General Physics
Physics 101
Final – Fall 2012
Wednesday – 12/12/12
Prof. Bob Ekey

Name (print):_____

I hereby declare upon my word of honor that
I have neither given nor received unauthorized
help on this work.

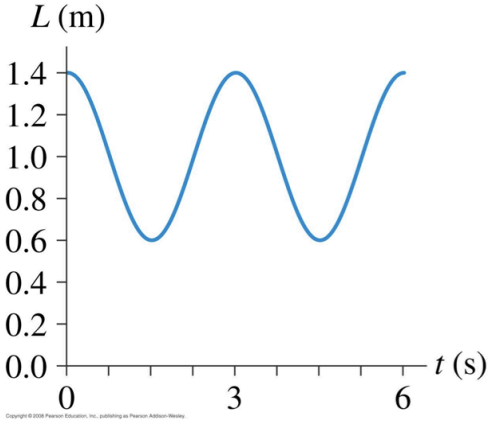
Signature:_____

Part I. Multiple Choice (3 pts each)

Instructions:

Please clearly circle one and only one answer for each of the following.
Show all of your work. Partial credit may be given if you include your work.

Questions:



1. Astronauts in space determine their mass by oscillating on a large spring attached to the wall. The spring's length oscillates as a function of time as shown. If the spring constant is 240 N/m, what is the maximum velocity the astronaut achieves?

(a) 0.84 m/s
(b) 2.1 m/s
(c) 2.9 m/s
(d) 1.7 m/s

2. A velociraptor spots you 40 meters away and attacks, accelerating at 4.0 m/s^2 up to its top speed of 25 m/s. How far has the velociraptor traveled before it reaches its top speed? I assume you can run fast enough to escape… and that you started running when he spotted you.


xkcd.com

(a) 78 m
(b) 3.1 m
(c) 1.6 x 10^2 m
(d) 40 m

3. A 2.0 kg, 20 cm diameter turntable rotates at 100 rpm on frictionless bearings. A 500 g block falls from above, landing on the turntable at the edge. What is the angular velocity of the turntable/block after this event?

(a) 6.981 rad/s
(b) 50 rpm
(c) 2.0 x 10^2 rad/min
(d) 67 rpm

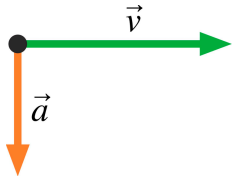
4. A 2.0 kg bag of money on the floor is lifted to a shelf 2.0 m above the floor with an acceleration of +2.0 m/s^2. How much work was done by the lift?

(a) 24 Nm
(b) 47 J
(c) 39 J
(d) 8.0 Nm

5. The left end of a spring is attached to a wall. When Bill pulls on the right end with a 200 N force, he stretches the spring by 20 cm. The same spring is then used for a tug-of-war between Bill and Carlos. Each pulls on his end of the spring with a 200 N force. How far does the spring stretch now?

(a) 10 cm
(b) 20 cm
(c) 40 cm
(d) 80 cm

6. The particle shown follows a…



(a) Parabolic trajectory
(b) Straight-line trajectory
(c) Circular trajectory
(d) Not possible to tell

7. If you spin a 0.50 kg ball on the end of a 2.0 m long string in a horizontal circle with twice the critical speed. What is the tension in the string?

(a) 9.8 N
(b) 4.9 N
(c) 20 N
(d) 8.8 N

8. A 5.0 kg mass is oscillating on a vertical spring that has a spring constant of 50 N/m. If the amplitude of oscillation is 1.0 m, what is the speed of the system when the mass is at its half-amplitude position?

(a) 3.2 m/s
(b) 1.6 m/s
(c) 2.7 m/s
(d) 2.2 m/s

9. Sled riding on break you have just slid down the hill and are traveling along a flat area, at 5.0 m/s on a sled (m_{tot} = 75 kg). You decide to let friction stop you, and it takes 15 seconds to uniformly come to rest. What is the coefficient of friction between the sled and snow?

(a) 0.25
(b) 0.034
(c) 0.50 N
(d) 0.34

10. A person swings on a swing. When the person sits still, the swing oscillates back and forth at its own natural period. If, instead, the person stands on the swing, the new natural period of the swing is

(a) greater.
(b) the same.
(c) smaller.
(d) impossible to determine with the information given.

11. A bullet is fired horizontally from a gun, and falls a vertical distance of 2.0 cm while traveling 50 m horizontally. What is the flight time of the bullet?

(a) 0.41 s
(b) 0.64 s
(c) 3.2 s
(d) 6.4×10^{-2} s

12. A 0.10 kg disc rolls from rest down an incline. The disc has a radius of 0.10 m and an angular velocity of 2.0 rad/s at the bottom of the ramp. Defining y=0 m at the bottom of the ramp, what is the total mechanical energy of the system?

