Name ____ Section ____________

Physics 1210 Final Exam

May 2011 v1.0

This test is closed-note and closed-book. No written, printed, or recorded material is permitted. Calculators are permitted but computers are not. No collaboration, consultation, or communication with other people (other than the administrator) is allowed by any means, including but not limited to verbal, written, or electronic methods. Sharing of calculators is prohibited. If you have a question about the test, please raise your hand. For multiple choice, you may choose two answers, and if one is correct, receive half credit, etc. For full credit on written problems, show the full thought process from basic equations to final results.

$V_{avg}=\frac{x_2-x_1}{t_2-t_1}=\frac{\Delta x}{\Delta t}$ $a_{avg}=\frac{v_2-v_1}{t_2-t_1}=\frac{\Delta v}{\Delta t}$ $a_{rad}=\frac{v^2}{R}=\frac{4\pi^2 R}{T^2}$

$\rho_{water}=1000\,kg/m^3$ $V_{sphere}=\frac{4}{3}\pi R^3$

$\rho_{ice}=920\,kg/m^3$ $2.2\,lbs=1\,kg$

$1\,Calorie=4200\,J$ $1\,mi=5280\,ft=1609\,m$

$x_1=x_0+v_0 t+\frac{1}{2}at^2$ $v_1=v_0+at$ $v_1^2=v_0^2+2a(x_1-x_0)$ $V_{cylinder}=Area\times Length$

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

Work/Energy $\Sigma\bar{F}=m\bar{a}$ $F_{spring}=-kx$ $F_f=\mu F_n$

$W=\bar{F}\cdot\bar{s}$ $W=\Delta K$ $U_s=\frac{1}{2}kx^2$ $U_g=mgy$ $P=\frac{\Delta W}{\Delta t}=Fv$ $W_{grav}=-\Delta U$ $F=-\frac{dU}{dx}$

Momentum/Impulse

$p=mv$ $J=\Delta(mv)=Ft$ $X_{cm}=\frac{\Sigma m_i x_i}{\Sigma m_i}$

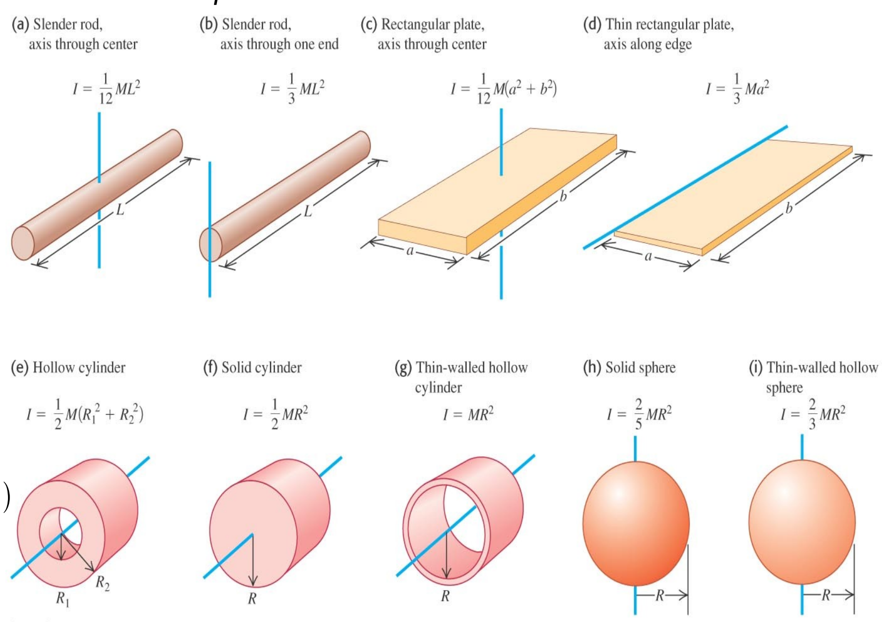
Angular Motion

$s=r\theta$ $v=r\omega$ $a_{tan}=r\alpha$ $a_{rad}=\omega^2 r$ $\omega=\frac{d\theta}{dt}$ $\alpha=\frac{d\omega}{dt}$

