General Physics
Physics 101
Final – Fall 2009
Thursday – 12/17/09
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:_________________________

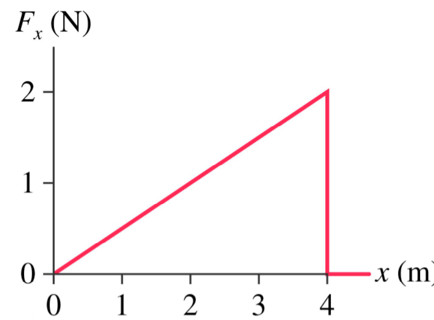
Part I. Multiple Choice (3 pts each)

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 2.0 kg mass is moving along the x-axis and experiences the force shown. What is the work done on the mass?



(a) 16.0 J
(b) 8.0 J
(c) 4.0 J
(d) 0.50 J

2. Jimmy and Jenny are playing on a 1.8 m long see-saw with pivot point at its center. The see-saw is balanced, when Jimmy sits 0.80 m from the pivot and Jenny sits 0.60 m on opposite side of from the pivot. If Jenny has a mass of 40 kg, what is Jimmy's mass?

(a) 30 kg
(b) 40 kg
(c) 53 kg
(d) 83 kg

3. The oscillation frequency of a pendulum is 1.0 Hz. If you halve the length of the pendulum, what is the new oscillation frequency?

(a) 2.0 Hz
(b) 1.4 Hz
(c) 0.71 Hz
(d) 0.50 Hz

4. Which of the following statements is false.

(a) Linear momentum can always be conserved.
(b) Mass does not affect the period of a pendulum.
(c) The center of mass can lie outside of an object.
(d) The velocity at the turn around point in projectile motion is always zero.

5. An ice skater has a moment of inertia of 100 kg m^2 when his arms are outstretched and a moment of inertia of 75 kg m^2 when his arms are tucked in close to his chest. If he starts to spin at an angular speed of 2.0 revolutions per second with his arms outstretched, what will his angular speed be when they are tucked in?

(a) 1.5 revolutions per second
(b) 2.0 revolutions per second
(c) 2.7 revolutions per second
(d) 5.3 revolutions per second

6. On a frictionless air track, a 1.0 kg car traveling at 2.0 m/s approaches a 2.0 kg car traveling at 1.0 m/s in the opposite direction. Assuming an elastic collision, what is the speed of the 2.0 kg car post-collision?

(a) 1.0 m/s
(b) 1.3 m/s
(c) 1.7 m/s
(d) 2.3 m/s

7. You are attempting to spin a 2.0 kg ball above your head in a horizontal circle at a speed of 2.1 m/s. Unfortunately the mass-less string snaps once you achieve this tangential speed. If a tension force of 12.61 N is necessary to snap the string, at approximately what radius were you spinning the ball?

(a) 0.6994 m
(b) 1.4 m
(c) 2.1 m
(d) 70 cm

8. A 1000 kg safe is 2.0 m above a heavy-duty spring when the rope holding the safe breaks. The safe hits the spring and compresses it by 50 cm. What is the spring constant of the spring?

(a) 156800 Nm
(b) 2.0 x 10^5 N/m
(c) 2.0 x 10^4 N/m
(d) 1.6 x 10^5 N/m

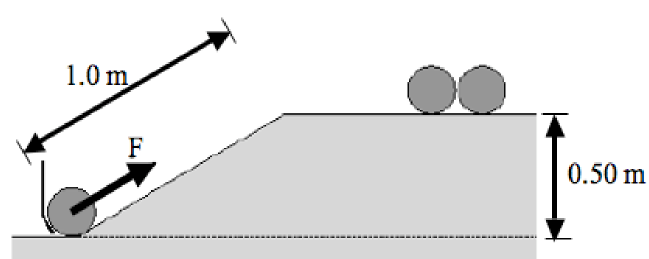
9. The distance from the earth to the moon is 3.8 x 10^5 km. If the mass of the earth and moon are 5.98 x 10^{24} kg and 7.4 x 10^{22} kg respectively, where is the location of the center of mass of the earth-moon system with respect to the center of the earth?

(a) 4664.8 km
(b) 3.8 x 10^5 m
(c) 3.8 x 10^8 m
(d) 4.6 x 10^6 m

10. 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.

11. At the bowling alley, the ball-feeder must exert a force to push the bowling balls up a 1.0-m long ramp. The ramp leads the balls to a chute 0.50 m above the base of the ramp. Approximately how much force must be exerted on a 5.0-kg bowling ball?



