Final Exam

physics & astronomy — university of manitoba

PHYS 1050 - PHYSICS I: Mechanics
Final Exam Information

PHYS 1050 Final Exam
Wednesday December 12th, 2007
Frank Kennedy Gold Gym (Seats 1 - 353)
1:30 to 4:30 PM

Formula Sheet from 2005	2005 Examination Paper	Answers for 2005 Exam.	Formula Sheet from 2007	
Formula Sheet from 2006	2006 Examination Paper	Answers for 2006 Exam.	Answers for 2007 Exam.	

Chapter 37

25. A sheriff riding on a fast train (frame S′) traveling at 0.50c witnesses a gunfight between two people standing on the ground (frame S). Person A is located at the origin $x = 0$ of frame S and person B is located at $x = 50$ m. According to observers on the ground, the two people fired simultaneously. According to the sheriff, which person fired first, and how much earlier did this person fire?
(a) Person B, by 3.4×10^{-7} s (b) Person A, by 3.4×10^{-7} s (c) Person B, by 9.6×10^{-8} s
(d) Person A, by 9.6×10^{-8} s (e) n.o.t.

24. You are standing at the side of a road, and your friend travels past you in her fast sports car at a speed of 0.660c. The length of the car as measured by you is 4.80 m. How long is the car when it is parked at the side of the road?
(a) 3.61 m (b) 7.63 m (c) 8.48 m (d) 6.39 m (e) n.o.t.

UNIVERSITY OF MANITOBA
December 20, 2004 (1:30 PM - 4:30 PM) FINAL EXAMINATION

Chapter 11

$\vec{a} = \frac{d\vec{v}}{dt}$ $\vec{v} = \frac{d\vec{r}}{dt}$

$t, \vec{r}, \vec{v}, \vec{a}$

$\vec{F}$

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

$\vec{F} = \frac{d\vec{p}}{dt}$

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

$t, \theta, \vec{\omega}, \vec{\alpha}$

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

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

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

Chapter 11

Translational Motion

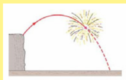
$m_1, \vec{r}_1$ $m_2, \vec{r}_2$ ... $m_n, \vec{r}_n$

$\vec{P} = \sum_{i=1}^{n} \vec{p}_i = \sum_{i=1}^{n} m_i \vec{v}_i = M\vec{v}_{com}$

$M = \sum_{i=1}^{n} m_i$

$\vec{F}_{net} = \frac{d\vec{P}}{dt} = M\vec{a}_{com}$

$\vec{r}_{com} = \frac{1}{M}\sum_{i=1}^{n} m_i \vec{r}_i$



Angular Motion

$m_1, \vec{r}_1$ $m_2, \vec{r}_2$ ... $m_n, \vec{r}_n$

$\vec{L} = \sum_{i=1}^{n} \vec{\ell}_i$

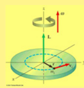
ω

$\vec{L} = I\omega$

$I = \sum_{i=1}^{n} m_i r_i^2$

$\vec{\tau}_{net} = \frac{d\vec{L}}{dt}$

$\vec{\tau}_{net} = I\alpha$



Vector Product

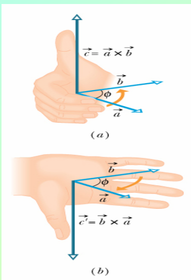
$\vec{\tau} = \vec{r} \times \vec{F}$

$\tau = rF\sin\phi$

Definition $\vec{c} = \vec{a} \times \vec{b}$

$c = ab\sin\phi$

$\vec{c}$ is perpendicular to the plane formed by $\vec{a}$ and $\vec{b}$ following the right-hand rule



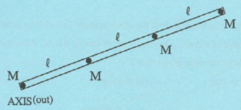
Chapter 11

23. A woman of mass m stands at the centre of a circular platform of radius R and moment of inertia I. At $t = 0$, the platform is rotating with negligible friction at angular velocity ω_0 about a vertical axis through its centre. At this instant, the woman begins walking with speed v, relative to the platform, radially outward towards a point on the edge of the platform. The angular velocity ω of the platform as a function of time t will be:
(a) $I\omega_0/[I - 2mRvt]$ (b) $I\omega_0/mv^2t^2$ (c) $2I\omega_0/3mRvt$
(d) $mv^2t^2\omega_0/I$ (e) $I\omega_0/[I + mv^2t^2]$

22. A particle of mass 2 kg moving in the xy plane has a position vector $\vec{r} = 3t^2\hat{i} - 4t^3\hat{j}$ relative to the origin 0 of the coordinate system. What torque $\vec{\tau}$ is acting on the particle about the origin?
(a) $-15t^2\hat{i} - 27t^3\hat{k}$ (b) $+47t^2\hat{k}$ (c) $-96t^3\hat{k}$ (d) $-18t\hat{k}$ (e) n.o.t.