(a) 3.0 mJ
(b) 4.0 x10^{-3} J
(c) 1.0 mJ
(d) 2.0 x 10^{-3} J

13. A 1000 kg car traveling at +10 m/s collides with a 2000 kg truck traveling at 20 m/s in the opposite direction. What is the velocity of the truck and car after the collision, assuming the collision is inelastic?

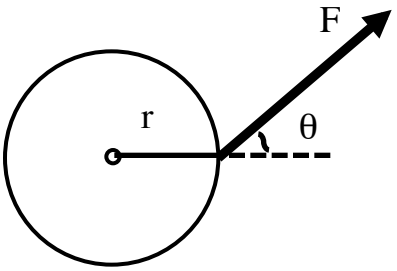
(a) 6.6 m/s
(b) -17 m/s0
(c) 25 m/s
(d) -10 m/s

14. A 100 kg solid sphere spins with angular velocity of 20 rad/s, and dissipates 40 W of power, in 10 seconds. How much energy is dissipated in 10 seconds?

(a) 4.0 x 10^{2} kJ
(b) 4.0 x 10^{2} J
(c) 4.0 J
(d) 0.25 J

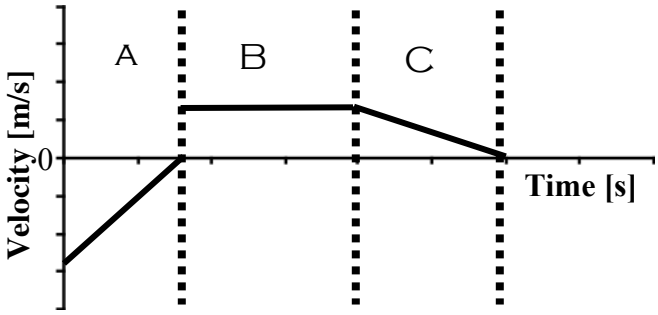
15. Suppose a ping-pong ball and a bowling ball are rolling toward you. Both have the same momentum, and you exert the same force to stop each. How does the time needed to stop them compare?

(a) It takes a longer time to stop the ping-pong ball.
(b) Both take the same time to stop.
(c) It takes a shorter time to stop the ping-pong ball.
(d) Need more information.



16. A force is applied to the solid disc shown causing it to spin with an angular acceleration. If you slightly increase the angle, θ, while keeping the force and radius the same, what happens to the angular acceleration of the disc? Ignore friction.

(a) It increases
(b) In remains the same
(c) It decreases
(d) Need more information.



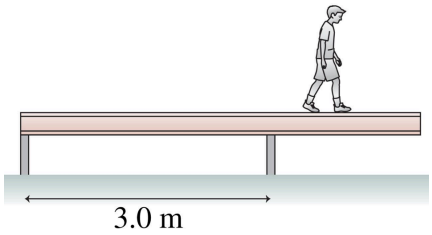
17. For the following velocity vs. time graph, which statement is false?

(a) The object has a negative decreasing velocity in A.

(b) The magnitude of acceleration in A is greater than the acceleration in C.

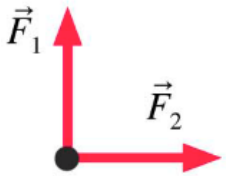
(c) The velocity in B is zero.

(d) The object is moving in the negative direction in A.



18. A 40 kg, 5.0 m long beam is supported, but not attached to the two posts shown. A 40 kg boy starts walking along the beam. How close to the edge of the beam can he walk without it falling over?

(a) 1.0 m
(b) 0.50 m
(c) 1.5 m
(d) 2.5 m



19. Three forces are acting on the same point and the system is in equilibrium. If F_1 and F_2 are equal to 4.0 N each. What is the magnitude and direction of the 3rd balancing force?

(a) 8.0 N to the North East
(b) 8.0 N to the South West
(c) 5.7 N to the North East
(d) 5.7 N to the South West

20. Davey Jones' Locker has a door that has an area of 1 fathom^2. If one fathom is equal to 1.829 m, what is the area in SI units.

(a) 3.345 m^2
(b) 1.8 m^2
(c) 3 m^2
(d) 0.3 m^2

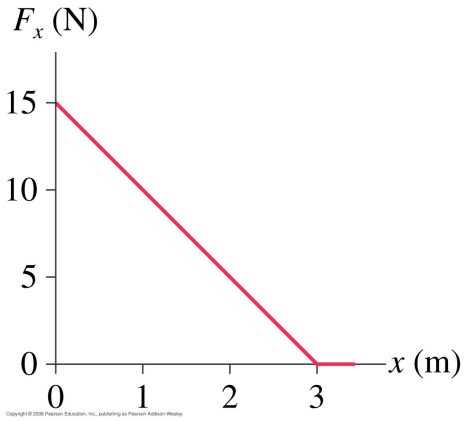
21. A 2.0 kg wooden block is launched up a wooden ramp that is inclined at a 30º angle. The block's initial speed is +10 m/s. What net force does the block experience as it travels up the ramp? Define up the ramp as the positive direction.