(a) 25 N
(b) 50 N
(c) 200 N
(d) 5.0 N

12. Two cylinders of the same size and mass roll from rest down an incline. Cylinder A has most of its weight concentrated at the rim, while cylinder B has its weight uniformly distributed. Which reaches the bottom of the incline first?

(a) A
(b) B
(c) Both reach the bottom at the same time.
(d) Need more information.

13. You have a training cannon that fires a cannon ball with a speed of 100 m/s at a fixed angle of 60.0º above the horizontal. If the target lies at the same altitude as the cannon, how long would the cannon ball spend in the air? Ignore air resistance.

(a) 10.2 s
(b) 17.7 s
(c) 8.84 s
(d) 20.4 s

14. A student derives an equation of the form $\frac{mv^3}{x^2}$.

What are the combined SI base units for this equation?

(a) $\frac{kg \cdot m^5}{s^3}$
(b) $\frac{kg \cdot m}{s}$
(c) $\frac{m^2}{s^3}$
(d) $\frac{kg \cdot m}{s^3}$

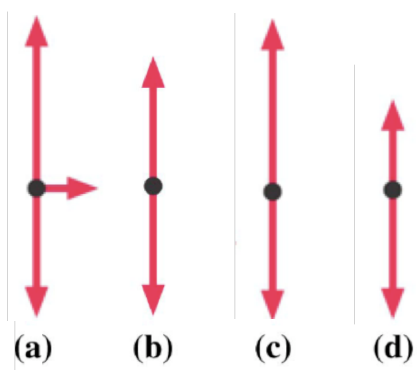
15. A cart sits motionless on a horizontal platform.
Which of these statements is false?

(a) the net force on the cart is zero.
(b) the normal force and force due to gravity are Newton III law pairs.
(c) the normal force and the force due to gravity are equal and opposite.
(d) the cart pushes on the platform with an equal and opposite force to the platform pushing on the cart.

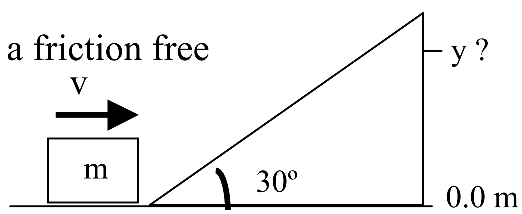
16. A clown car traveling at 10.0 km/hr on a straight level road undergoes an acceleration of 1.00 m/s^2 for 10.0 seconds. How far do the clowns travel in 10.0 s?

(a) 22.2 m
(b) 50.0 m
(c) 77.8 m
(d) 150 m

17. The car runs out of gas while driving down a hill. It rolls through the valley and starts up the other side. At the very bottom of the valley, which of the free-body diagram is correct? Friction and drag force are negligible.



18. A 2.0 kg block sliding with a velocity of 2.0 m/s on a friction free surface and approaches a ramp as shown. What vertical distance does the block travel up the ramp?

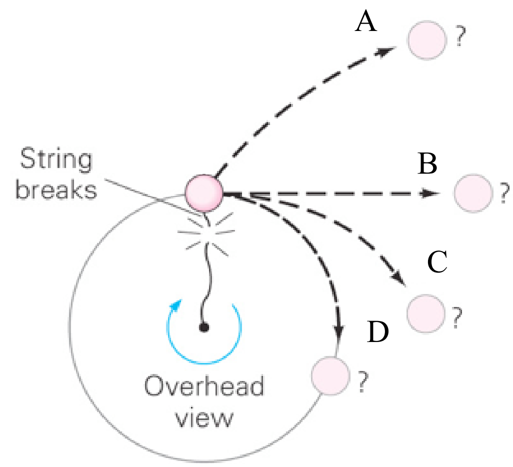


(a) 20 m
(b) 0.82 m
(c) 0.20 m
(d) 0.41 m

19. A mass-spring system completes 5.0 full oscillations in 1.0 second. If the mass is 5.0 kg, what is the value of the spring constant?

(a) 4.9 x 10^3 N/m
(b) 1.6 x 10^2 N/m
(c) 1.3 x 10^2 kg/s^2
(d) 4.9 x 10^3

20. You are spinning a ball on a string above your head. If the string breaks as shown, in what direction does the ball travel?

