General Physics
Physics 101
Final – Spring 2011
Thursday – 4/28/11
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:_____

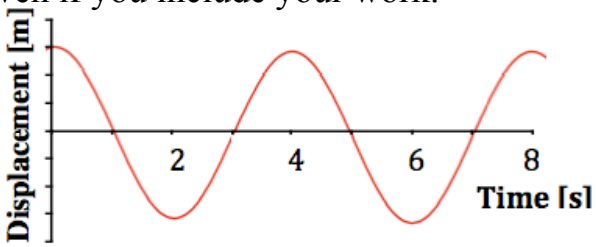
Part I. Multiple Choice (3 pts each)

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. For the oscillation shown, what is the angular frequency?



(a) 4.0 rad/s
(b) 0.25 rad/s
(c) 1.6 rad/s
(d) 0.789 rad/s

2. A 2.0 kg solid disc of radius 0.50 m is accelerated uniformly from rest to an angular velocity of -2.0 rad/s in 2.0 seconds. What torque was applied to the disc?

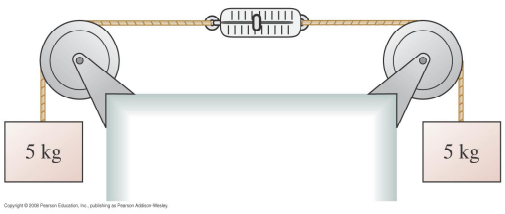
(a) 0.25 J
(b) -0.50 Nm
(c) 0.50 J
(d) -0.25 Nm

3. You carry your 2.0 kg backpack across our level campus a distance of 100 m. What is the work done by your vertical carrying/support force on the backpack?

(a) 2000 J
(b) 2.0×10^3 J
(c) 0 J
(d) 2.0×10^2 J

4. A 1500 kg car is traveling towards you at -2.0 m/s. If you want to stop the car, by firing a 10 kg blob of sticky clay at it. How fast should you fire the clay?

(a) 1.5×10^2 m/s
(b) 75 m/s
(c) 0.013 m/s
(d) 3.0×10^2 m/s



5. Two masses are at rest connected with a massless string over frictionless pulleys, as shown. What is the reading on the spring scale in Newtons?

(a) 5 kg
(b) 98 N
(c) 0
(d) 5×10^1 N

6. The wheel on a car has a radius of 0.25 m and undergoes 10 revolutions without slipping as it accelerates from rest in 2.0 seconds. What is the value of the angular acceleration of the wheel during this time?

(a) 64 rad/s^2
(b) 10 rad/s^2
(c) 5.0 rad/s^2
(d) 31 rad/s^2

7. An object has an initial kinetic energy of 30 J and work is done on the object to increase its kinetic energy to 50 J. If this is done over 2.0 seconds, how much power is used?

(a) 10 W
(b) 40 W
(c) 20 W
(d) 25 W

8. A person travels a distance of 3.0 km in 1.0 hour.
What of the following could not be true about this motion?

(a) The total displacement of the person could be zero.
(b) The average speed of the person is 3.0 km/hr.
(c) The average velocity of the person could be less than 3.0 km/hr.
(d) The average velocity of the person could be greater than 3.0 km/hr

9. A 1.0 kg rock is suspended by a mass-less string from one end of a 1.0 m long measuring stick. What is the weight of the measuring stick if it is balanced by a support force at the 0.25-m mark?

(a) 0.33 kg
(b) 0.50 kg
(c) 1.0 kg
(d) 2.0 kg

10. A student derives an equation of the form $\frac{t}{v^2}$.
What are the combined SI base units for this equation?

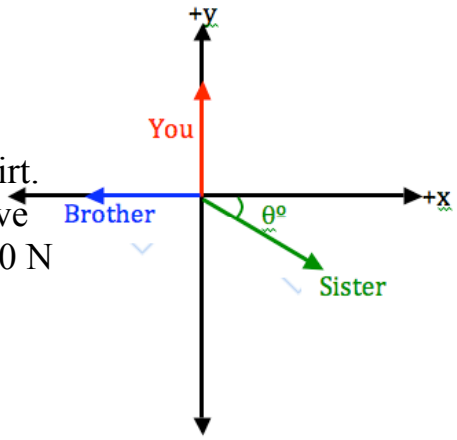
(a) $\frac{s^3}{m^2}$
(b) $\frac{1}{m^2 s}$
(c) $\frac{s^2}{m^2}$
(d) $\frac{s}{m^2}$

11. A pickup truck with a steel bed is carrying a steel file cabinet. If the truck's speed is 15.0 m/s, what is the shortest distance in which it can stop without the file cabinet sliding?