(a) – 13 N
(b) 9.8 N
(c) – 1.3 N
(d) – 6.4 N

22. A vertical spring (k=5005 N/m) launches a 100.1 kg mass to a maximum vertical distance of 300.3 m from the launch point. By how far was the spring compressed prior to launch?

(a) 10.85 m
(b) 20 cm
(c) 117.7 m
(d) 5.425 m

23. A 500 g particle moving along the x-axis experiences the force shown. What is the change in kinetic energy of the particle after traveling 2.0 m?



(a) 13 Nm
(b) 20 J
(c) 23 J
(d) 45 Ns

24. Jimmy is standing on an elevator that is accelerating downward at 1.0 m/s^2. By chance, or luck, he is standing on a scale that is reading 700 N. Using this information, what is Jimmy's mass?

(a) 65 kg
(b) 700 kg
(c) 71 kg
(d) 80 kg

25. A rocket is launched into the air with a constant force of 20 N and theoretically achieves a velocity of 50 m/s assuming no mass is lost. If the loss of mass of the rocket is considered the will velocity be _____ 50 m/s (original value)?

(a) Greater than
(b) Less than
(c) Equal to
(d) Impossible to tell

26. A mass-spring system (m=2.00 kg) oscillates with a 0.50 s period and a 0.25 m amplitude. Which of the following could be an equation of motion for the system? Units inside sine/cosine are suppressed.

(a) $v(t) = (0.25\text{ m}) \cos(4.0\,\pi\,t)$
(b) $a(t) = -(9.9\text{ m/s}^2) \cos(4.0\,t)$
(c) $v(t) = -(3.1\text{ m/s}) \sin(4.0\,\pi\,t)$
(d) $x(t) = (0.25\text{ m}) \cos(0.50\,\pi\,t)$

27. You throw a 50 g ball upward at 8.0 m/s, and it reaches a certain maximum vertical distance. If you decrease the launch velocity to 4.0 m/s, by what factor does the maximum vertical distance change?

(a) 1/2
(b) 1/4
(c) $1/\sqrt{2}$
(d) $\sqrt{2}$

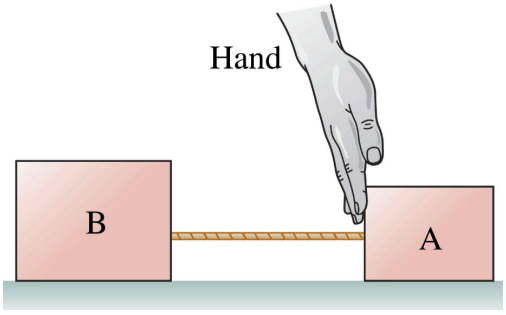
28. The kinetic energy of a system increases while the system does work on the environment. Ignoring thermal effects, which of the following statements is true.

(a) The system's potential energy must be decreasing.
(b) The work on the system is positive.
(c) The system's potential energy could be unchanged.
(d) The change in kinetic energy is negative.

29. A high-speed drill is rotating at 20 rad/s experiences a -20 rad/s^2 angular acceleration. Through what angle did the drill turn through in 2.0 seconds?

(a) 2.0 x 10^2 rad
(b) 40 rad
(c) 1.6 x 10^2 rev
(d) 80 rad

30. Block A and B, with masses 1 kg and 2 kg respectively, are connected via a massless string. If the hand exerts a 9 N force on block A, what is the force exerted on mass B by the string?



(a) 12 N
(b) 9 N
(c) 6 N
(d) 3 N

Part II. Short answer problems (12 pts each)

Instructions:

Solve four of the following six problems. If you try to solve all six problems, please clearly indicate which problems you wish to have graded. If you do not indicate this, I will assume you want me to grade problems one, two, three and four.

Please show all of your work, including equations without numbers.
Please provide units with all answers.
Partial credit may be given if you include your work.

Question 1. **Grade this problem? Yes or No (circle one)**

At football games, MUCaw ascends the stairs and then slides down the railing. After a short initial acceleration (which we will ignore), he coasts with a constant velocity of 3.3 m/s Assume friction is constant and it is the only force opposing the motion.

(a) Draw a force diagram, identifying all forces including the net force.

(b) What are the signs (+, - or zero) of the net work, work done by gravity and work done by friction as MUCaw slides down the railing? Words are required, an equation may help. No calculations are necessary.