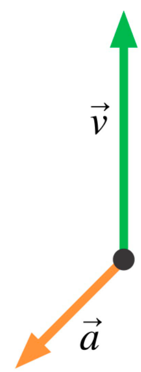


(a) A
(b) B
(c) C
(d) D

21. A force of is applied perpendicular to the edge of a 2.0 m radius 5.0 kg solid sphere that spins from rest about its center of mass for 10 seconds. If the angular acceleration of the sphere is 1.0 rad/s^2, what is the magnitude of the applied force?

(a) 3.3 N
(b) 2.0 N
(c) 8.0 N
(d) 4.0 N

22. For the given initial velocity and acceleration. In what general direction will the final velocity vector point?

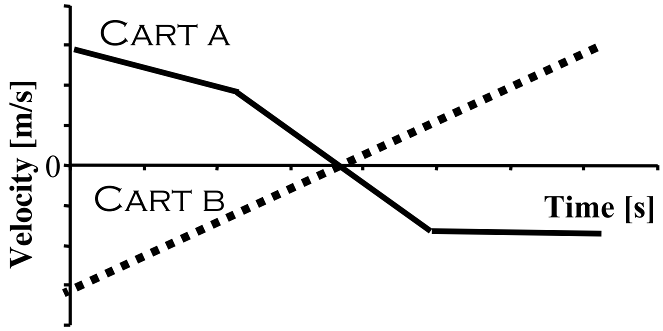


(a) South of West
(b) North
(c) West
(d) North of West

23. You throw a ball straight-up from the ground to a second story window. As the ball reaches the window, its velocity is zero. If you throw the ball with half of the initial velocity, the time it takes to reach the window is…

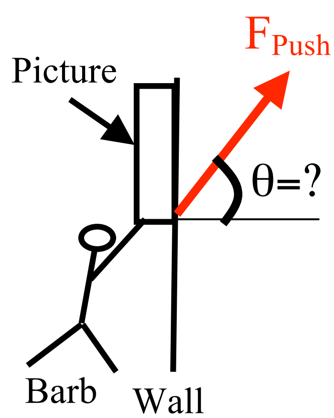
(a) the same.
(b) twice as long.
(c) four times as long.
(d) The ball never makes it to the second story window.

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



(a) CART A and CART B have the same acceleration at a point during the motion.
(b) In the beginning of the motion CART B has a negative increasing velocity.
(c) CART A and CART B both change directions during their motions.
(d) CART A has a negative decreasing velocity at some point during the motion.

25. Barb is holding a big picture (m=25 kg) on the wall by pushing on the picture with a force of 300 N at an angle. For the picture not to move, what does the angle of the push have to be?



(a) 35°
(b) 48°
(c) 55°
(d) 85°

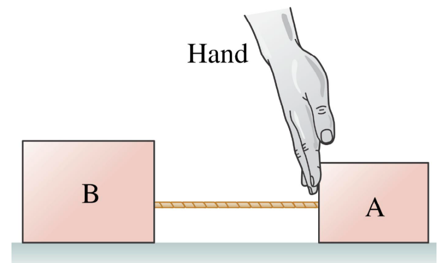
26. You push a 10.0 kg block of steel across a steel table at a constant speed of 1.00 m/s over a distance of 3.00 m. The force you apply is 58.8 N, and the coefficient of kinetic friction between the steel block and table is 0.600. What is the net work done by all forces acting on the block?

(a) 0.00 J
(b) 176 J
(c) 352 J
(d) 588 J

27. A horizontal mass-spring system with a mass of 1.00 kg has an equation of motion of x(t) = (3.14 m) cos (2.00 t). What is the maximum kinetic energy of the mass?

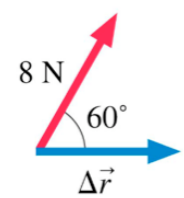
(a) 19.7 J
(b) 6.28 J
(c) 3.14 J
(d) Need more information

28. 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

29. A 0.50 kg ice-cube is sitting on a friction free table top. You push it with a constant force as shown, over a distance of 2.0 m. What is the ice-cubes kinetic energy after the push?



(a) 8.0 J
(b) 16 J
(c) 4.0 J
(d) 32 J

30. A 100g 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 x =-5.0 cm. What is the amplitude of oscillation?

(a) 5.0 cm
(b) 8.0 cm
(c) 4.0 cm
(d) 6.4 cm

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)**

You are on the Wheel of Fortune, and are about to take your next spin. You grab the edge of the 4.00 m diameter and 100 kg mass wheel and apply a 50.0 Nm torque on the outer edge and turn the wheel 10º before release.