Chapter 11

21. Four equal masses M are spaced at equal intervals ℓ along a horizontal straight rod with negligible mass. The system is rotating in the plane of the paper about an axis which passes through the mass at one end of the rod and is perpendicular to the paper. The rod is accelerating at a constant angular rate α. What minimum force must be applied to the mass which is farthest from the rotation axis in order to impart this angular acceleration to the system?



(a) $14\ m\ell\alpha/3$ (b) $3\ m\ell\alpha/14$ (c) $7\ m\ell\alpha/5$ (d) $5\ m\ell\alpha/7$ (e) n.o.t.

20. A 2.4 kg ball glued to the end of a thin, light rod is rotating in a horizontal circle of radius 1.2 m about an axis through the rod. A constant air resistance of 0.20 N opposes the motion of the ball. Calculate the applied torque needed to rotate the ball with a constant angular acceleration of 0.20 rad/s². Neglect the effect of air resistance on the rod.

(a) 10.2 N·m (b) 7.6 N·m (c) 5.1 N·m (d) 2.7 N·m (e) 0.93 N·m

Chapter 10

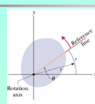
$a = \frac{dv}{dt}$ $v = \frac{dr}{dt}$

0	x_0	v_0	a
t	x	v	a

The relations between them:

$v = v_0 + at$

$x = x_0 + v_0 t + \frac{1}{2}at^2$



$\theta = \frac{s}{r}$

$s = \theta r$

$v = \omega r$

$a_t = \alpha r$

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

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

0	θ_0	ω_0	α
t	θ	ω	α

The relations between them:

$\omega = \omega_0 + \alpha t$

$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$

Chapter 10

$a = \frac{dv}{dt}$ $v = \frac{dr}{dt}$

t, r, v, a

$F = ma$

$W = \int F dx$

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

$P = Fv$

$W = \Delta K$

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

$t, \theta, \omega, \alpha$

$\tau = I\alpha$

$W = \int \tau d\theta$

$K = \frac{1}{2}I\omega^2$

$P = \tau\omega$

$W = \Delta K$

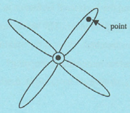
$\tau = rF\sin\phi$

$I = \int r^2 dm$

$I = I_{COM} + MD^2$

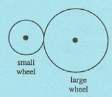
Chapter 10

19. The blades of a helicopter start from rest and rotate with a constant angular acceleration of 0.49 rad/s². How much time elapses before a point on one of the blades experiences the same value for the magnitudes of its centripetal acceleration and its tangential acceleration?



(a) 0.10 s (b) 0.50 s (c) 4.3 s
(d) 1.4 s (e) n.o.t.

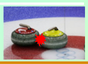
18. A small wheel of radius 2.0 cm and a large wheel of radius 25.0 cm are mounted on parallel frictionless rotation axes so that their circular edges touch. If the small wheel is given a constant angular acceleration of 7.2 rad/s², how long does it take the large wheel to reach an angular speed of 6.8 rad/s, starting from rest, assuming that no slipping occurs between the wheels?



(a) 12 s (b) 21 s (c) 35 s
(d) 61 s (e) n.o.t.

1st piece paper of Chap 9

Collision



t_i

$m_1,\ \vec{v}_{1i}$

$m_2,\ \vec{v}_{2i}$

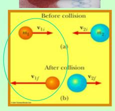
$\vec{J} = \Delta\vec{p}$

$\vec{J} = \int_{t_i}^{t_f} \vec{F}(t)dt$

t_f

$m_1,\ \vec{v}_{1f}$

$m_2,\ \vec{v}_{2f}$



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

$\vec{P}_i = \vec{P}_f$

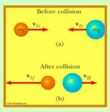
$\vec{P}_f = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$

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

$K_i = K_f$

Elastic only !