$Power_{rot}=\tau\omega$ $\theta_1=\theta_0+\omega_0 t+\frac{1}{2}\alpha t^2$ $\omega_1=\omega_0+\alpha t$ $\omega_1^2=\omega_0^2+2\alpha(\theta_1-\theta_0)$

$\Sigma\bar{\tau}=I\bar{\alpha}$ $I=\Sigma_i m_i r_i^2$ $I_{parallel}=I_{cm}+Md^2$ $\bar{\tau}=\bar{r}\times\bar{F}=rF\sin\phi$ $W=\Delta K=\tau\Delta\theta$

$K_{rot}=\frac{1}{2}I\omega^2$ $K_{total}=\frac{1}{2}mv_{cm}^2+\frac{1}{2}I_{cm}\omega^2$



Gravity: $G=6.67\times10^{-11}\ N\ m^2/kg^2$

$\bar{L}=\bar{r}\times\bar{p}=rmv=I\omega$ $\Delta L=\tau\Delta t$

$F_g=\frac{GM_1M_2}{r^2}$ $U_g=\frac{-GM_1M_2}{r}$ $P^2=\frac{4\pi^2a^3}{GM}$

Periodic Motion

$f=\frac{1}{T}$ $\omega=2\pi f$ $\omega=\sqrt{\frac{k}{m}}$ $pendulum: \omega=\sqrt{\frac{g}{l}}$

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

$\omega_{physical\ pendulum}=\sqrt{\frac{gdm}{I}}$ $v=-\omega A\sin(\omega t+\phi)$

$a=-\omega^2 A\cos(\omega t+\phi)$

$damped\ motion: x=Ae^{(-bt/2m)}\cos(\omega' t)$

$\omega'=\sqrt{\frac{k}{m}-\frac{b^2}{4m^2}}$

Fluids $P=\frac{dF}{dA}$ $p_2-p_1=-\rho g(y_2-y_1)$ $\rho_1A_1v_1=\rho_2A_2v_2$ $p_1+\rho g y_1+1/2\rho v_1^2=p_2+\rho g y_2+1/2\rho v_2^2$

Mechanical Waves $v=\lambda f$ $y(x,t)=A\cos(kx-\omega t)$ $k=2\pi/\lambda$ $\omega=2\pi f=vk$ $v_{wave\ onstring}=\sqrt{F/\mu}$

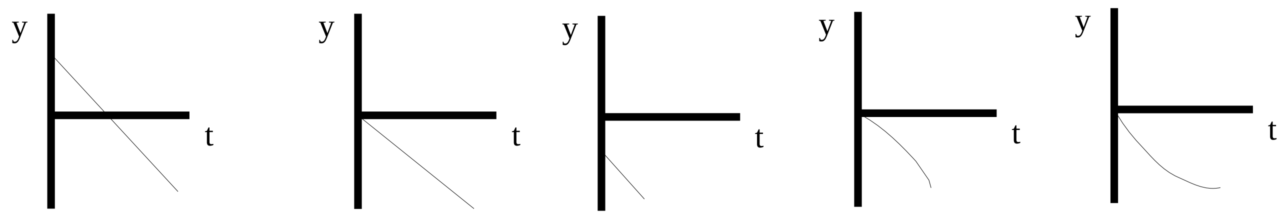
$f_{fundamental}=\frac{1}{2L}\sqrt{\frac{F}{\mu}}$ $f_n=n\frac{v}{2L}=nf_1$ $(n=1,2,3,\ldots)$ $\frac{I_1^2}{I_2^2}=\frac{r_2^2}{r_1^2}$ $I=\frac{P}{4\pi r^2}$