(a) Assuming that the wheel is a solid cylinder spinning about its center of mass, what is the magnitude of the angular acceleration of the wheel as you spin it?

(b) What is the angular velocity of the wheel immediately after you release it?

(c) After release, do all points on the Wheel travel the same angular distance during one revolution? Explain.

Once in motion the wheel starts to slow down, because the markers that read off the dollar value you have are applying a torque.

(d) If it takes 5.0 seconds for the wheel to stop spinning after release, what is the magnitude and direction of the torque applied to the wheel?
Use NII law for rotations.

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

Left alone in the physics lab, you spy a room-length air track, which is beautiful, level and friction free (when the air is turned on). You take a 2.0 kg cart and send it with a velocity of 3.0 m/s towards a stationary 1.0 kg cart. The carts stick together and move on their way.

(a) What is the final velocity of the stuck-together carts post-collision?

(b) Explain whether the 2.0 kg or 1.0 kg cart experiences a larger force during the collision? Words are necessary and equations with calculations may help, but are not required.

Just to see what happens, you decide to turn the air off, and the stuck-together carts come to rest after traveling a distance of 1.0 m.

(c) Using the work-energy theorem determine the magnitude and direction of the force applied to the cart.

(d) How long did it take for the stuck together masses to stop?

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

A 1000 kg elevator accelerates upward at 1.0 m/s^2 for 10 m starting from rest.

(a) Draw a force diagram identifying all forces acting on the elevator. Explain which forces are doing work on the elevator including the sign (+/-).
No calculations are necessary, but words with equations may help.

(b) Determine the tension in the elevator cable.

(cs) Determine the work done by non-conservative force(s).

(d) What is the speed of the elevator when it reaches 10 m?
You may use either work-energy or kinematics to find the answer.

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

Extremely bored during break, you decide to attach a rubber band to the end of your calculator. When hanging vertically, the calculator has a mass of 0.50 kg and the rubber band stretches a distance of 10 cm from its original length.

(a) Assuming the rubber band obeys Hooke's Law, what is the value for the spring constant for the rubber band?

You displace the calculator and watch it oscillate with an amplitude of 5.0 cm.
(b) Where is the acceleration a maximum and where is the velocity a maximum? Explain your answer with words and possibly pictures/equations.

(c) What is the frequency of oscillation for this system?

(d) What is the speed of the system when the calculator is at a position equal to half of its amplitude?

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

We'll now take some physical insight from Mr. Chuck Norris.

(a) When Chuck Norris does a pushup, he isn't lifting himself up, he's pushing the Earth down. If he pushes with an average force of 100 N over a time of 0.10 second, what impulse does the earth experience?

(b) Some kids play kick the can. Chuck Norris played kick the keg. If the velocity of the keg is 200 m/s at an angle of 45.0º above the horizontal, what is the maximum altitude that the keg reaches?

(c) If tapped, a Chuck Norris roundhouse kick could power the country of Australia for 44 minutes. If the average power usage of Australia is 3.00×10^{15} Watts, what is the average energy in the kick? Assume all of the energy from the kick goes into powering the country.

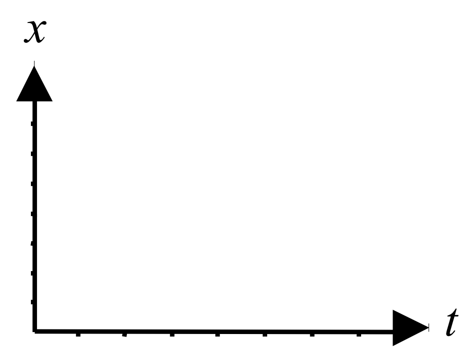
(d) Chuck Norris destroyed the periodic table, because he only recognizes the element of surprise. Assuming this is possible, are mechanical energy and/or momentum conserved in this destruction/collision? Explain/Justify your answer.

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

The engine in your ice sled has failed and you are sliding with a velocity of 10 m/s in the middle of a large icy lake. The mass of entire system (sled + you) is 200 kg, and the sled travels 100 m before coming to rest.

(a) Draw a motion diagram for this situation including the velocity and acceleration vectors and labeled starting and final positions & velocities.

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



(c) Determine the magnitude and direction of the sled's acceleration.

(d) Determine the coefficient of kinetic friction between the sled and ice.