(a) 14.3 m
(b) 19.1 m
(c) 7.15 m
(d) 1.27 m

12. For a pendulum, if you double the length of the pendulum, the frequency of oscillation will…

(a) Increases by a factor of $\sqrt{2}$
(b) Decreases by a factor of $\sqrt{2}$
(c) Increases by a factor of 2
(d) Decreases by a factor of 2



13. You and two siblings are having a tug of war over a t-shirt. Each person is pulling with the proper amount of force to have the net force on the shirt is zero. You pull with a force of 3.0 N and your brother pulls with 2.0 N, as shown.
What angle does your sister have to pull with?

(a) 33º south of east
(b) 56º south of east
(c) 3.7º south of east
(d) 45º south of east

14. Which of the following statements is true?

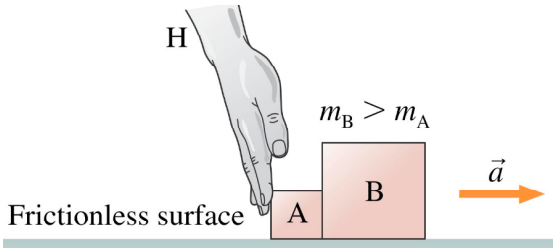
(a) The acceleration vector always points towards the center when rotating.
(b) The net torque on an object can be zero, and it can still be rotating.
(c) The velocity at the maximum altitude of a projectile motion is zero.
(d) The center of mass must always lie in the object.

15. Two balls of equal mass but opposite velocities approach each other for a head-on elastic collision. After the collision the balls will

(a) move off stuck together
(b) both be at rest
(c) move off in the same direction
(d) recoil in opposite directions.

16. A 1.0 kg block with a massless string is being pulled upward at a constant velocity. How does the magnitude of the tension in the string compare with the force of gravity acting on the block?

(a) The same as the force of gravity
(b) Greater than the force of gravity
(c) Less than the force of gravity
(d) Impossible to tell without more information.



17. Two blocks with masses m_A=5.0 kg and m_B = 10.0 kg are pushed on a frictionless surface as shown, and the blocks accelerate at 1.0 m/s^2. What is the magnitude and direction of the force of block B on A?

(a) 5.0 N
(b) -15 N
(c) -10 N
(d) -5.0 N

18. A 2.0 kg block approaches a spring at 10 m/s and recoils with a speed of 5.0 m/s in the opposite direction. What impulse was applied to the block by the spring?

(a) 10 Ns
(b) 30 kg m/s
(c) 15 N
(d) 35 Ns

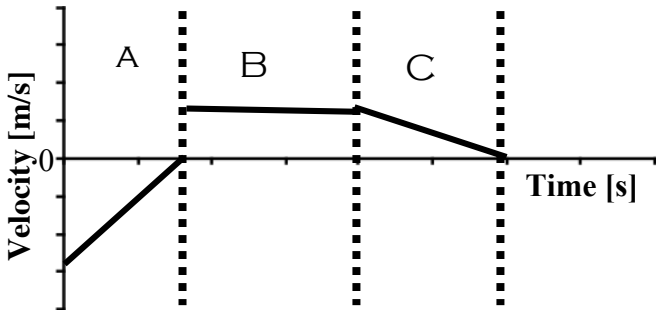
19. A process occurs in which a system's potential energy increases while the system does work on the environment. Ignoring thermal effects, what must happen to the kinetic energy of the system?

(a) Increase
(b) Decrease
(c) Remain the same
(d) Unable to determine

20. It's a snowball fight. You have barricaded yourself at the front door of your house, and your friends are 6.0 m away, you lob a snowball towards your friends and it lands 2.0 seconds later. Assume the initial and final altitude are equal. What is the initial vertical velocity of the snowball?

(a) 3.0 m/s
(b) 9.8 m/s
(c) 20 m/s
(d) 4.9 m/s

21. For the following velocity vs. time graph, what is true.



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

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

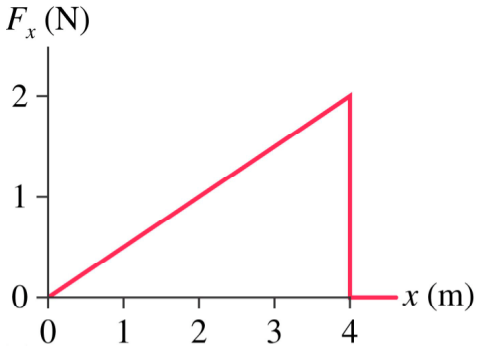
(c) The velocity in B is zero.

