General Physics
Physics 101
Final – Spring 2012
Thursday – 4/26/12
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:

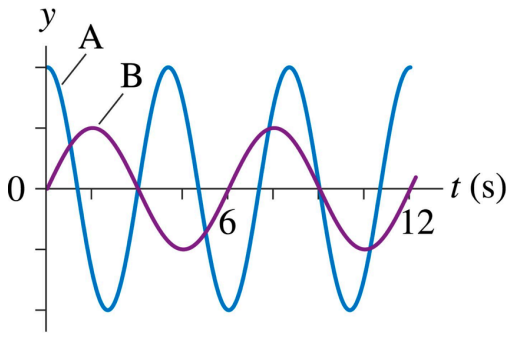
Please clearly circle one and only one answer for each of the following.
Show all of your work. Partial credit may be given if you include your work.

Questions:

1. A 80 kg person is riding on a 20 kg cart (100 kg total for the system). You pull the cart with a 20 N force starting from rest over a 3.0 m distance, and achieve a final velocity of 0.75 m/s. What is the net-work done on the system?

(a) 60 J
(b) 38 J
(c) 28 J
(d) 32 J

2. The two graphs shown are for two different vertical mass-spring systems. For A, what is the period?



(a) 2.5 s
(b) 2.0 s
(c) 3.0 s
(d) 4.0 s

3. A 1.0 kg ball and a 2.0 kg ball are connected by a 1.0 m long rigid, mass-less rod and it is rotating counter-clockwise about its center of mass. What is the total moment of inertia for the system?

(a) 0.66 kg m^2
(b) 0.25 kg m^2
(c) 0.33 kg m^2
(d) 1.0 kg m^2

4. An object moves from A to B to C.
What is the direction of the acceleration vector?

(a) North-East
(b) South-East
(c) South-West
(d) North-West

5. A 2.0 kg, 40 cm diameter turntable rotates at 100 rpm on frictionless bearings. Two 1.0 kg blocks fall from above, hit the turntable simultaneously at opposite ends of a diagonal and stick. What is the turntable's angular velocity in rpm just after this event?

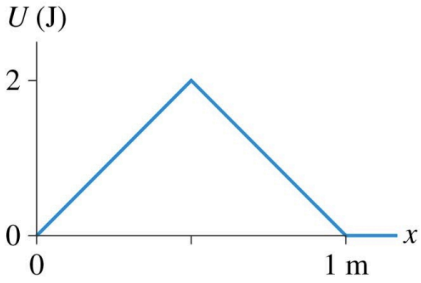
(a) 25 rpm
(b) 67 rpm
(c) 33 rpm
(d) 50 rpm

6. A helicopter is moving vertically with a constant velocity of 15.0 m/s and a person riding in the helicopter releases a 2.00 kg rock when the helicopter is 50.0 m from the ground. What is the impact velocity of the rock as it hits the ground?

(a) 31.3 m/s
(b) -34.7 m/s
(c) -27.4 m/s
(d) -3.13×10^{1} m/s

7. A wheel of radius 1.5 m rotates with a constant angular speed.
What statement about a point on the rim of the wheel is true?

(a) It is experiencing no acceleration
(b) It is experiencing only tangential acceleration
(c) It is experiencing only angular acceleration
(d) It is experiencing only centripetal acceleration



8. For the graph shown, what is the force on the particle when it is at a location of 0.25 m?

(a) -4.0 N
(b) 1.0 N
(c) 0.50 N
(d) 4.0 N

9. 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?

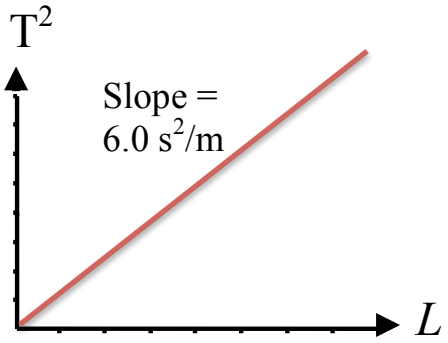
(a) 10 cm
(b) 20 cm
(c) 40 cm
(d) 80 cm

10. 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) 8.8 N
(d) 20 N

11. A 1.0 kg toy car traveling at 2.0 m/s approaches a 3.0 kg toy car that is stationary. Assuming they collide elastically, what is the velocity of the 1.0 kg car post-collision?