Sound

$pressure_{max}=BkA$ $v_{longitudnal}=\sqrt{\frac{B}{\rho}}$ $v_{ideal\ gas}=\sqrt{\frac{\gamma RT}{M}}$ $v_{solid\ rod}=\sqrt{\frac{Y}{\rho}}$ $I_{sound\ intensity}=\frac{P_{max}^2}{2\rho v}$

$B_{sound\ intensity}=(10\,dB)\log\frac{I}{I_0}$ $f_{n(open\ pipe)}=\frac{nv}{4L}$ $f_{n(closed\ pipe)}=\frac{nv}{4L}$ $f_{beat}=f_1-f_2$ $f_L=\frac{v+v_L}{v+v_S}f_S$

1. (10 pts) A child standing on a bridge throws a rock straight down.   The rock leaves the child's hand at t=0. Which of the graphs shown here best represents the position of the stone as a function of time? (Ignore air resistance)



A B C D E

2. (10 pts) A girl pulls two other children in a wheeled cart up a hill at increasing speed. The cart moves uphill because
A. the girl is strong enough to overcome gravity and pulls harder on the cart than the cart pulls back on her
B. the force the girl applies to the cart is stronger than the force of gravity on the cart
C. the forward force from static friction on the girl is larger than the backward force from rolling friction and gravity on the cart
D. the net frictional force and gravity force is negative but smaller than the net force of her pull which is the largest force acting on the cart
E. the girl is brilliant and has invented anti-gravity

3. (10 pts) Starting from rest, a box of mass M is pushed across a frictionless floor by a force F. It ends up with a kinetic energy K. If you wanted to double the final kinetic energy of the box by changing one thing, you could (circle one or more true answers)
A. double the force to 2F
B. double the mass of the box to 2M
C. double the distance that you push the box while pushing with force F
D. double the amount of time you push while pushing with force F
E. none of the above will work

4. (15 pts) A block of ice slides to the right at constant speed across a level frictionless floor. Draw a labeled free body diagram for the block.

5. (10 pts) A hollow ball and a solid ball of the same mass and radius initially have the same total kinetic energy when they start rolling up the same ramp of constant angle above the horizontal.
A. They both reach the top of their maximum height at the same time.
B. They both started with the same translational speed
C. They both started with the same angular speed
D. The both go the same height up the ramp before coming to a stop.
E. They both have the same moment of inertia.

6. (10 pts) A car rounds a curve on a normal day in the usual way at constant speed on a flat road. As it does so
A. static friction produces a centripetal force
B. its kinetic energy is changing
C. its tangential speed is zero
D. kinetic friction produces a tangential force
E. its centripetal acceleration is changing magnitude

7. (10 pts) A box of mass *m* slides along a surface that is inclined at an angle β from horizontal. The coefficient of kinetic friction between the box and the surface is μ_k. How would the magnitude of its acceleration if it slides *up* the incline compare to the magnitude of its acceleration if it slides *down* the incline?
A. The magnitude of its acceleration would be greatest if it slides downhill.
B. The magnitude of its acceleration would be greatest if it slides uphill.
C. It would accelerate with the same magnitude when sliding in either direction.
D. The ranking depends on the specific values of μ_k and β.

8. (10 pts) A perfect Hooke's law spring hangs at rest from a rigid support. A metal ball of mass M is attached to the bottom end of the spring and released from rest, thereafter oscillating up-and-down in simple harmonic motion. If this scenario were repeated on another planet whose gravitational acceleration were smaller than 9.8 m/s^2, the mass would oscillate: (select the correct choice from each list)