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

22. A Frisbee is stuck 16.0 m above the ground in a tree. To dislodge the Frisbee you have to hit it with a rock traveling at 5.00 m/s. If you release the 0.500 kg rock 2.00 m above the ground, with what minimum kinetic energy must you throw it with?

(a) 68.6 J
(b) 72.3 J
(c) 78.3 J
(d) 74.9 J

23. A 2.0 kg mass is moving along the x-axis and experiences the force shown. What is the work done on the mass over the 4.0 m distance?



(a) 4.0 J
(b) 8.0 J
(c) 0.50 J
(d) 16 J

24. A 1.0 kg mass in a mass/spring system oscillates with an angular frequency of 2.0 rad/s and amplitude of 0.20 m. What is the velocity of the mass, when it is at half of its amplitude?

(a) 0.34 m/s
(b) 0.40 m/s
(c) 0.44 m/s
(d) 0.086 m/s

25. You're riding on a train, which is traveling with a constant velocity. Bored, you decide to drop a ball from the ceiling of the train. When it lands on the train floor, where does it land?

(a) directly below where it was dropped
(b) ahead of where it was dropped
(c) behind where it was dropped
(d) not enough information given

26. A 100 g ball and a 200 g ball rotate are connected by a 30-cm long massless, rigid-rod. The balls rotate about their center of mass at 20 rad/s. What is the speed of the 100 g ball?

(a) 6.0 m/s
(b) 4.0 m/s
(c) 3.0 m/s
(d) 2.0 m/s

27. In the depths of space, a rocket-ship is traveling at a velocity of 100 m/s and it fires its retro-rockets for 10 seconds and the ship experiences an acceleration of -10 m/s^2. How far did the ship travel during these 10 seconds? Assume all 1D motion.

(a) 0.0 m
(b) 1.0×10^3 m
(c) 5.0×10^2 m
(d) 1500 m

28. Calculate the moment of inertia for a 1.0 kg meter stick oscillating about its 0.25 m mark

(a) 0.33 kg m^2
(b) 0.40 kg m^2
(c) 0.15 kg m^2
(d) 0.083 kg m^2

29. A horizontal mass-spring system of mass 1.0 kg oscillates with a period of 1.0 s and amplitude of 0.50 m. Which of the following equations could describe the motion of the system? Units inside the sine/cosine are suppressed.

(a) $x(t) = (0.50\ m) \cos (2.00\ t)$
(b) $x(t) = (2.0\ m) \cos (2.00\ \pi\ t)$
(c) $v(t) = -(3.14\ m/s) \sin (2.00\ \pi\ t)$
(d) $a(t) = -(1.57\ m/s^2) \cos (1.00\ t)$

30. A block pushed along the floor with velocity, *v*, slides a distance, d, after the pushing force is removed. What initial velocity is necessary, if you want the block to travel a distance of 2d before stopping?

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

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)**

A girl swings back and forth on a playground swing. The length of the swing is 3.00 m and the girl has a mass of 40 kg.

(a) You measure her average oscillation period to be 3.48 seconds. Treating this system as a simple pendulum, you can make an estimation of the value of gravity for the playground. What is the value of gravity for this system?

(b) If the little girl stands on the swing, what happens to the period of oscillation? Explain why this is the case. Equations are not necessary, but they may help.

(c) If you wanted to setup a mass spring system with the same period and mass as found in part (a), what would the value of the spring constant have to be?

(d) If the amplitude of oscillation is 50 cm, what is the maximum acceleration of the mass spring system and where does this occur?

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

You have a 2.0 kg rifle, and want to measure the velocity of a 10 g bullet as it leaves the gun's barrel. In the first experiment you measure the recoil velocity of the gun to be 1.5 m/s as the bullet leaves the gun. The gun and bullet were initially at rest.

(a) Assuming a 1D explosion, what is the velocity of the bullet as it leaves the gun?

(b) In the next experiment, you fire the bullet into a motionless door on hinge 20 m away. If gun is horizontal, and we ignore air resistance, how long did it take the bullet to reach the door?

(c) The bullet imbeds itself in the 10 kg, 1.0 m wide door at the edge opposite the hinges, causing the door to swing open. What is the angular velocity of the door just after impact? Assume the bullet's velocity is the same as in (a).

(d) During this collision, was the force of the bullet on the door greater, equal or less than the force of the door on the bullet. Explain your answer with words, and theory… no equations are necessary.