(a) 0.50 m/s
(b) 1.0 m/s
(c) -1.0 m/s
(d) -2.0 m/s



12. A student on planet X, generated the following graph for a pendulum's period squared as a function of length. What is the value of the acceleration due to gravity on planet X?

(a) 6.6 m/s^2
(b) 1.0 m/s^2
(c) 0.15 m/s^2
(d) 2.1 m/s^2

13. Which of the following statements is true?

(a) In a conservative system, the total mechanical energy can change.

(b) Friction always points in the opposite direction of motion.

(c) The unit "candela" is not an SI base unit.

(d) The period of a pendulum can depend on amplitude.

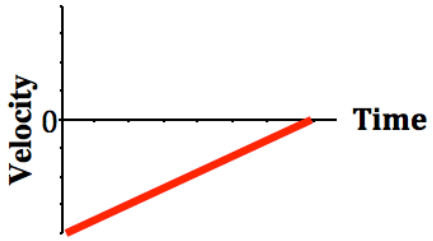
14. Ann is pulling a 20 kg box across the floor with a rope at an angle of 45º above the horizontal. If the tension in the string is 50 N and the box moves with constant velocity, what is the coefficient of friction between the box and the floor.

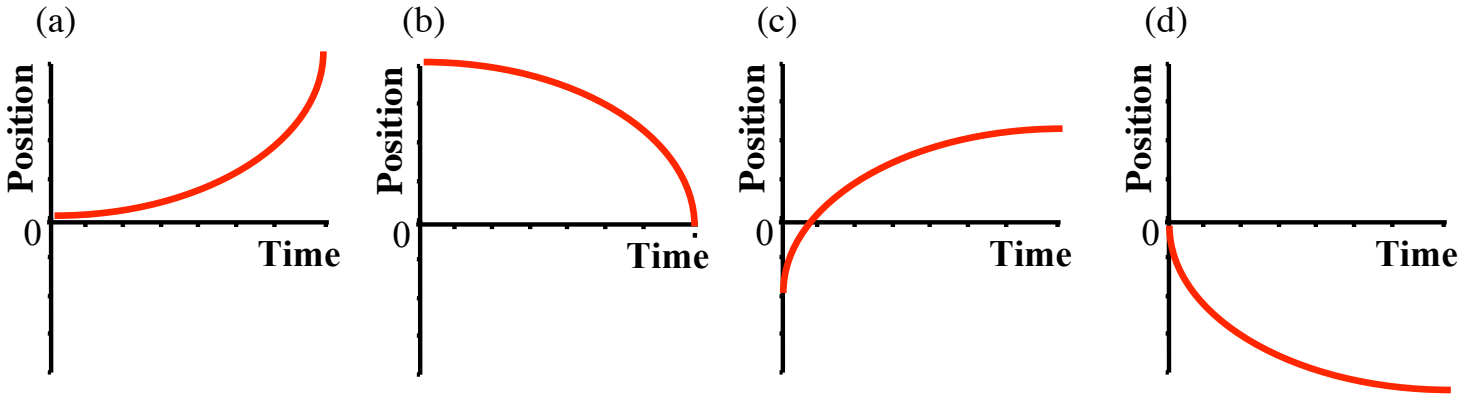
(a) 0.15
(b) 0.26
(c) 0.18
(d) 0.22

15. A truck traveling at 50 m/s collides head on with a car traveling in the opposite direction at 30 m/s. Which vehicle experiences a larger impulse?

