EXAM NEXT WEEK!

Concepts this Week

Relevant Lectures for Discussion Session:

- Lecture 5: Forces and Free body Diagrams (FBDs)
  1. The Free Body Diagram
  2. Force Inventory
- Lecture 6: Friction
  1. Kinetic Friction
  2. Static Friction
- Lecture 7: Work and Energy
  1. Kinetic Energy
  2. Work
  3. Work-Kinetic Energy Theorem
- Lecture 8: Conservative Forces and Potential Energy
  1. Potential Energy
  2. Mechanical Energy

Current PreLectures: PreLectures 7 and 8

Key concepts this week:

- Kinetic Energy (PreLecture 7)
- Work (PreLecture 7)
- Potential Energy (PreLecture 8)
- Mechanical Energy Conservation
  - $\Delta E_{\text{Mechanical}} = W_{\text{Non-conservative}}$
    $\Delta E_{\text{Mechanical}} = 0 \quad (\text{When } W_{\text{Non-conservative}} = 0)$

Block on Incline

A block of mass 3 kg is moved up an incline that makes an angle of 37^{o} with the horizontal under the action of a constant *horizontal* force of 40 N. The coefficient of kinetic friction between the block and the incline is 0.1. The block is initially at rest. What is the kinetic energy of the block after it has been displaced 2 m along the incline?

Loop

You are designing a new roller-coaster. The main feature of this particular design is to be a vertical circular loop-the-loop where riders will feel like they are being squished into their seats even when they are in fact upside-down (at the top of the loop).

The coaster start at rest a height of 80m above the ground, speeds up as it descends to ground level, and then enters the loop which has a radius of 20m. Suppose a rider is sitting on a bathroom scale that initially reads W (when the coaster is horizontal and at rest). What will the scale read when the coaster is moving past the top of the loop?
(You can assume that the coaster rolls on the track without friction).

Colliding Binary

Two identical stars, each having mass and radius M = $2x10^{29}$ kg and R = $7x10^{8}$ m, are initially at rest in outer space. Their initial separation is the same as the distance between our sun and the earth, D = $1.5x10^{11}$ m. Their gravitational interaction causes the stars to be pulled toward one another. Find the speed of the stars just before they collide, i.e., when their centers are a distance 2R apart.

G=6.67x10^(-11)

Review: Noise-Maker

After watching the movie "Crocodile Dundee", you and some friends decide to make a communications device invented by the Australian Aborigines. It consists of a noise-maker swung in a vertical circle on the end of a string. You are worried about whether the string you have will be strong enough, so you decide to calculate the tension in the string when the device is swung with constant speed. You and your friends can't agree whether the maximum tension will occur when the noise-maker is at the highest point in the circle, at the lowest point in the circle, or will always be the same. To settle the argument, you decide to calculate the tension at the highest point and at the lowest point and then compare them.

Carnival Ride

A neighbor's child wants to go to a carnival to experience the wild rides. The neighbor is worried about safety because one of the rides looks particularly dangerous. She knows that you have taken physics and so asks you for advice. The ride in question has a 4 kg chair which hangs freely from a 10 m long chain attached to a pivot on the top of a tall tower. When the child enters the ride, the chain is hanging straight down. The child is then attached to the chair with a seat belt and shoulder harness. When the ride starts up, the chain rotates about the tower. Soon the chain reaches its maximum speed and remains rotating at that speed, which corresponds to one rotation about the tower every 3 seconds. When you ask the operator, he says the ride is perfectly safe. He demonstrates this by sitting in the stationary chair. The chain creaks but holds, and he weighs 90kg. Has the operator shown that the ride is safe for a 25 kg child?

Kinematics

$g = 9.81\frac{\text{m}}{\text{s}^2} = 32.2\frac{\text{ft}}{\text{s}^2}$

$\vec{v} = \vec{v}_0 + \vec{a}t$

$x = x_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$

$v^2 = v_0^2 + 2a\left(x - x_0\right)$

$\vec{v}_{A,B} = \vec{v}_{A,C} + \vec{v}_{C,B}$

Uniform Circular Motion

$a = \frac{v^2}{r} = \omega^2 r$

$v = \omega r$

Dynamics

$\vec{F}_{\text{net}} = m\vec{a} = \frac{d\vec{p}}{dt}$

$\vec{F}_{A,B} = -\vec{F}_{B,A}$

$F = mg$ (near Earth's surface)

$F_{\text{gravity}} = G\dfrac{m_1 m_2}{r^2}$ (in general)

(where $G = 6.67 \times 10^{-11}$)

$F_{\text{spring}} = -kx$

Friction

$f = \mu_k N$ (kinetic)

$f \le \mu_s N$ (static)

Work & Kinetic Energy

$W = \int \vec{F} \cdot d\vec{l}$

$W = \vec{F} \cdot \Delta\vec{r} = F\Delta r\cos\theta$

(constant force)

$W_{\text{grav}} = -mg\Delta y$

$W_{\text{spring}} = -\frac{1}{2}k\left(x_2^2 - x_1^2\right)$

$K = \frac{1}{2}mv^2$

$W_{\text{NET}} = \Delta K$