General Physics
Physics 101
Final – Spring 2019
Tuesday – 5/14/19
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:

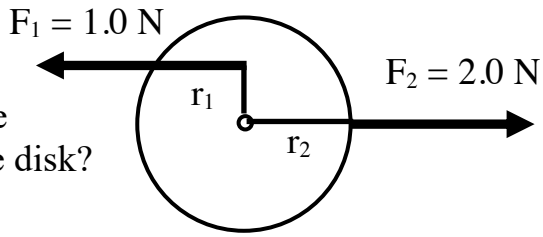
Please clearly circle one and only one answer for each of the following.
Show all of your work. Partial credit may be given if you include your work.

Questions:

1. A gas cylinder contains O_2 at 150ºC, a pressure of 3.0 atm and a volume of 1.16 x10^{-3} m^3. The gas expands adiabatically until the pressure is halved. What is the final volume?

(a) 0.77 x10^{-3} m^3
(b) 2.3 x10^{-3} m^3
(c) 1.8 x10^{-3} m^3
(d) 0.71 x10^{-3} m^3

2. Two forces 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?

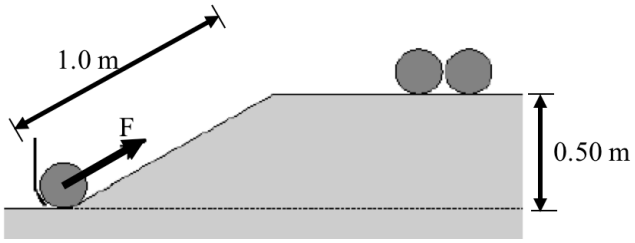


(a) 0.0 Nm
(b) 3.0 Nm
(c) 1.0 Nm
(d) -3.0 Nm

3. A mass-spring system (m=2.00 kg) oscillates with a 2.0 Hz frequency and a 0.25 m amplitude. Which of the following could be an equation of motion for the system? Units inside sine/cosine are suppressed.

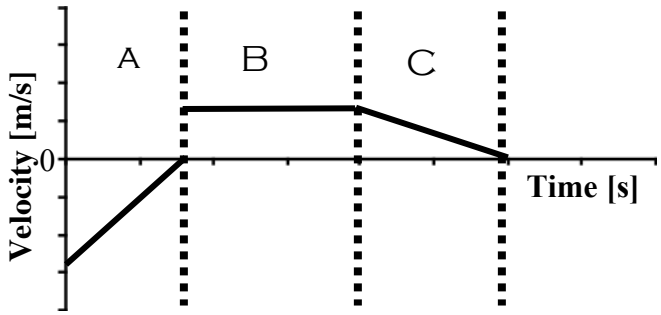
(a) v(t) = (0.25 m) cos (4.0 π t)
(b) a(t) = -(9.9 m/s^2) cos (4.0 t)
(c) v(t) = -(3.1 m/s) sin (4.0 π t)
(d) x(t) = (0.25 m) cos (2.0 t)

4. At the bowling alley, the ball-feeder mechanism 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) 200 N
(b) 50 N
(c) 25 N
(d) 10 N

5. For the following velocity vs. time graph, which statement is false?



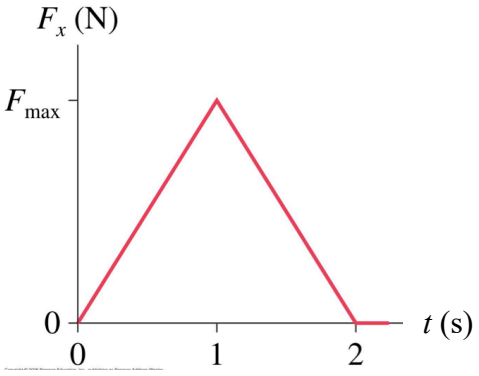
(a) The velocity in B is zero.

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

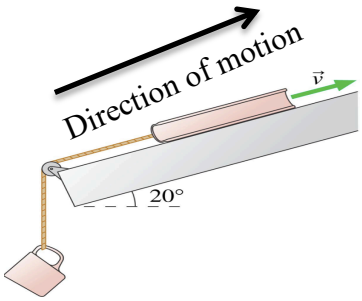
(c) The object has a negative decreasing velocity in A.