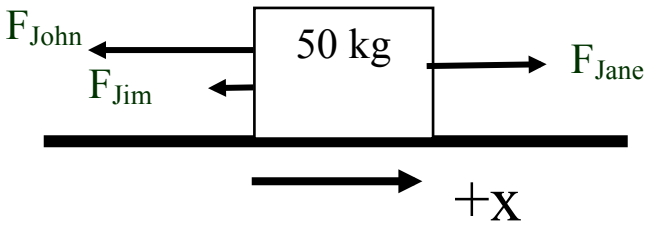
(a) The truck experiences the larger impulse.
(b) The car experiences the larger impulse.
(c) Both experience the same impulse.
(d) Impossible to determine without the masses.

16. Which of the following position versus time graphs could represent the velocity vs time graph shown.



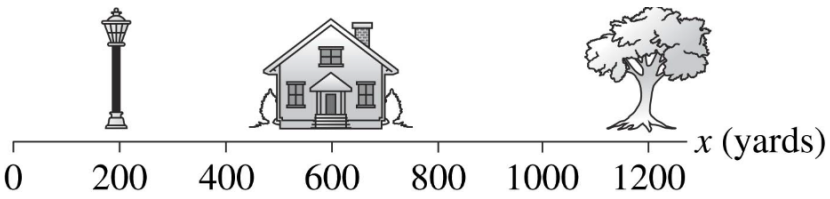


17. John, Jane and Jim are pulling horizontally on a 50 kg cart as shown If the magnitude of the forces are John = 5.0 N, Jane 3.0N and Jim 1.0 N, what is the net acceleration of the cart? Pretend friction doesn't exist.



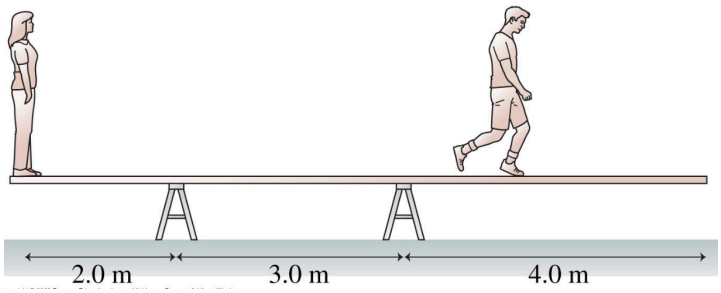
(a) 0.090 m/s^2
(b) 0.18 m/s^2
(c) 6.0 x 10^{-2} m/s^2
(d) 1.8 x 10^{-1} m/s^2

18. Larry leaves home at 9:05 and runs at a constant speed to the lamppost. He reaches the lamppost at 9:07, immediately turns around and runs to the tree. Larry arrives at the tree at 9:10. What is Larry's average velocity for the entire run?



(a) +120 yd/min
(b) -200 yd/min
(c) +333 yd/min
(d) +280 yd/min

19. Adrienne (50kg) and Bo (90 kg) are playing on a "massless", 9.0 m long, rigid plank resting on the supports as shown. If Adrienne stands on the left end, how far from the other end can Bo walk?



(a) 2.8 m
(b) 1.2 m
(c) 2.0 m
(d) All the way to the end.

20. A student derives an equation of the form $\frac{v^2}{a}$.

What are the combined SI base units for this equation?

(a) $\frac{m^3}{s^4}$

(b) $\frac{1}{ms}$

(c) m

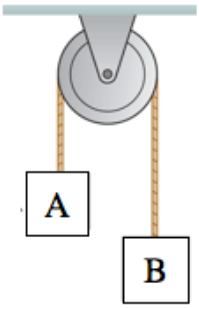
(d) s

21. A ball is thrown with velocity components of 2.0 m/s and 4.0 m/s in the x and y directions. What is the ball's horizontal displacement during its flight? Assume the same start and stop altitude.

(a) 1.6 m
(b) 0.82 m
(c) 4.9 m
(d) 3.2 m

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

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



23. In lab you measure the acceleration of an Atwood's machine to be 3.3 m/s^2. What is the tension in the string if m_A = 2.0 kg and m_B = 4.0 kg?

