General Physics
Physics 101
Final – Fall 2010
Monday – 12/13/10
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.

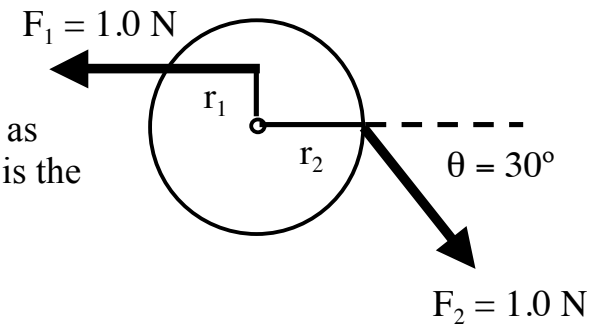
Signature:_____

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. Two forces, both 1.0 N, are applied to the disk as shown, with the $r_1 = 1.0$ m and $r_2 = 2.0$ m. What is the net torque on the disk?

(a) 0.0 Nm
(b) 3.0 Nm
(c) -3.0 Nm
(d) -1.0 Nm

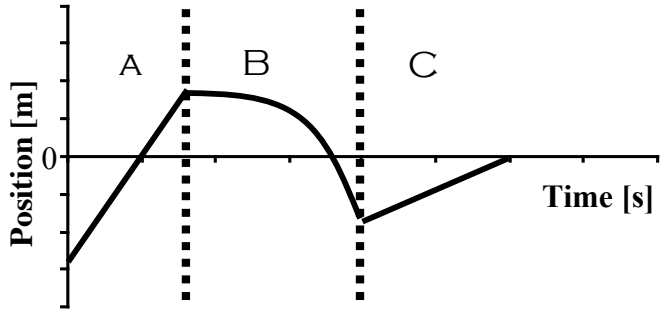
2. A person swings on a swing. When the person sits still on the seat, the swing oscillates back and forth at its own natural frequency. If, instead, two people sit still on the seat of the swing, what happens t the natural frequency of the swing?

(a) The frequency increases.
(b) The frequency decreases.
(c) The frequency does not change.
(d) It is impossible to determine.

3. The Moon revolves around the Earth in 27.3 days in a nearly circular orbit with a radius of 3.8×10^5 km. Assuming that the Moon's orbital motion is a uniform circular motion, what is the Moon's acceleration as it "falls" towards the Earth?

(a) 2.7×10^{-3} m/s^2
(b) 1.0 m/s^2
(c) 2.7 m/s^2
(d) 1.0×10^3 m/s^2

4. For the following position vs. time graph, what is true.



(a) The cart has a negative then positive velocity in A.
(b) The velocity in A is less than the velocity in C.
(c) The velocity in B is negative and increasing.
(d) The total displacement is zero for this motion.

5. The volume of a cylinder is given as 3.34 m^3.
Express this volume in cubic inches.

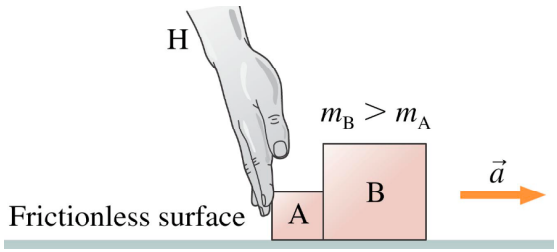
(a) 203740 in^3
(b) 2.04 x 10^5 in^3
(c) 5.48 x 10^{-5} in^3
(d) 131 in^3

6. Two solid discs roll from rest down an incline with Cylinder A has twice the radius but half the mass of cylinder B. Which cylinder reaches the bottom of the incline first?

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

7. A 2.0 kg car collides with a 1.0 kg stationary car and they travel together after the collision at 2.0 m/s. What is the velocity of the 2.0 kg car initially?

(a) 6.0 m/s
(b) 1.0 m/s
(c) 2.0 m/s
(d) 3.0 m/s



8. Two blocks with masses m_A=5.0 kg and m_B = 10.0 kg are pushed on a frictionless surface with a force of 15.0 N as shown. Determine the force (mag & dir) of mass B on mass A.

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

9. A mass spring system is in simple harmonic motion in the horizontal direction. If the mass is 0.25 kg, the spring constant is 12 N/m, and the amplitude is 15 cm, what would be the speed of the mass at a half-amplitude position?

(a) 0.52 m/s
(b) 0.81 m/s
(c) 0.90 m/s
(d) 1.0 m/s

10. 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 ramp with an equal and opposite force to the ramp pushing on the cart.

