts as 1-Dimension)
   - CM or lab frame: same relative speeds before and after a collision
   - Kinetic energy of a sum of particles: $K_{system,lab} \equiv \sum_i \frac{1}{2} m_i v_i^2 = \sum_i \frac{1}{2} m_i v_i^{*2} + \frac{1}{2} M_{Total} v_{CM}^2$
12. Rotational Motion
   - new parameters: θ ω α
   - Moment of interia, I , rods, spheres, cylinders
   - Parallel axis theorem for shortcut approach
   - Kinetic energy: Centre of mass plus rotational
   - Torques and Newton's 2nd Law for Rotation:

$$I = \int r^2 dm \qquad I \equiv \sum m_i r_i^2 \qquad K_{system} = \frac{1}{2} I\omega^2$$

$$\vec{\tau} = \vec{r} \otimes \vec{F} \qquad \sum \vec{\tau}_{net} = I\vec{\alpha}$$

13. Angular Momentum
   - new parameter: L
   - Conservation of L: eg. gyroscopes presession rate:
   - Change in L equal to external net torques applied

$$\vec{L} \equiv \vec{r} \times \vec{p} \qquad \vec{L}_{Total} = \sum \vec{L}_i$$

$$\Omega = \frac{\tau_{weight}}{L} \qquad \vec{\tau}_{Net,External} = \frac{d\vec{L}_{Total}}{dt}$$

14. Harmonic Motion
   - mass on a spring, pendulums:
   - sinusoidal solutions to:

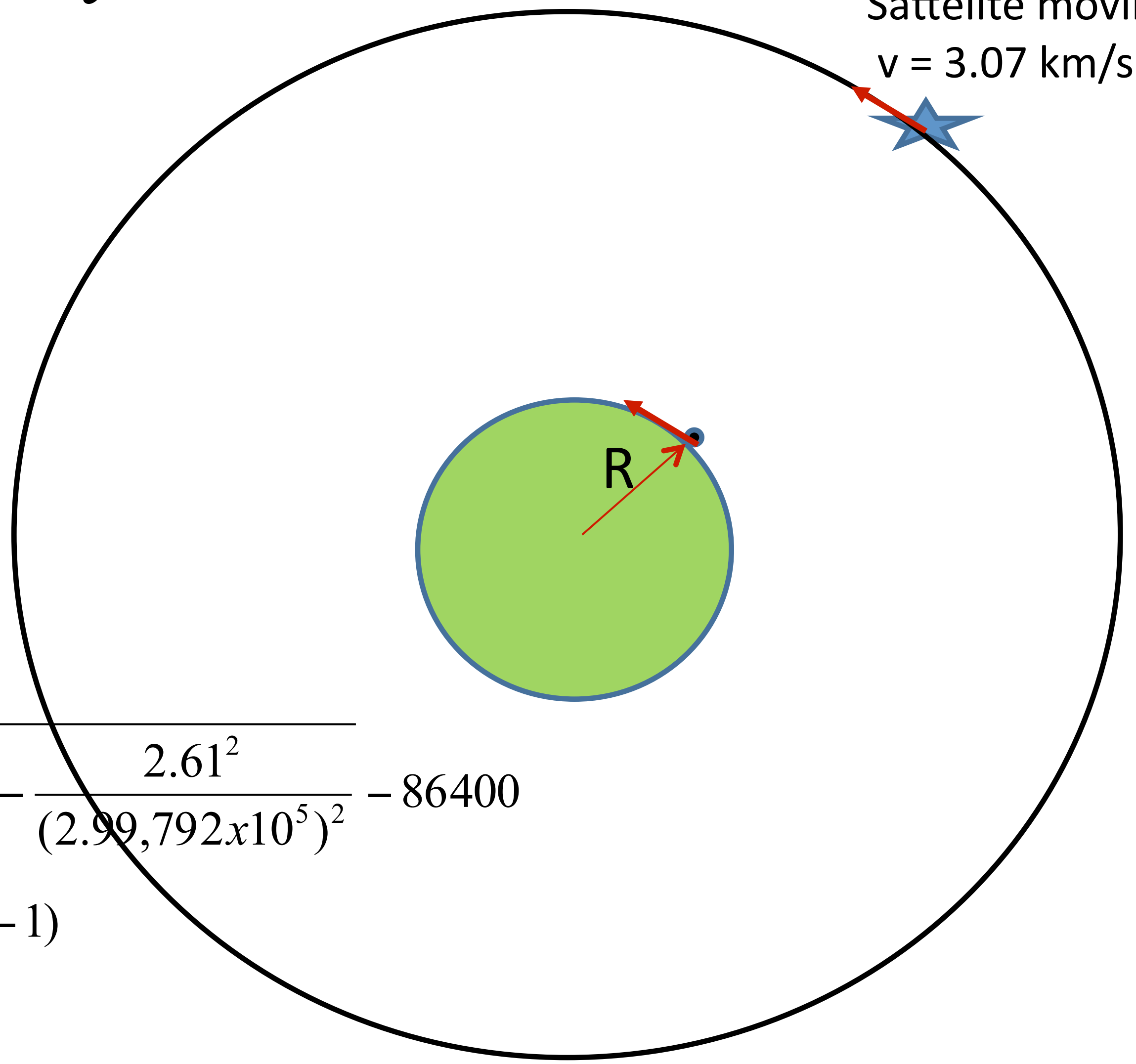
$$x(t) = A\cos(\omega t - \phi)$$

$$\omega = \sqrt{\frac{\kappa}{I}}$$

$$\frac{d^2x}{dt^2} = -\omega^2 x \qquad \omega = \sqrt{\frac{k}{m}} \qquad \frac{d^2\theta}{dt^2} = -\omega^2\theta \qquad \omega = \sqrt{\frac{MgR_{CM}}{I}}$$

