Physics Midterm 1

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March 31, 2016

- The following five equations describe the motion of a particle with constant acceleration, and don't work anywhere else:
  - $v = v_0 + at$
  - $x - x_0 = v_0 t + \frac{1}{2}at^2$
  - $v^2 = v_0^2 + 2a(x - x_0)$
  - $x - x_0 = \frac{1}{2}(v_0 + v)t$
  - $x - x_0 = vt - \frac{1}{2}at^2$
- Scalars have only magnitude. Vectors have both magnitude and direction.
- Two vectors $\vec{a}$ and $\vec{b}$ may be added geometrically by drawing them to a common scale and placing them head to tail. The vector connecting the tail of the first to the head of the second is the vector sum $\vec{s}$. Vector addition is commutative and obeys the associative law.
- The components of a a two-dimensional vector $\vec{a}$ are given as $a_x = \cos\theta$ and $a_y = a\sin\theta$
- Magnitude and orientation of a vector are given as $a = \sqrt{a_x^2 + a_y^2}$ and $\tan\theta = \frac{a_y}{a_x}$
- Unit vectors $\hat{\imath}, \hat{\jmath}, \hat{k}$ have magnitudes of unity and are directed in the positive directions of the $x, y,$ and x axes. Unit vectors are defined as $\hat{v} \equiv \frac{v}{|v|}$
- The scalar (or dot product) of two vectors $\vec{a}$ and $\vec{b}$ is written $\vec{a}\dot{b}$ and is the scalar quantity given by $ab\cos\theta$ where θ is the angle between the directions of $\vec{a}$ and $\vec{b}$.
- The vector (or cross) product of two vectors is a vector whose magnitude is given as $c = ab\sin\theta$. The rest of it is ugly and we do not care.
- Projectile motion for an object in flight:
  - $1x - x_0 = (v_0\cos\theta_0)t$
  - $y - y_0 = (v_0\sin\theta_0)t - \frac{1}{2}gt^2$
  - $v_y = v_0\sin\theta_0 = -gt$
  - $v_y^2 = (v_0\sin\theta_0^2) - 2g(y - y_0)$

  The trajectory (path) of a particle in projectile motion is parabolic and is given by $y = (tan\theta_0)x - \frac{gx^2}{2(v_0\cos\theta_0)^2}$ if x_0 and y_0 are 0.
- The particle's horizontal range R (distance from launch to landing assuming both points are at the same height) is given as $R = \frac{v_0^2}{g}\sin 2\theta_0$
- A particle is in uniform circular motion if it travels around a circle or a circular arc at constant (uniform) speed.
- The magnitude of the centripetal acceleration is given as $a = \frac{v^2}{r}$
- A particle in uniform circular motion will the circumference of the circle in time $T = \frac{2\pi r}{v}$.
- When two frames of reference A and B are moving relateive to each other at constant velocity, the velocity of a particle P as measured by an observer in frame A usually differs from that measured from frame B. The two measured velocities are related by $\vec{V}_{PA} = \vec{V}_{PB} + \vec{V}_{BA}$ where $\vec{V}_{BA}$ is the velocity of B with respect to A.
- $1\text{N} = 1kg\dot{m}/s^2$d

- If a body does not slide, the frictional force is a static frictional force $\vec{F_s}$. If there is sliding, the frictional force is a kinetic frictional force $\vec{F_k}$.
- If a body does not move, the static frictional force $\vec{F_s}$ and the component of $\vec{F}$ parallel to the surface are equal in magnitude, and $\vec{F_s}$ is directed opposite that component.
- The magnitude of $\vec{f_s}$ has a maximum value $f_{s,max}\mu f_N$.
- If a particle moves in a circle or circular arc of radius R at constant speed v, the particle is said to be in uniform circular motion. It then has a centripetal acceleration $\vec{a}$ with magnitude given by $a = \frac{v^2}{R}$, which is directed inwards towards the center of the circle. **mnemonic: "ForMoV^{2}eR"**
- Kinetic energy associated with the motion of a particle of mass m and speed v is $k = \frac{1}{2}mv^2$
- Work is defined as the engery transferred to or from an object via a force acting on that object. Energy transferred to the object is positive work, and from the object, negative work.
- Work done on a particle by a constant force $\vec{F}$ during displacement $\vec{d}$ is $w = Fd\cos\theta = \vec{F}\vec{d}$
- work done by the gravitational force on a particle-like object of mass m is given as $W_g = mgd\cos\theta$ where θ is the angle between $\vec{F_g}$ and $\vec{d}$.
- The force $\vec{F_s}$ from a spring is $\vec{f_s} = -k\vec{d}$ (Hooke's Law)
- Work done by a spring is given as $W_s = \frac{1}{2}(kx_i^2 - kx_f^2)$