A. with a higher frequency.
with a lower frequency.
at the same frequency.

B. with a larger amplitude.
with a smaller amplitude.
at the same amplitude.

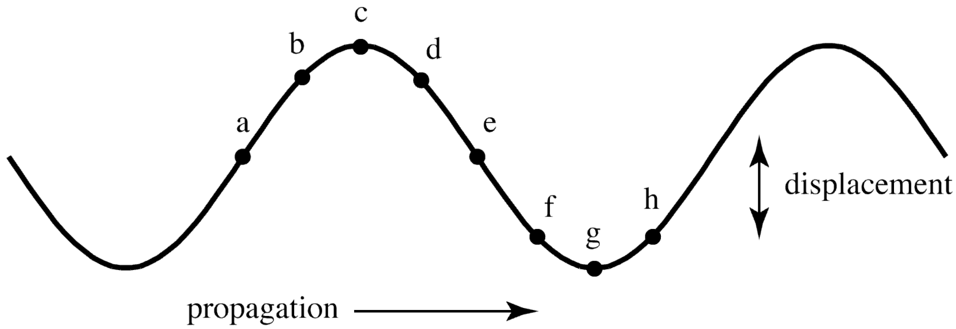
C. with a faster maximum speed.
with a slower maximum speed.
with the same maximum speed.

9. (10 pts) Which one of the following statement regarding work and energy is correct?
A. The work done by any type of force can be represented by a potential energy function
B. Frictional forces always do negative work
C. When potential energy increases, the corresponding conservative force must have done positive work
D. When potential energy increases, kinetic energy must decrease
E. None of the above

10. (10 pts) Two cars with speed $v_1>v_2$ but same masses ($m_1 = m_2$) collide head-on and stick together after the collision.
A. The total kinetic energy before the collision is the same as the total kinetic energy after the collision
B. The total momentum before the collision is larger than the total momentum after the collision
C. Both cars stop after the collision
D. The cars do not stop after the collision but move along the initial traveling direction of the car with speed v_1
E. The cars do not stop after the collision but move along the initial traveling direction of the car with speed v_2

11. (10 pts) A chunk of space rock fall to the earth from the distance of the moon. As it is falling,
A. The object's kinetic energy decreases
B. The object's gravitational potential energy decreases
C. The object's angular momentum increases
D. The object's momentum stays the same
E. The object's total mechanical energy decreases

12. (10 pts) The diagram below shows a snapshot at one time of a string with a purely transverse wave traveling along it to the right. Eight points on the string are indicated. (The points are points on the string, not phases of the wave. They move up and down with the string, not to the right.)

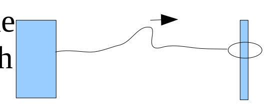


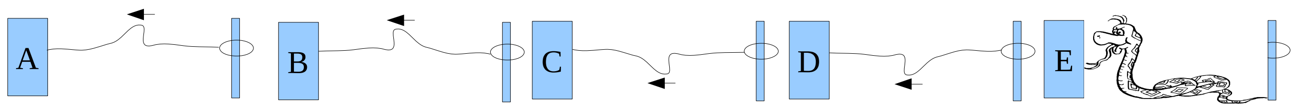
A. Which points have a speed of zero? ___
B. Which points have an acceleration of zero? ___
C. Which points are moving upward (↑)? ___
D. Which points are moving downward (↓)? ___
E. Which points are accelerating upward? ____
F. Which points are accelerating downward? ___

13. (10 pts) An airport worker near a jet experiences a sound intensity 16 times the safe level. In order to decrease the his sound exposure to the maximum safe level he needs to increase his distance from the jet by a factor of
A. 2 B. 4 C. 8 D. 16 E. 32

14. (10 pts) The Bernoulli equation is really a statement of
A. energy conservation for a moving fluid
B. Newton's third law, i.e., action and equal reaction
C. Conservation of linear momentum
D. F=ma as applied to a fluid
E. the continuity principle for mass conservation

15. (10 pts) Shown is a wave traveling along a clothesline. The line is tied at one end and the other end is tied to a ring free to move on a pole. The tension force remains the same. Which of the following figures show the form of the wave when it travels back toward the tied end?