11. A 12-cm diameter CD has a mass of 21 g. What is the CD's moment of inertia for rotation about a perpendicular axis through the edge of the disk?

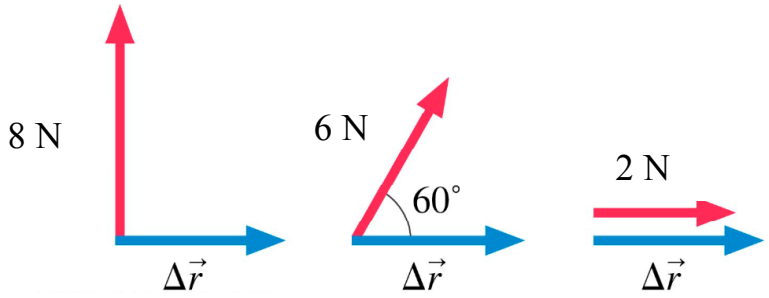
(a) 3.8×10^{-5} kg m^2
(b) 1.5×10^{-4} kg m^2
(c) 4.5×10^{-4} kg m^2
(d) 1.1×10^{-4} kg m^2

12. A child on a scooter is traveling to the left at a speed of 4.0 m/s and experiences an acceleration to the right of magnitude 2.0 m/s^2. What is the velocity of the scooter after the child travels a distance of 1 m?

(a) -3 m/s
(b) -2.23 m/s
(c) 4.47 m/s
(d) 3.46 m/s

13. Which force does the most work?

(a) 8 N
(b) 6 N
(c) 2 N
(d) They all do the same amount.



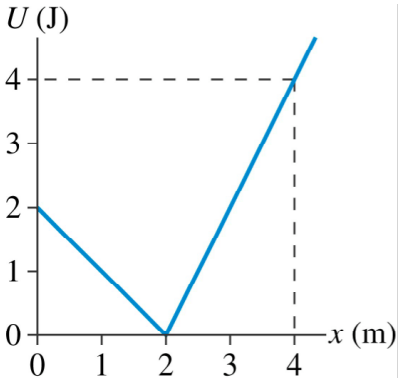
14. You push a 10 kg box across a room by applying a 5.0 N force, which is parallel to the floor. This force causes the box to move across the room with a constant velocity. What is the coefficient of kinetic friction between the floor and the box? Draw a picture if it helps.

(a) $\mu_k = 0.04$ N
(b) $\mu_k = 0.05$
(c) $\mu_k = 19.6$
(d) $\mu_k = 0.05$ N

15. A 1.5 kg box is sliding on a frictionless surface with a speed of 12 m/s approaches a horizontal spring. If the spring has a spring constant of 2000 N/m, how far will the spring be compressed in stopping the box?

(a) 0.94 m
(b) 0.33 m
(c) 0.28 m
(d) 0.11 m

16. A particle moves along the x-axis with potential energy shown. The x-component of the force on the particle when it is at x=4 m is?

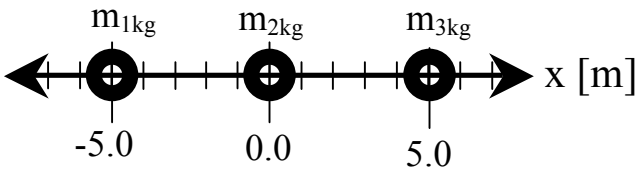


(a) 8.0 N
(b) 1.0 N
(c) -1.0 N
(d) -2.0 N

17. A 50 g red marble moving at 2.0 m/s strikes a 20 g blue marble at rest. What is the speed of the blue marble immediately after the elastic collision?

(a) 2.9 m/s
(b) 1.1 m/s
(c) 1.4 m/s
(d) 0.86 m/s

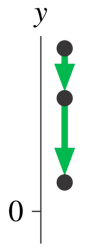
18. Three particles of mass 1.0 kg, 2.0 kg and 3.0 kg are located as shown.



Calculate the location of the center of mass for the system.

(a) 0.0 m
(b) 1.7 m
(c) -3.3 m
(d) 3.3 m

19. For the following diagram, what is false.



(a) Velocity is increasing
(b) Acceleration is negative
(c) Velocity is negative
(d) Position is negative

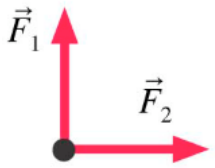
20. A certain amount of work W is required to accelerate a car from rest to a speed v. How much work is required to accelerate the car from rest to a speed v/2?