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



2nd piece paper of Chap 9

Motion of a System

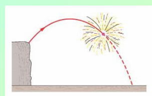
$m_1, \vec{r}_1$ $m_2, \vec{r}_2$ … $m_n, \vec{r}_n$

$\vec{r}_{com} = \frac{1}{M}\sum_{i=1}^{n} m_i\vec{r}_i$

$\vec{P} = M\vec{v}_{com} = \sum_{i=1}^{n}\vec{p}_i = \sum_{i=1}^{n} m_i\vec{v}_i$

$\vec{F}_{net} = M\vec{a}_{com}$

$\vec{F}_{net} = \frac{d\vec{P}}{dt}$



Chapter 9

17. A 5-kg block moving to the right with a speed of 2 m/s makes an elastic head-on collision with a 10-kg block initially at rest. What fraction of the total kinetic energy is transferred to the 10-kg block?
(a) 1/9 (b) 3/4 (c) 1/2 (d) 2/3 (e) 8/9

16. A 12-gram bullet traveling at 190 m/s penetrates a 2.0-kg block of wood and emerges going 150 m/s. If the block is stationary on a frictionless surface when hit, how fast does the block move after the bullet emerges?
(a) 0.12 m/s (b) 0.24 m/s (c) 0.60 m/s (d) 1.2 m/s (e) 10.2 m/s

15. A 50-kg boy stands at the stern (rear end) of a 90-kg boat when the bow (front end) of the boat touches the edge of a dock. The length of the boat is 4.0 m. After the boy walks to the front of the boat, how far is he from the edge of the dock?
(a) 0 m (b) 0.45 m (c) 2.0 m (d) 1.4 m (e) n.o.t.

Chapter 8

$\vec{r}_i,\ \vec{v}_i$

$E_{mec,i} = K_i + U_i$

$\vec{r}_f,\ \vec{v}_f$

$E_{mec,f} = K_f + U_f$

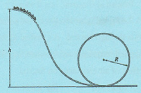
$\Delta E_{th} = f_k d$

$K_i + U_i = K_f + U_f + \Delta E_{th}$

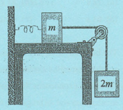
Isolated Systems

Chapter 8

14. A frictionless roller coaster has a circular vertical loop as shown. The height at which the cars are released is h and the radius of the loop is R. What is the smallest value of the height h, expressed in terms of the radius of the loop R, that will ensure that the cars remain on the track at all times?
(a) 1.5 R (b) 2 R (c) 2.5 R
(d) 3 R (e) 4 R



13. Two blocks of mass m and $2m$ are connected to a spring that has one end fixed as shown in the diagram. The mass $m = 3.0$ kg, the spring constant $k =$ 175 N/m, and the coefficient of kinetic friction between the block of mass m and the horizontal surface is $\mu_k = 0.15$. The pulley is frictionless and has negligible mass. The blocks are released from rest with the spring unstretched. What is the maximum distance that the hanging block moves before momentarily stopping?
(a) 0.29 m (b) 0.48 m (c) 0.62 m (d) 0.67 m (e) 0.78 m



12. A 34-kg child jumps upward from the top of a platform with a vertical speed of 5.0 m/s and lands on a trampoline 2.0 m below. If the trampoline behaves like a spring of spring constant 8500 N/m, how far does the child depress it?
(a) 0.32 m
(b) 0.64 m
(c) 0.47 m
(d) 0.55 m
(e) n.o.t.