(a) 26 N
(b) 20 N
(c) 13 N
(d) 52 N

24. A bicycle wheel rotates with a constant angular speed of 60 rpm. Through what angle does the wheel turn through in 60 seconds?

(a) 360 radians
(b) 60 revolutions
(c) 376.9 radians
(d) 592 revolutions

25. You throw a rock into the air with a velocity v, and it reaches a maximum vertical distance of 2.0 m. If you double the throw velocity, how high does the rock go now?

(a) 8.0 m
(b) 4.0 m
(c) 2.8 m
(d) 2.0 m

26. A moving coconut explodes into two pieces, a 0.25 kg piece travels in the negative x direction with a speed of 4.0 m/s, and a 0.10 kg piece travels in the positive x-direction with a speed of 2.0 m/s. What is the total of the momentum of the system before the explosion?

(a) 0.0 kg m/s
(b) 1.2 kg m/s
(c) -0.80 Ns
(d) Need more information

27. A 2.0 kg block is sliding with a velocity of 5.0 m/s, and comes to rest over a distance of 4.0 m. What is the magnitude of the force that stopped the block?

(a) 1.3 N
(b) 6.3 N
(c) 4.8 N
(d) 50 N

28. A crane lowers a steel girder into place. The girder moves with constant speed. Consider the work done by gravity (W_G) and the work done by the tension in the cable (W_T). Which of the following are correct?

(a) W_G is positive and W_T is positive
(b) W_G is negative and W_T is negative
(c) W_G is negative and W_T is positive
(d) W_G is positive and W_T is negative

29. A mass-spring system (m=2.00 kg and k=8.00N/m) oscillates with 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) $v(t) = (0.25\text{ m}) \cos (2.0\text{ t})$
(b) $a(t) = -(1.0\text{ m/s}^2) \cos (2.0\text{ t})$
(c) $v(t) = -(0.25\text{ m/s}) \sin (2.0\ \pi\text{ t})$
(d) $x(t) = (0.25\text{ m}) \cos (4.0\text{ t})$

30. Two wheels initially at rest roll the same distance without slipping down identical inclined planes starting from rest. Wheel B has twice the radius but the same mass as wheel A. All the mass is concentrated in their rims, so that the rotational inertias are $I=mR^2$. Which has more translational kinetic energy when it gets to the bottom?

(a) Wheel A
(b) Wheel B
(c) The kinetic energies are the same.
(d) need more information

Part II. Short answer problems (12 pts each)

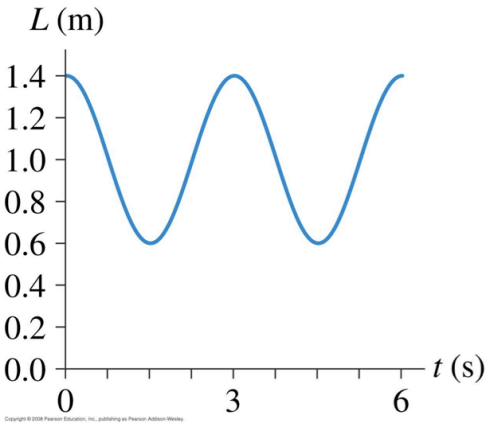
Instructions:

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)**

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.



(a) What is her mass if the spring constant is 240 N/m?

(b) Calculate the maximum velocity and state at what length of spring where this occurs.

(c) What is her speed when the spring's length is 1.2 m?

(d) If she conducted this experiment near a planet with a large gravitational field, what effect would a large "g" have on the measurement of her mass? Explain your answer with words and possibly equations. No calculations are necessary.

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

A 2.0 kg, 2.0 m diameter solid disc is rotating clockwise with 20.0 J of kinetic energy. Assume that this rotation is frictionless (we paid the extra $ for good ball-bearings).

(a) If the disc is rotating about its center, what is its angular velocity?