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

6. A 500 g particle moving along the x-axis experiences the force shown. If the particle goes from $v_x = 2.0$ m/s at $t = 0$ s to $v_x = 6.0$ m/s at $t = 2.0$ s, what is F_{max}?



(a) 2.0 kg m/s^2
(b) 4.0 J/m
(c) 8.0 N
(d) 1.0 N



7. The physics book (m_b = 1.0 kg) shown is connected by a string to a coffee cup (m_c=500g). The book is given a push up the slope and released with a speed, v, and experiences an acceleration, a. Which of the following net force equations is true?

(a) $\sum F_c = m_c a = -T + m_c g$

(b) $\sum F_{b\parallel} = m_b a = m_b g \sin\theta - T - f_{k,b}$

(c) $\sum F_{b\perp} = m_b a = n - m_c g \cos\theta$

(d) $\sum F_{tot} = m_{tot} a = -m_c g - F_{g\parallel,\, b} - f_{k,b}$

8. I'm gonna take my horse to the old town road. I'm gonna ride 'til I can't no more. The road starts by running west for 20 mi and then heads 10 mi north. Finally, the road travels in a vector like fashion $(10\hat{\imath} + 20\hat{\jmath})$ mi 'til I can't no more. What is your total displacement during this journey?

(a) $(-10\hat{\imath} + 30\hat{\jmath})$
(b) (30 mi E, 30 mi N)
(c) 30 mi to the North, 10 mi to the West
(d) $(-20\hat{\imath} + 0\hat{\jmath})$ mi

9. Two carts are put back-to-back on a track. Cart A (300 g) has a spring-loaded piston; Cart B (600 g) is entirely passive. When the piston is released, it pushes against cart B. After the release cart B is traveling at 3.0 m/s. The speed of cart A post release is _____ the speed of Cart B.

(a) greater than
(b) less than
(c) equal to
(d) not possible to tell

10. Henry (94.9 kg) stands on a bathroom scale in an elevator. For the first three seconds after the elevator starts moving, the scale reads 830 N. What is the acceleration of the elevator?

(a) -1.05 m/s^2
(b) 18.2 m/s^2
(c) -9.8 m/s^2
(d) -8.75 m/s

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

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

12. A 4000 kg truck is parked on a 15º slope and the coefficient of static friction between the tires and the road is 0.90. How big is the friction force on the truck?

(a) 34078 N
(b) 3.8×10^4 N
(c) 3.4×10^4 N
(d) 10 kN

13. A cylinder contains 10 g of Helium (4 g/mol). How much work is required to compress the gas at a constant temperature of 80ºC until the volume is half of its original value?

(a) 1.2×10^3 J
(b) 2.0×10^4 J
(c) 5.1×10^3 J
(d) 8.1×10^4 J

14. You have two solid steel spheres. Sphere two has three times the radius of sphere one. By what factor does the moment of inertia of sphere two exceed the moment of inertia of sphere one?

(a) 9
(b) 32
(c) 81
(d) 243

15. Ball A is released from rest 2.0 m above a flat, horizontal surface. At exactly the same instant, Ball B with the same mass is fired horizontally at 3.0 m/s also from 2.0 m. Which ball hits the ground first?

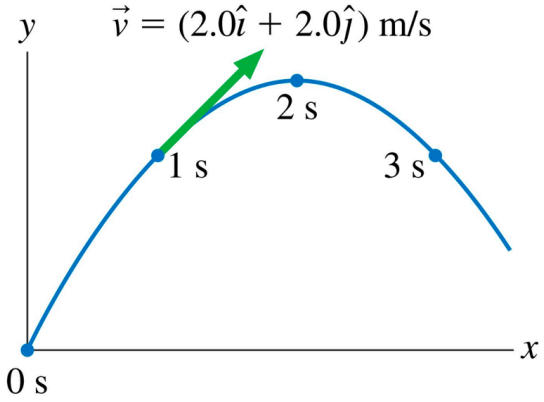
(a) A
(b) B
(c) both at the same time
(d) impossible to determine with the information given

16. To melt 0.25 kg of ice at 0.0 ºC, how much heat energy must be added to make water at 20 ºC?

(a) 2.1×10^4 J
(b) 6.2×10^5 J
(c) 5.9×10^5 J
(d) 1.0×10^5 J

17. A space station is constructed as a 1000-m-diameter rotating cylinder that rotates about its axis. To create artificial gravity on the outer deck, what rotation period will provide an acceleration equivalent to “normal” gravity?