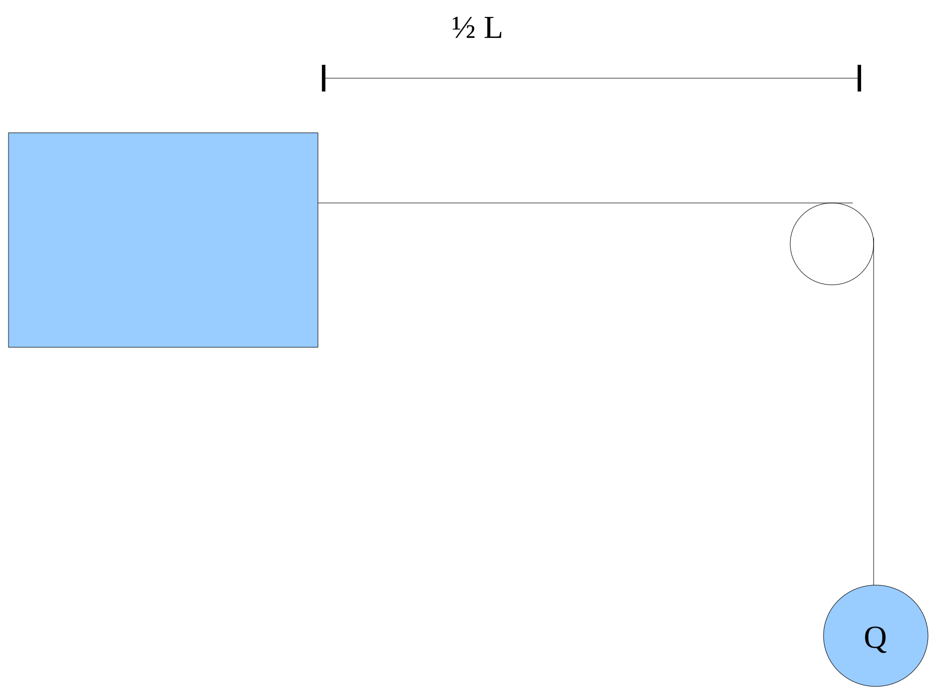
16. (25 pts) Survivors of mass m=70 kg from a shipwreck spot a cylindrical wooden log with length L=5m and diameter D=1.5m and mass M=600 kg. Give an expression for N, the number of people that the log can support before it is completely submerged in terms of the other given constants and any needed constant values. Then compute a value for N. (Assume that the people are entirely out of the water on top of the log).

17. (45 pts) A uniform bar with mass M and length L rests on a frictionless surface and pivots at a point that has a distance of d from the left end. A bullet with mass m traveling perpendicular to the rod with speed v hits the bar at the right end and becomes embedded in it. Express the angular speed of the bar after the strike using M, L, d, m, and v.

18. (25 pts total) A rope of mass M and Length L is tied to an immovable wall on one end and the other end is draped over a pulley and then a steel ball of mass Q is hung at the end, as pictured. You may neglect the mass of the pulley but not the mass of the rope. Assume that the rope does not stretch.

A. (20 pts) If the rope is plucked like a guitar string at the wall, give an expression for the time required for a wave to travel to the pulley and back to the wall again. Also show that your expression evaluates to the correct units.

B. (5 pts) On the diagram, draw in the appearance of the string if it is vibrating in the third harmonic (second overtone).



19. (50 pts) A box of mass M starts from rest and slides down a ramp a distance S where there is coefficient of kinetic friction μ_k. It falls off the edge and lands a distance D from the base of the ramp. The dashed boxes show locations at various points in the journey.

A. (10 pts) Draw a vector at each of the dashed boxes to show the magnitude and direction of the NET FORCE on the box at any point.

B. (20 pts) Find an expression for v_1, the speed of the box as it goes off the end of the ramp in terms of given variables.

C. (20 pts) Find an expression for t, the time the box is in the air, in terms of any or all of the other given variables. You may use v_1 for the speed of the box for the speed at the end of the ramp if you don't solve part B fully. Explain in a sentence or two the meaning of the expression you give.