(c) If MUCaw (100 kg) falls a vertical distance of 4.0 m, what is the work done by friction during the motion?

(d) At the bottom of the rail, MUCaw slows to a stop before dismounting. If the stop takes 0.10 s, what acceleration does he experience during the stop?

Question 2. Grade this problem? Yes or No (circle one)

A long string is wrapped around a 2.0 kg, 100 cm diameter disc, initially at rest that is free to rotate about its center. The string is pulled tangentially to the edge of the disc with a constant acceleration of 1.5 m/s^2, and it gains 5.0 J of rotational kinetic energy

(a) What is the angular acceleration of the disc?

(b) What is the final angular velocity of the disc?

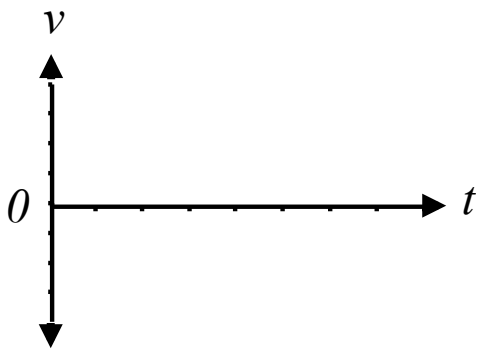
(c) What torque does the disc experience during the pull?

(d) If you apply the same force to a cylinder that is twice the diameter as this one but the same mass, does the angular acceleration increase, decrease or stay the same? No calculations are necessary, but equations will help, along with words.

Question 3. **Grade this problem? Yes or No (circle one)**

A student standing on the ground throws a 0.50 kg ball straight up. The ball leaves the student's hand with a speed of 15 m/s when the hand is 2.0 m above the ground. The student moves her hand out of the way, and the ball strikes the ground.

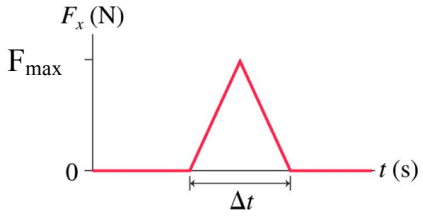
(a) Sketch a velocity vs time plot that could represent the motion of the ball during its motion. Please explain the shape & meaning of the graph.



(b) What is the velocity (mag+dir) of the ball before it hits the ground?

(c) How long is the ball in the air before it hits the ground?

(d) As the ball strikes the ground it comes to rest. If the impulse lasted for $\Delta t = 3.0$ ms as shown, what is the maximum force experienced by the ball?



Question 4. **Grade this problem? Yes or No (circle one)**

A 100 g ball attached to a spring with spring constant 2.5 N/m oscillates horizontally on a frictionless table. Its velocity is 20 cm/s when it is located at a position of -5.0 cm from equilibrium.

(a) What is the angular frequency for this system?

(b) What is the amplitude of oscillation?

(c) Where is the acceleration a maximum and where is the velocity a maximum? Explain your answer with words and possibly pictures/equations.

(d) What is the speed of the ball when it is located at a position of 3.0 cm from equilibrium?

Question 5. **Grade this problem? Yes or No (circle one)**

On an ice rink, you send a 1.0 kg puck at a speed of 1.0 m/s, which collides with a 2.0 kg puck sliding at 2.0 m/s in the opposite direction. They collide elastically (all 1D).

(a) What is the velocity of the 2.0 kg puck post-collision?

(b) The 2.0 kg puck travels away with the velocity found in (a) and travels across a "rough" patch of ice. If the puck slows to a stop over a distance of 3.0 m, what is the change in kinetic energy of the puck?

(c) What force (mag+dir) was applied to the puck to slow it down?

(d) The 2.0 kg puck has now returned to its initial launch point, and it has traveled a total distance of 10 m in 20 s. What is the average velocity of the 2.0 kg puck during the whole motion?

Question 6. **Grade this problem? Yes or No (circle one)**

A 2.0 kg block is launched along a flat floor and then up a ramp. As it leaves the top of the ramp, it is traveling with a speed of 10 m/s at an angle of 30º above the horizontal (v_x = 8.7 m/s), v_y=5.0 m/s). Ignore friction.

(a) Draw a full motion diagram for the motion of the block as it travels along the floor and up the ramp. Do include an acceleration vector during the transition from the floor to the ramp.

(b) If the ramp is 5.0 m high vertically, what was the initial velocity of the block as it traveled up the ramp?

The block now leaves the ramp (5.0 m vertically from the ground) and exhibits beautiful projectile motion.

(c) What are the components of the velocity immediately before it hits the ground?

(d) How long did it take for the block to hit the ground after leaving the ramp?