(a) 70 s
(b) 45 s
(c) 64 s
(d) 0.090 s



18. A physics student on the planet Exidor throws a ball, and it follows the parabolic trajectory shown. The velocity vector for t=1 second is also shown. From this information, what is the launch velocity?

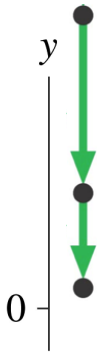
(a) $\vec{v} = (2.0\hat{i} + 2.8\hat{j})\, m/s$
(b) $\vec{v} = (4.0\hat{i} + 2.0\hat{j})\, m/s$
(c) $\vec{v} = 2.8\, m/s^2$
(d) $\vec{v} = (2.0\hat{i} + 4.0\hat{j})\, m/s$

19. A vat has a volume of 100 x 10^1 cm^3. What is the SI equivalent value for this volume?

(a) 0.0001 m^3
(b) 1.00 x 10^{-3} m^3
(c) 100 m^3
(d) 1.00 x 10^{-4} m^3

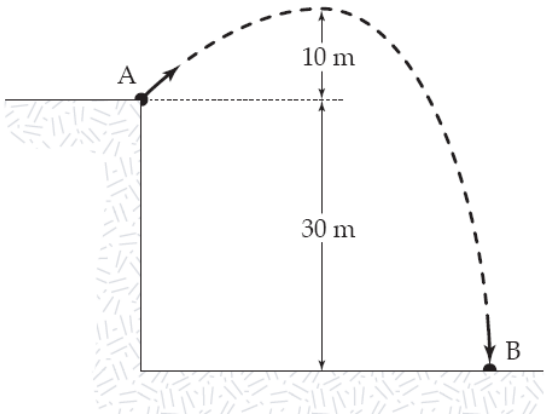
20. If you lift a light block (m=1.0 kg) from the floor to a 2.0 m high shelf with a constant acceleration of 1.0 m/s^2, what is the total work done on the block?

(a) 1.0 N
(b) 9.8 Nm
(c) 20 J
(d) 2.0 Nm



21. For the following diagram, what is true?

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



22. A 40 g ball is thrown from a 30-m tall building (point A) at an unknown angle above the horizontal. As shown, the ball attains a maximum height of 10 m above the top of the building before striking the ground at point B. If air resistance is negligible, what is the change in kinetic energy of the ball at B compared to that at the launch?

(a) 12 Nm
(b) – 12 J
(c) 16 kg m^2/s^2
(d) -16 J

23. A ball is spun in a vertical circle with constant angular velocity, as the ball spins in the circle, which of the following forces change magnitude?

(a) Net Force
(b) Tension Force
(c) Force of Gravity
(d) Centripetal Force

24. You launch a ball of mud vertically upward and it hits the ceiling 0.500 seconds later. What is the launch velocity of the ball, if the distance from launch to the ceiling is 100 in?

(a) 8 m/s
(b) 7.53 m/s
(c) 200 m/s
(d) 2.63 m/s

25. A drill is spinning counter-clockwise at 20 rad/s slows to 10 rad/s and makes 20 complete revolutions. What is the angular acceleration of the drill?

(a) -1.2 rad/s^2
(b) - 2.0 rad/s^2
(c) 2.4 rev/s^2
(d) 7.5 m/s^2

26. 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) 2.0×10^5 N/m
(c) 2.0×10^4 N/m
(d) 1.6×10^5 N/m

27. A 500 kg m^2 flywheel with a diameter of 1.5 m is used to store energy. By applying a constant 50 Nm torque the wheel spins slowly from rest. Ignoring bearing friction, how long did it take the flywheel to spin-up to its maximum counter-clockwise angular velocity of 125 rad/s?