Chapter 7

$\vec{r}_i,\ \vec{v}_i$

$\vec{r}_f,\ \vec{v}_f$

$\vec{d} = \vec{r}_f - \vec{r}_i$

$K_i = \frac{1}{2}mv_i^2$

$K_f = \frac{1}{2}mv_f^2$

$K_f - K_i = W$

$\vec{F}$ $\quad W = \vec{F}\cdot\vec{d}$ $\quad \vec{F}_g = m\vec{g}$ $\quad W_g = m\vec{g}\cdot\vec{d}$

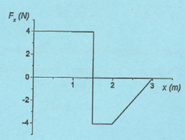
$F(x)$ $\quad W = \int_{x_i}^{x_j} F(x)dx$ $\quad \vec{F}_x = -kx$ $\quad W_s = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$

$\vec{F}(\vec{r})$ $\quad W = \int_{r_i}^{r_j} \vec{F}\cdot d\vec{r}$

$P_{avg} = \frac{W}{\Delta t}$ $\quad P = \frac{dW}{dt} = \vec{F}\cdot\vec{v}$

Chapter 7

10. The force on a particle varies with position as shown in the figure. How much work is done by the force on the particle as it is moved from $x = 0$ to $x = 3.0$ m?
(a) 2.0 J (b) 6.0 J (c) –1.0 J
(d) 4.0 J (e) –4.0 J



9. A crate is pushed along the x axis by a force that increases linearly with distance. If the crate starts from rest at $x = 0$, the kinetic energy is proportional to:
(a) x (b) x^2 (c) x^4 (d) $1/x$ (e) $1/x^2$

Chapter 5 & 6

$t \quad \vec{r} \quad \vec{v} \quad \vec{a} \quad \vec{F}_{net}$

The cause of motion:

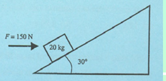
Gravitational Force
Normal Force
Tension

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

Friction
Drag Force
Centripetal Force

Chapter 5 & 6

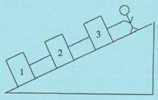
11. A constant horizontal force of 150 N pushes a 20-kg block a distance of 5.0 m up a 30° inclined plane, as shown in the figure. The coefficient of kinetic friction between the block and the incline is $\mu_k = 0.10$. If the speed of the block is zero initially, what is its speed after this displacement?



(a) 2.7 m/s (b) 4.0 m/s (c) 5.1 m/s
(d) 3.6 m/s (e) 1.2 m/s

8. A man rides in a closed boxcar that travels at a constant speed of 10 m/s. He has suspended a weight from the ceiling of the boxcar by a string. If he sees the string make an angle of 15° with the vertical, he knows that the train is
(a) traveling in a circle of radius 12 m (b) traveling in a circle of radius 17 m
(c) traveling in a circle of radius 38 m (d) traveling in a circle of radius 75 m
(e) being attacked by reptulians

7. A person pulls three identical blocks, connected by ropes of negligible mass, up a frictionless inclined plane at constant speed. Where is the tension greatest?
(a) between blocks 1 and 2
(b) between blocks 2 and 3
(c) between block 3 and the person
(d) the tension is the same in every segment
(e) the tension is zero because there is no acceleration.



6. A girl pulls a bucket of water of mass 10 kg up from the bottom of a well. The rope will break if the tension exceeds 150 N. With what maximum acceleration can she pull up the bucket?
(a) 0 (b) 3.1 m/s² (c) 5.2 m/s² (d) 9.8 m/s² (e) 15 m/s²

Chapter 4

the Projectile Motion

$$\begin{matrix} 0 & 0 & v_{0x} & 0 \\ t & x & v_x & 0 \end{matrix}$$

The relations

$$\boxed{v_x = v_{0x}}$$
$$\boxed{x = v_{0x} t}$$

$$\begin{matrix} 0 & 0 & v_{0y} & -g \\ t & y & v_y & -g \end{matrix}$$

The relations

$$\boxed{v_y = v_{0y} - gt}$$
$$\boxed{y = v_{0y} t - \frac{1}{2} g t^2}$$

the Uniform Circular Motion

$$\begin{matrix} & & r & v & a \\ t & \theta & \vec{r} & \vec{v} & \vec{a} \end{matrix}$$

The relations

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

$$\boxed{\vec{r} = (r\cos\theta)\hat{i} + (r\sin\theta)\hat{j}}$$
$$\boxed{\vec{v} = (-v\sin\theta)\hat{i} + (v\cos\theta)\hat{j}}$$
$$\boxed{\vec{a} = (-a\cos\theta)\hat{i} + (-a\sin\theta)\hat{j}}$$

the Relative Motion

$$t \quad \vec{r}_{PA} \quad \vec{v}_{PA} \quad \vec{a}_{PA} \qquad \boxed{\text{constant } \vec{v}_{BA}} \qquad t \quad \vec{r}_{PB} \quad \vec{v}_{PB} \quad \vec{a}_{PB}$$