Special Relativity

Geosynchronous
Sattelite moving at
v = 3.07 km/s



1. Average radius of earth
is 6371 km
$2\pi r$ = 40,000 km
one day = 86400 s
Lab speed = 0.46 km/s

Relative speed of the
satellite is 2.61 km/s

$$t_{moving} = t_{lab}\sqrt{1 - \frac{v^2}{c^2}}$$

$$\Delta t = t_{moving} - t_{lab} = 86400\sqrt{1 - \frac{2.61^2}{(2.99{,}792x10^5)^2}} - 86400$$

$$= 86400(\sqrt{1 - 7.6x10^{-11}} - 1)$$

$$= 86400(-3.8x10^{-11})s$$

$$= 3.28x10^{-6}s$$

Special Relativity

1. Muon

$$t_{lab} = t_{muon}\sqrt{1-\frac{v^2}{c^2}}$$

$$= 2.2x10^{-6}\sqrt{1-\frac{(8.5x10^7)^2}{(3.0x10^8)^2}}$$

$$= 2.2x10^{-6}\sqrt{0.92}$$

$$= 2.1x10^{-6}s$$

Unit 9 Two-Dimensional Collisions

Two particles of equal masses are moving along the *x*-axis, one with velocity $+v_o$ and the other with $-v_o$. They undergo a perfectly elastic collision. After the collision, one goes off at an angle 37 degrees to the *x*-axis in the *xy* plane. What happens to the other? What are their speeds after the collision?

Concepts you need to solve this?

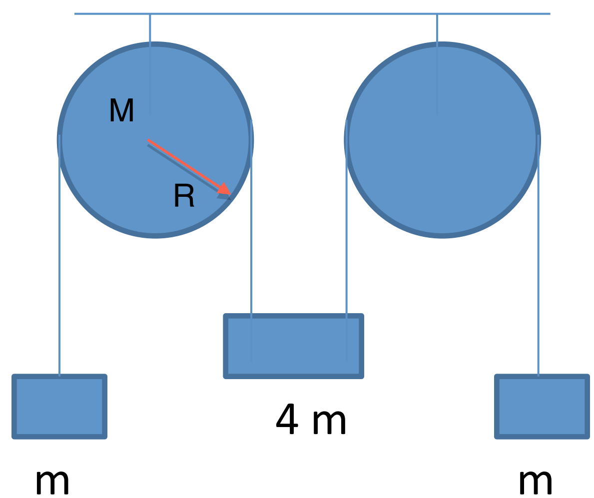
Unit 12 Rotational Motion

Text

1. A wheel with moment of inertia 20 kg-m^2 is rotating at 120 rpm when it is allowed to coast to rest. If it stops in 30 s, how large a frictional torque slowed it down?

Concepts you need to solve this?

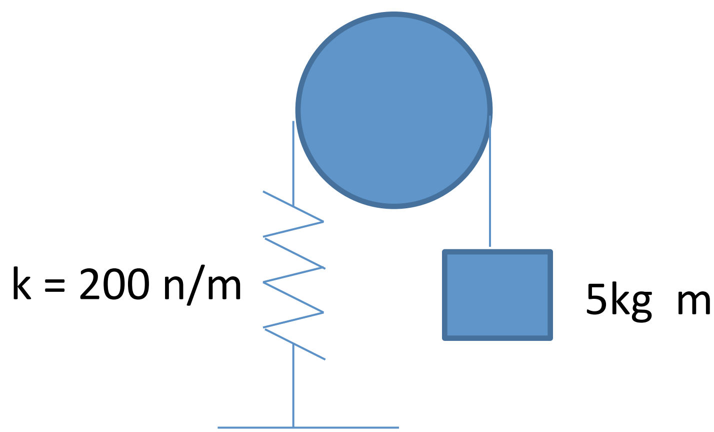
2. The two pulleys in the diagram shown below are identical and are uniform disks of mass *m*. Find an expression for the linear acceleration of the 4*m* mass.



Unit 13 Angular Momentum

When the system in the figure below is first released, the spring is unstretched. How fast will the block be moving when it has fallen 10 cm? The moment of inertia of the wheel is 1 kg-m^2 and its radius is 20 cm.

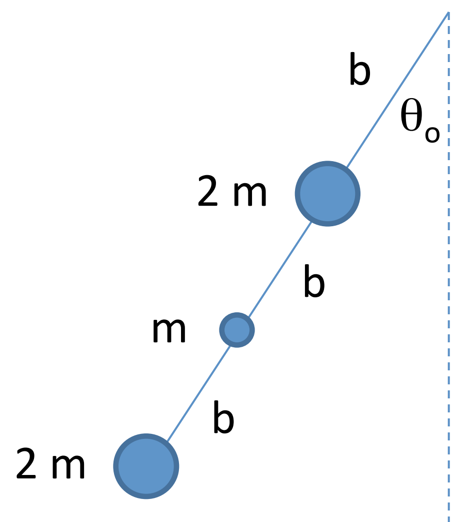
Concepts you need to solve this?



Unit 14 Harmonic Motion

1. Find the equation of motion of the pendulum below and its frequency in terms of m, b, and θ_o

Concepts you need to solve this?



2. A 20 g bullet hits the 2 kg block in the figure below and sticks to it. If the frequency of the vibration of the block after the collision is 3.0 Hz and its amplitude is 50 cm, find the speed of the bullet before the collision.