General Physics
Physics 101
Test #4 – Fall 2020
Friday 11/20/20
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:

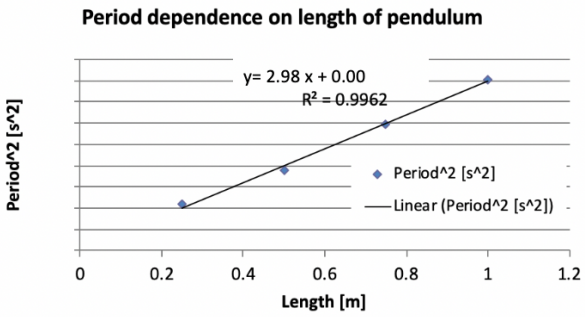
Please clearly circle one and only one answer for each of the following.
Show all of your work. Partial credit may be given if you include your work.

Questions:

1. A 1.0 kg toy car to the left traveling at 1.0 m/s approaches a 2.0 kg toy car traveling to the right at 2.0 m/s. Assuming they collide elastically, what is the speed of the 2.0 kg car post-collision?

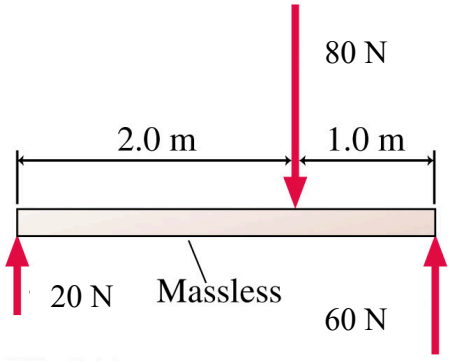
(a) 3.0 m/s
(b) 1.3 m/s
(c) 1.0 m/s
(d) 0.0 m/s

2. Students on planet CV-19 measured the period of a pendulum for different lengths, and created a graph of period squared versus length. Using the slope of the graph calculate the acceleration due to gravity on planet CV-19.



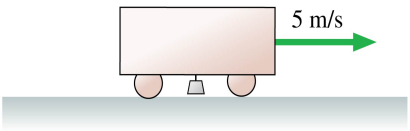
(a) 13.2 m/s^2
(b) 6.62 m/s^2
(c) 4.21 m/s^2
(d) 39.4 m/s

3. The massless beam shown can rotate about its left end. What is the net outcome of the applied forces?



(a) Rotates CW
(b) Rotates CCW
(c) Does not rotate but translates.
(d) Is in equilibrium.

4. A cart is rolling at 5 m/s. A heavy lead weight is suspended by a thread beneath the cart. Suddenly the thread breaks and the weight falls. Immediately afterward, the speed of the cart is…



(a) More than 5 m/s
(b) Still 5 m/s
(c) Less than 5 m/s
(d) Not possible to determine with the information given.

5. A horizontal mass-spring system with a mass of 1.00 kg has an equation of motion of $x(t) = (3.14\ m) \sin (2.00\ t)$. What is the total energy of the system?

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

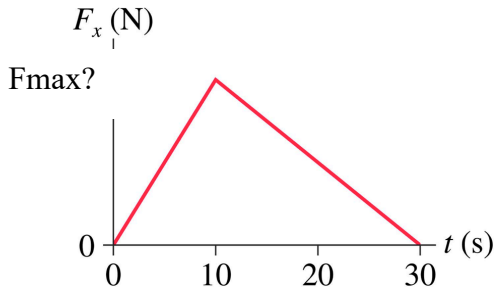
6. A 2.0 kg block oscillates on the end of a large spring (100 N/m) and has a speed of 0.50 m/s when it is at a location of 0.25 m from equilibrium. What is the amplitude of oscillation for this system?

(a) 20 cm
(b) 3.5 m
(c) 26 cm
(d) 4.0 m

7. 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?

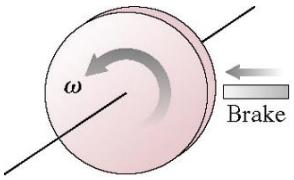
(a) 0.25 kg m^2
(b) 0.33 kg m^2
(c) 0.66 kg m^2
(d) 1.0 kg m^2

8. Far in space, where gravity is negligible, a 425 kg rocket traveling at 75 m/s fires its engines and experiences a 1.5×10^4 Ns impulse. The graphs shows the force the rocket experiences as a function of a time. Assume the mass of the ship is constant. Calculate the maximum thrust force.



(a) 1000 N
(b) 2.0 x 10^3 N
(c) 5.0 x 10^2 N
(d) 1.0 kN

9. The 3.50 kg, 30.0-cm-diameter disk in the figure is spinning at 33.5 rad/s. How much friction force must the brake apply to the rim to bring the disk to a halt in 2.00 s ?