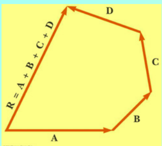
A frame

The relations

$$\boxed{\vec{r}_{PA} = \vec{r}_{PB} + \vec{r}_{BA}}$$
$$\boxed{\vec{v}_{PA} = \vec{v}_{PB} + \vec{v}_{BA}}$$
$$\boxed{\vec{a}_{PA} = \vec{a}_{PB}}$$

B frame

Chapter 3



$$\vec{a} = a_x\hat{i} + a_y\hat{j}$$

$$\boxed{a = \sqrt{a_x^2 + a_y^2}}$$

$$\boxed{\tan\theta = \frac{a_y}{a_x}}$$

$$\vec{a}\cdot\vec{b} = ab\cos\phi$$

$$\boxed{\begin{aligned}\vec{a}\cdot\vec{b} &= \left(a_x\hat{i} + a_y\hat{j} + a_z\hat{k}\right)\cdot\left(b_x\hat{i} + b_y\hat{j} + b_z\hat{k}\right) \\ &= a_x b_x + a_y b_y + a_z b_z\end{aligned}}$$

Chapter 2

The general relations :

$$v = \frac{dx}{dt} \qquad a = \frac{dv}{dt}$$

Derivative →

$$t \qquad x(t) \qquad v(t) \qquad a(t)$$

← **Integration**

$$\boxed{x - x_0 = \Delta x = \int_0^t v\,dt} \qquad \boxed{v - v_0 = \Delta v = \int_0^t a\,dt}$$

The relations for constant acceleration (*e.g.*, fee fall):

$$\begin{matrix} 0 & x_0 & v_0 & a \\ t & x & v & a \end{matrix}$$

$$\boxed{v = v_0 + at}$$
$$\boxed{x = x_0 + v_0 t + \frac{1}{2} a t^2}$$

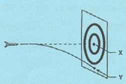
Chapter 2 - 4

1. Given two vectors $\vec{A} = 3\hat{i} + 6\hat{j} + 4\hat{k}$ and $\vec{B} = \hat{i} - \hat{j} - \hat{k}$, find the angle between $\vec{C} = \vec{A} - 3\vec{B}$ and the positive x-axis.
(a) 45° (b) 180° (c) 29° (d) 61° (e) 90°

2. The position of a particle is given by $x = 12.0\text{m} + (2.00\text{m/s})\,t - (0.500\ \text{m/s}^3)\,t^3$. What is the acceleration when the particle is at its maximum x coordinate?
(a) −0.500 m/s² (b) −1.50 m/s² (c) −3.46 m/s² (d) −1.82 m/s² (e) n.o.t.

3. On a windless day, snow is falling straight down. The driver of a car traveling at 36 km/hr sees the snow hitting the windshield at an angle of 60° with the vertical. What is the speed of the snow relative to the ground just before it hits the windshield?
(a) 3.3 m/s (b) 5.8 m/s (c) 12.1 m/s (d) 17.3 m/s (e) n.o.t.

4. A dart is thrown horizontally at 20 m/s toward the point X, as shown. It hits the point Y, 0.1 s later. The distance XY is:
(a) 2 m (b) 1 m (c) 0.5 m
(d) 0.1 m (e) 0.05 m



5. A car accelerates at a constant rate from 0 to 60.0 km/hr in 30.0 m. How long does this take?
(a) 12.1 s (b) 5.80 s (c) 4.60 s (d) 3.60 s (e) n.o.t.

Active Learning

Thin → Thick → Thin

Knows very little | Learnt a lot formulas | Get a clear mental picture

- Read the text book before the class,
- Listen to the lecture, & make notes,
- Study sample problems, & do home works,
- Summarize physics in a piece of paper.

Successful Testing

Simulating
Analyzing
Studying

Reviewing

- Simulating your exam using old test sheets,
- Analyzing those questions you failed to answer,
- Studying the related chapters (& home works),
- Repeating the simulation – analyze – study cycle,
- Summarize physics in a piece of paper.

Thank You

and

Good Bye & Good Luck !