UNIVERSITY OF MANITOBA

December 13, 2008
(9:00 AM - 12:00 PM)

FINAL EXAMINATION
Formula Sheet

PAPER NO.: 484

PAGE NO.: 1 of 2

COURSE NO.: PHYS 1050

TIME: 3 hours

EXAMINATION: Physics 1: Mechanics

EXAMINERS: K. S. Sharma, G. Williams, C-M Hu

Mathematics

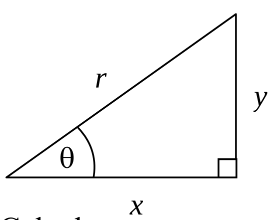
Quadratic equation:

$$ax^2 + bx + c = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Trigonometry:

$$x^2 + y^2 = r^2$$



$$\sin\theta = y/r$$
$$\cos\theta = x/r$$
$$\tan\theta = y/x$$

$$\tan\theta = \frac{\sin\theta}{\cos\theta}$$

Calculus:

$$\frac{d}{dt}(a \cdot t^n) = a \cdot n t^{n-1}$$

$$\int x^n dx = \frac{x^{n+1}}{n+1}$$

Constants and Units

$\mathrm{k} = 10^3$, $\mu = 10^{-6}$, $\mathrm{n} = 10^{-9}$

$c = 3.0\times10^8$ m/s
$g = 9.80$ m/s^2

Translational Kinematics

Three dimensions:

$$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$$

$$\vec{\mathrm{v}}_{\mathrm{av}} = \frac{\Delta\vec{r}}{\Delta t} = \frac{\vec{r}_2 - \vec{r}_1}{t_2 - t_1} \qquad \vec{\mathrm{v}} = \lim_{\Delta t \to 0} \frac{\Delta\vec{r}}{\Delta t} = \frac{d\vec{r}}{dt}$$

$$\vec{a}_{\mathrm{av}} = \frac{\Delta\vec{\mathrm{v}}}{\Delta t} = \frac{\vec{\mathrm{v}}_2 - \vec{\mathrm{v}}_1}{t_2 - t_1} \qquad \vec{a} = \lim_{\Delta t \to 0} \frac{\Delta\vec{\mathrm{v}}}{\Delta t} = \frac{d\vec{\mathrm{v}}}{dt}$$

One dimension:

$$\mathrm{v}_{x,\mathrm{av}} = \frac{\Delta x}{\Delta t} \qquad \mathrm{v}_x = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

$$a_{x,\mathrm{av}} = \frac{\Delta \mathrm{v}_x}{\Delta t} \qquad a_x = \lim_{\Delta t \to 0} \frac{\Delta \mathrm{v}_x}{\Delta t} = \frac{d\mathrm{v}_x}{dt}$$

Constant acceleration in one dimension:

$$x = x_0 + \mathrm{v}_{0x} t + \tfrac{1}{2} a_x t^2$$

$$\mathrm{v}_x = \mathrm{v}_{0x} + a_x t$$

$$\mathrm{v}_x^2 = \mathrm{v}_{0x}^2 + 2a_x(x - x_0)$$

Uniform circular motion:

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

Particle Dynamics

$$\Sigma\vec{F} = m\vec{a} \qquad f_s \le \mu_s N$$

$$W = mg \qquad f_k = \mu_k N$$

(N = normal force)

Relative Motion

$\vec{\mathrm{v}}_{PA} = \vec{\mathrm{v}}_{PB} + \vec{\mathrm{v}}_{BA}$ (PA means P relative to A, etc.)

Work, Kinetic Energy, Potential Energy

$$\mathrm{W} = \vec{F} \cdot \vec{s} \qquad \mathrm{W} = \int_A^B \vec{F} \cdot d\vec{s}$$

$$\vec{A} \cdot \vec{B} = |\vec{A}||\vec{B}| \cos\theta \qquad \mathrm{K} = \frac{1}{2} m\mathrm{v}^2$$

$$\mathrm{W} = \Delta\mathrm{K} = \mathrm{K_f} - \mathrm{K_i} \qquad \mathrm{E} = \mathrm{K} + \mathrm{U}$$

$$\Delta\mathrm{E} = \mathrm{E_f} - \mathrm{E_i} = \mathrm{W_{nc}}$$

$$\mathrm{U_s} = \frac{1}{2} kx^2 \qquad \text{(spring)}$$

$$\mathrm{U_g} = mgz \qquad \text{(gravity)}$$

$$\text{Power} = \frac{dW}{dt} = \vec{F} \cdot \vec{\mathrm{v}}$$

UNIVERSITY OF MANITOBA

December 13, 2008
(9:00 AM - 12:00 PM)

FINAL EXAMINATION
Formula Sheet

PAPER NO.: 484

COURSE NO.: PHYS 1050

TIME: 3 hours

EXAMINATION: Physics 1: Mechanics

EXAMINERS: K. S. Sharma, G. Williams, C-M Hu

Momentum and Collisions

$$\vec{p} = m\vec{v} \qquad \vec{F} = \frac{d\vec{p}}{dt}$$

$$\vec{J} \equiv \int \vec{F}\,dt = \vec{F}_{av}\,\Delta t = \Delta\vec{p} \quad \text{(impulse)}$$

$$\vec{r}_{cm} = \frac{1}{M}\sum_i m_i\vec{r}_i \qquad \vec{v}_{cm} = \frac{1}{M}\sum_i m_i\vec{v}_i$$

$$\vec{P} = \sum_i \vec{p}_i = \sum_i m_i\vec{v}_i = M\vec{v}_{cm} \qquad \vec{F}_{ext} = \frac{d\vec{P}}{dt}$$

$$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$$

(conservation of momentum)

$$\frac{1}{2}m_1 v_{1i}^2 + \frac{1}{2}m_2 v_{2i}^2 = \frac{1}{2}m_1 v_{1f}^2 + \frac{1}{2}m_2 v_{2f}^2$$

(elastic collision)

Rotational Kinematics

$$\omega = \frac{d\theta}{dt} \qquad \alpha = \frac{d\omega}{dt}$$

$$v = \omega r \qquad a_T = \alpha r \qquad a_R = \frac{v^2}{r} = \omega^2 r$$

$$\left.\begin{aligned} \theta &= \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2 \\ \omega &= \omega_0 + \alpha t \\ \omega^2 &= \omega_0^2 + 2\alpha(\theta - \theta_0) \end{aligned}\right\} \text{constant acceleration } \alpha$$

Torque and Angular Momentum

$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$\vec{\ell} = \vec{r} \times \vec{p}$$

$$\vec{\tau} = \frac{d\vec{\ell}}{dt}$$

$$|\vec{A} \times \vec{B}| = |\vec{A}||\vec{B}|\,\sin\theta$$

$$\left.\begin{aligned} L &= I\omega \\ \tau &= I\alpha \\ I &= \sum_i m_i r_i^2 \end{aligned}\right\} \text{(rotating rigid object)}$$

Special Relativity

$$\left.\begin{aligned} x' &= \gamma(x - vt) \\ y' &= y \\ z' &= z \\ t' &= \gamma(t - vx/c^2) \end{aligned}\right\} \text{Lorentz transformation} \quad \left(\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}\right)$$

$$L = L_0/\gamma \qquad \Delta t = \gamma\Delta t_0$$

Relative velocity formula for motion in one dimension:

$$u = \frac{u' + v}{\left(1 + \frac{vu'}{c^2}\right)}$$

Energy and momentum:

$$\vec{p} = \gamma m\vec{v}$$

$$E = K + mc^2$$

$$E^2 = c^2p^2 + m^2c^4$$