(a) 0.660 N
(b) 17.6 N
(c) 8.80 N
(d) 4.40 N

10. Which of the following statements is true?

(a) When moving in uniform circular motion, the momentum is not constant.

(b) When walking forward from rest, your change in momentum is greater than the change in momentum of the earth.

(c) If you double the radius of a sphere, the moment of inertia increases by a factor of 4.

(d) The period of a pendulum never depends on amplitude.

11. A hoop and a solid disc of the same radius and mass roll from rest down an incline. Which reaches the bottom of the incline first?

(a) The hoop
(b) The solid disc
(c) Both reach the bottom at the same time.
(d) Need more information.

12. An object moves with simple harmonic motion. If the amplitude and the period are both doubled, the object's maximum acceleration is:

(a) Quadrupled
(b) Doubled
(c) Halved
(d) Unchanged

Part II. Short answer problems (12 pts each)

Instructions:

Solve three of the following four problems. If you try to solve all four 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 and three.

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 flywheel with a diameter of 1.5 m is used to store energy. It is spinning with a constant angular speed of 126 rad/s ccw and kinetic energy of 5.55×10^5 J. Ignore bearing friction.

(a) What is the moment of inertia of the flywheel?

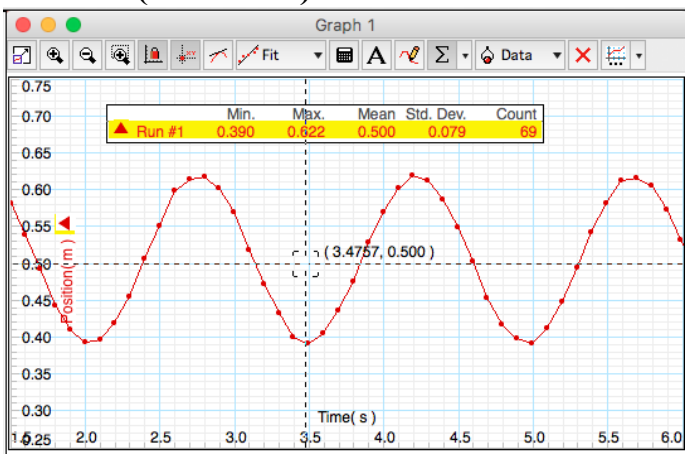
(b) The spinning wheel is connected to a machine, which slows the flywheel to 88 rad/s in 2.0 seconds. What is the torque applied to the flywheel as it slows?

(c) What happens to the angular momentum of the machine, flywheel and system as the torque in (b) occurs? Words, equations and theory are required, but no additional calculations. Assume the system is friction free, has no external torques and machine's inertia is constant (the lies get worse as the system rotates)

(d) How much power does the flywheel use as it slows from the torque in (b)?

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

In the last lab, you took the following data for the position vs time of a 500 g mass oscillating on a spring.



(a) On the graph circle where the magnitude of the velocity is a maximum,
Explain why this is the case using theory.

(b) Write an equation of motion for the position as a function of time.
No phase constant is required.

(c) What is the spring constant?

(d) What is the speed of the mass at a position of 0.55 m?

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

A 2.50 kg coconut is traveling to the east at 5.00 m/s. It explodes and splits into two pieces (1.50 kg and 1.00 kg) and the 1.50 kg piece travels to the north at 2.50 m/s.

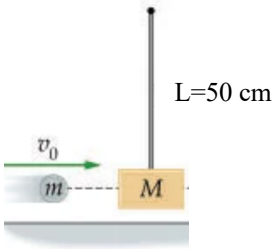
(a) In this explosion are momentum and/or kinetic energy conserved? Explain your answer using words, and be sure to address both momentum and kinetic energy.

(b) What is the x-velocity of the 1.00 kg piece of the coconut post explosion?

(c) What is the y-momentum of the 1.00 kg piece of the coconut post explosion?

(d) What is the velocity (mag and dir) of the 1.00 kg piece of coconut post explosion?

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



A 20 g ball is fired horizontally with a speed v_o towards a 100 g mass hanging motionless from a 50 cm long string.

(a) If the ball undergoes a head-on inelastic collision and the system travels off at 5.0 m/s, what is v_o?

(b) With no further calculations explain/justify whether the magnitude of the impulse experienced by the 20 g ball is greater than, the same as, or less than the 100 g mass. Be sure to use words in your response.

(c) During the collision, the torque applied to the mass is 1.0 kNm for 10 ms, what is the change in angular momentum of the mass?

(d) The system now moves as a pendulum and oscillates back and forth. What is the frequency of oscillation?