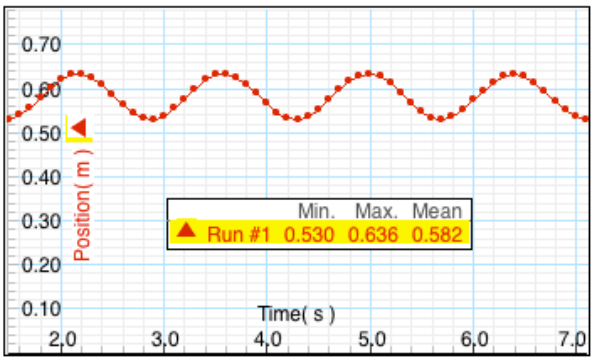
(a) 1.25×10^3 s
(b) 0.80 ms
(c) 12.5 s
(d) Need more information

28. A space station orbits 300 km above the surface of the earth. What is the gravitational force on a 2.0 kg sphere inside the space station?

(a) 20 N
(b) 9.0 N
(c) 8.9 kN
(d) 18 N

29. Biff (75 kg) and Jesup (150 kg) are wrestling on an icy pond, which we can assume to be friction free. They are at a standstill and Biff unexpectedly pushes Jesup with a force of 1.5 kN. If the push takes 0.10 second, what is the magnitude of the acceleration of Biff?

(a) 20 m/s^2
(b) 10 m/s^2
(c) 0.0 m/s^2
(d) Need more information



30. In the last lab, you took the following data for the position vs time of a 0.50 kg mass oscillating on a spring. What is the spring constant?

(a) 23 N/m
(b) 12 N/m
(c) 5.9 N/m
(d) 3.7 N/m

31. A 5000 kg open train car is rolling on frictionless horizontal rails at 20 m/s to the right when it approaches a second train car of equal mass that is traveling at 10 m/s to the left. If the train cars stick together after the collision, what is the speed of the combined system post collision?

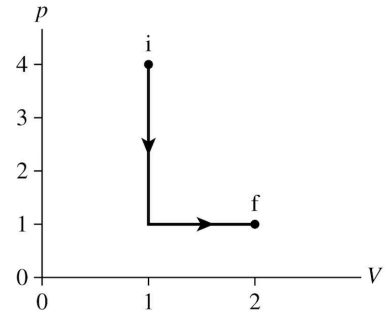
(a) 20 m/s
(b) 15 m/s
(c) 10 m/s
(d) 5.0 m/s

32. 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) $4v$
(c) $\frac{1}{4}v$
(d) $\sqrt{2}v$

33. On a loading dock, a 10 kg box is launched up a long ramp with an initial velocity of 10 m/s. What is the velocity of the box when it has traveled a vertical distance of 3.0 m? The angle of the ramp is 30° and assume there is no friction.

(a) 6.4 m/s
(b) 7.7 m/s
(c) 13 m/s
(d) The box never makes it to the top of the ramp



34. For the following processes, what is the ratio of T_f/T_i?

(a) 1/4
(b) 1/2
(c) 1/1 (no change)
(d) 2/1

35. 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 equal
(d) need more information

36. Which of the following statements is false?

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

(b) At the maximum altitude of projectile motion, the kinetic energy is always zero.

(c) In uniform circular motion the acceleration is non-zero.

(d) The friction force does not always point in the opposite direction of motion.

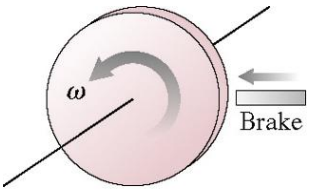
Part II. Short answer problems (12 pts each)

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)



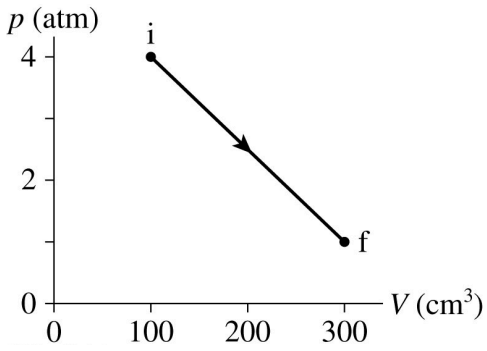
A 3.50 kg, 30.0-cm diameter disk is spinning at 33.5 rad/s.