(a) $\sqrt{2}$ W
(b) W/2
(c) W/4
(d) W/8

21. A horizontal mass-spring system of mass 2.00 kg oscillates with a frequency of 1.00 Hz and amplitude of 0.500 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) v(t) = -(3.14 m/s) sin (2.00 π t)
(c) x(t) = (2.0 m) cos (2.00 π t)
(d) a(t) = -(1.57 m/s^2) cos (1.00 t)

22. 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

23. A horizontal spring with spring constant 100 N/m is compressed 20 cm and used to launch a 2.5 kg box across a frictionless, horizontal surface. After the box travels some distance, the surface becomes rough. The coefficient of kinetic friction of the box on the surface is 0.15. Use work and energy to find how far the box slides across the rough surface before stopping.

(a) 0.54 m
(b) 0.27 m
(c) 0.081 m
(d) 0.036 m

24. 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 rock 2.00 m above the ground, with what minimum speed must you throw it?

(a) 10.5 m/s
(b) 17.0 m/s
(c) 17.7 m/s
(d) 17.3 m/s

25. A projectile is fired into the air and has initial velocity components of v_x=1.0 m/s and v_y=4.9 m/s. Determine the time it takes to reach its maximum vertical distance (altitude)?

(a) 0.50 s
(b) 1.2 s
(c) 2.0 s
(d) 0.10 s

26. A block pushed along the floor with velocity of 5.0 m/s slides a distance of 5.0 m after the pushing force is removed. What is the acceleration of the mass after the push?

(a) -13 m/s^2
(b) -5.0 m/s^2
(c) -2.5 m/s^2
(d) -0.50 m/s^2

27. You (70 kg) are riding a 30 m diameter Ferris wheel at an amusement park, which spins with a constant angular velocity of 0.25 rad/s. If the seats in the Ferris wheel remain upright during the ride, what is the magnitude of the normal force acting on you when you are at the top of the Ferris wheel?

(a) 5.5 x 10^2 N
(b) 7.5 x 10^2 N
(c) 6.2 x 10^2 N
(d) 6.9 x 10^2 N

28. A person attempts to knock down a large wooden bowling pin by throwing a ball at it. The person has two balls of equal size and mass, one made of rubber and the other of putty. The rubber ball bounces back, while the ball of putty sticks to the pin. Which ball is most likely to topple the bowling pin?

(a) the rubber ball.
(b) the ball of putty.
(c) makes no difference.
(d) need more information.

29. A 2.0 kg hoop of radius 1.0 m is spinning with an angular velocity of 2.0 rpm, what torque is necessary to stop the rotation of the hoop in 2.0 seconds?

(a) 2.0 Nm
(b) 0.21 Nm
(c) -0.21 Nm
(d) -20 Nm

30. If the spring constant of a mass-spring system is halved, the new period of oscillation is

(a) $\sqrt{2}$ times the original period.
(b) 2 times the original period
(c) 1/2 times the original period.
(d) $1/\sqrt{2}$ times the original period.

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 father and son are playing with a merry-go-round (MGR). The MGR is essentially a solid cylinder with a radius of 2.00 m and mass of 100 kg.

The father spins the MGR from rest by running along side it through an angle of 90º while applying a constant torque of 200 Nm. The father then releases the MGR and it spins freely (ignore friction).

(a) What is the angular acceleration of the MGR during the push?

(b) What is the angular velocity of the MGR immediately after the push?

The father now gently places his 25 kg son on the edge of the rotating MGR.

(c) What is the total moment of inertia of the MGR + son system?

(d) Using words and possibly equations (no numbers), describe what happens to the angular velocity of the merry-go-round after the boy is placed on the MGR.

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

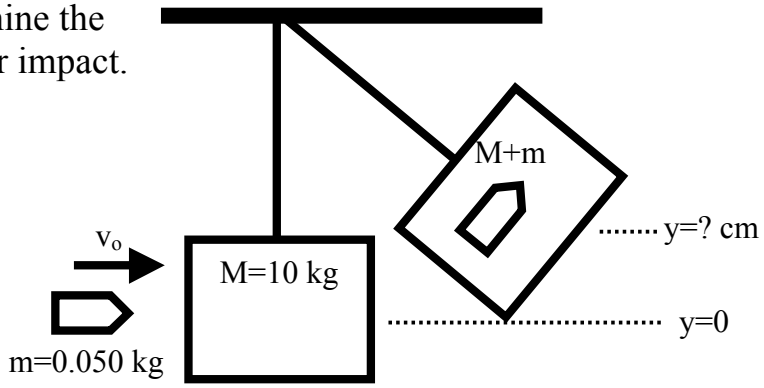
A 0.050 kg bullet is shot horizontally into a piece of 10 kg wood. Before the collision, the bullet travels with a velocity of 200 m/s and the block is stationary.