(b) If the disc is stopped over 2.0 seconds, what is the average torque exerted on the disc?

(c) If you want to apply this torque by applying the smallest force possible, where do you apply it, and at what angle? Be sure to justify your answer with words, theory and possibly equations. No calculations are necessary.

(d) How much power was used during in slowing the disc?

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

A 1.0 kg model rocket is launched into the air, and provides a constant thrust force. When the rocket reaches 20 m above the ground it is traveling with a velocity of 10 m/s. The rocket continues to provide thrust after this point. Ignore the loss of the fuel from the rocket, and assume it travels vertically.

(a) How much work was done by the thrust of the rocket by the time it reached 20 m above the ground?

(b) What is the force from the thrust of the rocket during the launch?

(c) What was the net acceleration of the rocket?

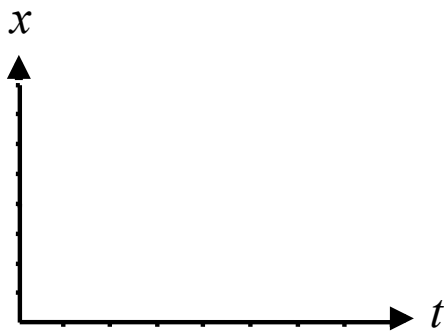
(d) If we didn't ignore the loss of the fuel and assumed that the thrust would remain constant during the launch, would the velocity of the rocket be bigger, smaller or the same when it reached 20m? Words and reasoning are necessary in your answer. Further calculations are not.

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

Packing to go home you placed a 50 kg wooden bookcase on a level piece of plywood that is secured to the roof of your car. You claim that you don't need to tie-down the shelf, as you know physics and you're a good driver. You drive down the street traveling at 5.0 m/s, and you spy a physics text in the road ahead. Not wanting to hit the book, you apply your brakes uniformly for 2.0 seconds.

(a) What acceleration (mag + dir) did the car experience during the stop?

(b) Sketch a position vs time plot that could represent the motion of the car as it slows. Please explain the shape & meaning of the graph.



(c) If the coefficient of static friction between the shelf and wood is 0.40, what is the maximum static friction force the bookcase can experience without moving?

(d) Did the bookshelf slide off the plywood atop your car? A justification is required, which should include words, and possibly a short calculation.

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

You're sliding ice-cubes on top of a table. You slide a 10 g ice-cube at 3.0 m/s at a 20 g ice-cube traveling at -2.0 m/s. We'll assume friction free.

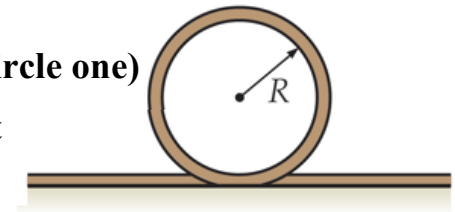
(a) If the cubes collide and stick together, what is their final velocity?

(b) In this collision was kinetic energy or momentum conserved? Be sure to state whether each are conserved or not, and justify your answer with words and possibly equations.

(c) You stop the combined cubes by applying a constant force of 3.0 N to the 10 g cube. What is the magnitude of the force of the 10 g cube on the 20 g cube?

(d) If you then push the combined block off the horizontal table with a velocity of 2.0 m/s, how long does it take to hit the floor 1.5 m below?

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



A 2.0 kg block is sliding along a frictionless track at a constant 10 m/s and it approaches a loop-da-loop of radius 1.0 m.

(a) What is the velocity when the block is at the top of the loop (assumed to be a vertical distance of twice the radius)?

(b) At the top of the loop, what is the magnitude of the normal force of the track acting on the block?

(c) After the block leaves the loop it is traveling with the same velocity of 10 m/s, and it approaches a horizontal spring that is compressed a total distance of 50 cm while bringing the block to rest. What is the spring constant of the spring?

(d) At the instance the block comes to rest, draw a force diagram showing all forces acting on the block including the net force (state it is zero, if it is zero). Be sure to use proper labels for each force.