(a) What is the angular acceleration of the disk if it comes to a halt in 2.0 seconds as the brake is applied?

(b) How much friction force must the brake apply to the rim to bring the disk to a halt in 2.00 s?

(c) How much power is dissipated during the braking?

(d) If you apply the same force to a cylinder that is twice the diameter as this one but the same mass, does the angular acceleration increase, decrease or stay the same? No calculations are necessary, but equations will help along with words.



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

The figure shows a thermodynamic process followed by 0.015 mol of hydrogen (H_2).

(a) What is the initial temperature of the gas?

(b) What is the work done on gas?

(c) If the change in thermal energy is -15.2 J, how much heat is transferred to the gas?

(d) If the gas is changed from hydrogen (H_2) to argon (Ar) with the same number of mols and the argon gas undergoes the same thermodynamic process. Would the change in thermal energy be larger, smaller or the same for the argon in comparison to the hydrogen? No calculations are necessary, but words and equations are required.

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

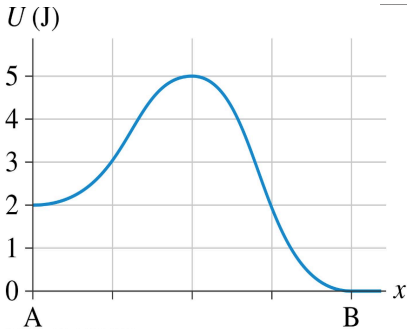
A horizontal mass-spring system oscillates on a frictionless table. Its velocity is 20 cm/s when it is located at a position of -5.0 cm from equilibrium. The mass is 0.10 kg and the spring constant is 2.5 N/m.

(a) What is the angular frequency for this system?

(b) What is the amplitude of oscillation?

(c) Where is the potential energy a maximum and where is the kinetic energy a maximum? Explain your answer with words and possibly pictures/equations.

(d) What is the speed of the ball when it is located at a position of 3.0 cm from equilibrium?



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

A 200 g mass glides over a friction free track and experiences the potential energy versus position graph shown.

(a) What is the minimum kinetic energy needed at point A to reach point B?

(b) What is the velocity of the particle when it reaches point B?

At point B the 200g particle collides elastically with a 100 g particle traveling in the opposite direction as the 200 g particle with a speed of 1.0 m/s. Assume all 1D.
(c) What is the velocity of the 100 g particle after the collision?

(d) The 100g particle now goes through a vertical loop-da-loop (not shown on graph) that has a diameter of 1.0 m. At the top of the loop the particle is twice the critical speed, what is the centripetal force acting upon the particle at the top of the loop?

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

Morgan launches a 50 g rock at an angle of 60 degrees above the horizontal. The initial speed is 40 m/s ($20\,\hat{\imath}\,\mathrm{m/s} + 35\,\hat{\jmath}\,\mathrm{m/s}$) and the rock impacts the ground 7.5 s later.

(a) If a slingshot is used to launch the rock and it was pulled back a distance of 10 cm from equilibrium. What is the spring constant of the slingshot? Ignore the effects of gravity.

(b) What maximum vertical altitude above the launch point does the rock reach?

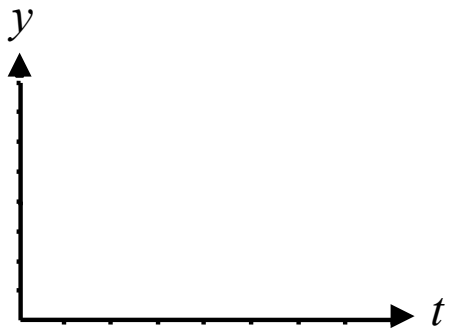
(c) What is the magnitude of the velocity of the rock right before the rock impacts the ground?

(d) Is the landing point higher or lower than the launch point? Explain your answer with words and possibly equation(s)/calculation(s).

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

A 50 g mass attached to a string is lowered from rest by pulling upward on the string.

(a) Sketch a position vs time plot that could represent the motion of the mass as it is lowered Please explain the shape & meaning of the graph.



(b) If it takes 0.20 s to travel 1.0 m, what is the net force on the mass?

(c) What is the change in kinetic energy of the mass?

(d) What is the work done by tension?