In the 1st experiment the bullet hits the block, and slows uniformly to a stop while penetrating a distance of 0.50 m into the block and the block does not move.

(a) What was the force exerted on the bullet in bringing it to rest?

In the 2nd experiment, you attach the block to a string, and hang it from the ceiling, as shown. The bullet is horizontally fired into the block, which is initially motionless. After impact the pendulum (block and bullet) swings to an unknown height.

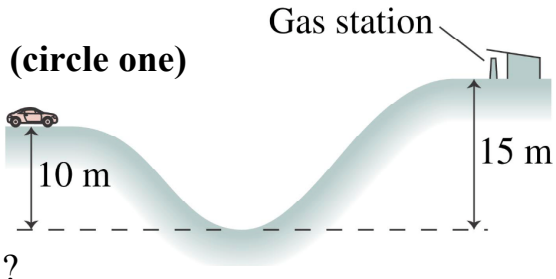
(b) Using momentum conservation, determine the velocity of the pendulum immediately after impact.



(c) Using energy conservation, determine the height to which the pendulum swings.

(d) Following the impact the pendulum swings back and forth. If you were to repeat this experiment and double the amplitude of oscillation, would the oscillation period always be the same? Explain your answer with words and possibly an equation.

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



A 1500 kg car traveling at 10 m/s suddenly runs out of gas while approaching the valley shown. Ignore Friction for (a) – (c).

(a) What is the speed of the car at the bottom of the hill?

(b) Discuss the normal force acting on the car at the bottom of the hill, and whether it is greater than or less than the weight of the car. Words are necessary in your answer, and calculations and a force diagram could help but are not required.

(c) What will be the car's kinetic energy as it coasts into the gas station on the other side of the valley?

(d) Assuming the car arrived at the station. The driver applies the cars brakes, what is the work done on the car to make it come to rest?

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

You've been chosen to be on the first NASA mission to Mars as the oscillations specialist. Before you left earth, you performed some experiments/predictions.

(a) Your mass-spring system has a mass of 4.0 kg and frequency of 2.0 Hz on earth. What is the spring constant?

Time passes and you make it to Mars.
(b) If your pendulum had a period of 1.50 s on earth and now has a period of 2.45 s, what is the value of "g" (acceleration due to gravity) on mars?

(c) How will the period of the mass spring system change once you are on Mars? Explain your answer with words. Equations and calculations could help.

(d) If the amplitude of oscillation is 5.0 cm, what is the maximum speed of the mass spring system and where does this occur?

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

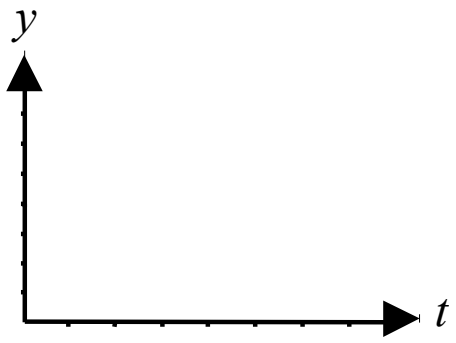
It's a snowball fight. You have barricaded yourself at the front door of your house, and your friends are 6.0 m away, you lob a snowball towards your friends and it lands 2.0 seconds later. Assume the initial and final altitude are equal.

(a) What is the initial vertical velocity of the snowball?

(b) How high did the snowball travel?

Sneak attack. Your mother let your friends in the back door and they took snow to the second floor, and dumped it out the window on to you.
(c) If the snow started from rest, what is the velocity of the snow when it reaches you after falling through a distance of 3.0 m?

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



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

A 10 kg steel block sits on a long steel table. You push the block across the table at a steady 0.50 m/s speed covering a distance of 1.5 m in 3.0 seconds.

(a) What is force of friction (mag + dir) acting upon the block?

(b) What is the work done by friction as the block moves across the table?

(c) What is the net work done on the block as it moves across the table? Words are necessary to justify your answer.

(d) What is the power used by you as you push the block across the table?