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

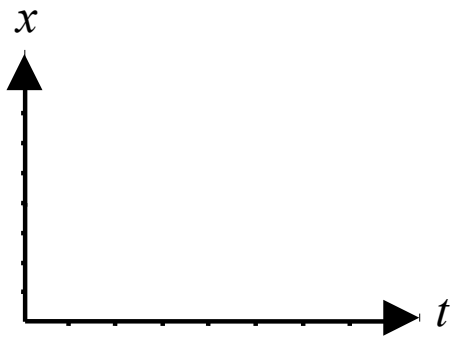
A block slides along a smooth horizontal floor at 10.0 m/s then starts up a 20.0º ramp. We are only interested in the motion of the block as it travels to its highest point (do not worry about it traveling back down). Ignore Friction.

(a) Determine the acceleration of the block as it travels up the ramp, clearly stating the direction of the acceleration.

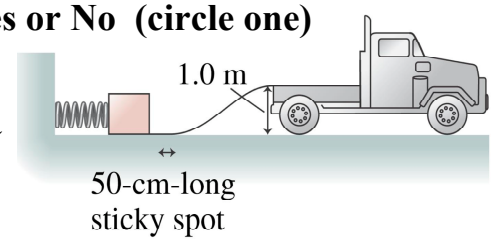
(b) Determine how high (vertical distance) the block travels before it slides back down.

(c) How long did it take the block to go from the bottom of the ramp to its highest point?

(d) Sketch a position on the ramp (x) vs time plot that could represent the motion of the block on the ramp. Please explain the shape & meaning of the graph.



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



A freight company uses a compressed spring to shoot 2.00 kg packages up a 1.00 m high frictionless ramp into a truck. The spring constant is 500 N/m and the spring is compressed by 30.0 cm.

(a) What is the kinetic energy of the package just after it leaves the spring? Define initial position as y=0.

Note the unfortunate 50.0 cm long sticky spot on the horizontal section just prior to the ramp. The spot has a kinetic coefficient of friction of 0.300.

(b) Draw a force diagram showing all forces acting on the package as it travels across the sticky spot. Be sure to include the net force in your diagram.

(c) Using the work energy theorem, calculate the change in kinetic energy of the package as it travels across the sticky spot.

(d). By whatever means necessary, determine whether the package makes it onto the truck or not. Calculations are necessary, and you must state whether the package makes it or not, and why this is the case.

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

Bob can throw a 500 g rock with a speed of 30 m/s starting from rest. He moves his hand forward 1.0 m while doing so.

(a) What is the rock's acceleration (assumed to be constant) during the throw?

(b) How much work does Bob do on the rock?

(c) Bob releases the rock horizontally and it falls through a vertical distance of 2.5 m to the floor. What is the vertical component of the velocity (mag + dir) right before it strikes the ground?

(d) As the rock collides with the earth are either momentum or total mechanical energy conserved? Words are necessary in your explanation. Calculations are not.

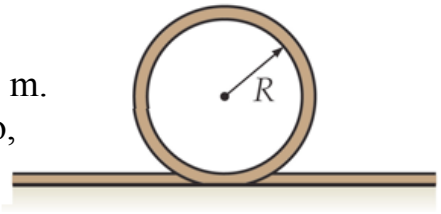
Question 6. **Grade this problem? Yes or No (circle one)**

I got my son a happy-fun-ball™ as an Easter present. The instructions say that it is a solid sphere with a uniform mass of 1.0 kg and a diameter of 0.20 m. I've designed an obstacle course for us to play with. I'm stoked. Anyway, the ball begins by rolling without slipping down a nice level bit of floor.

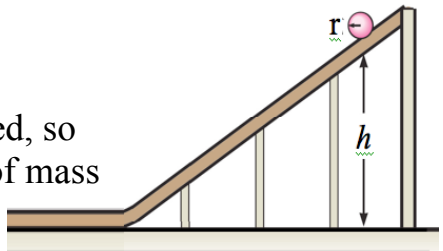
(a) If the ball rolls a distance of 6.0 meters in 2.0 seconds, what is the angular velocity of the ball?

(b) What is the total kinetic energy of the ball as it rolls along the floor?

The ball then approaches a loop-da-loop with a radius of 0.50 m.
(c) If at the top of the loop the normal force on the ball is zero, what is the speed of the ball at the top?



We've of course assumed that mechanical energy is conserved, so the ball leaves the loop with the same velocity of the center of mass as it had in part (a). It now approaches a ramp.



(d) What is the maximum height, h, above the start of the ramp that the ball reaches?