General Physics
Physics 101
Final – Spring 2020
Thursday – 5/7/20
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.

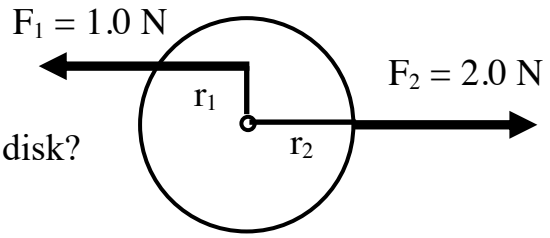
Signature:_____

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:



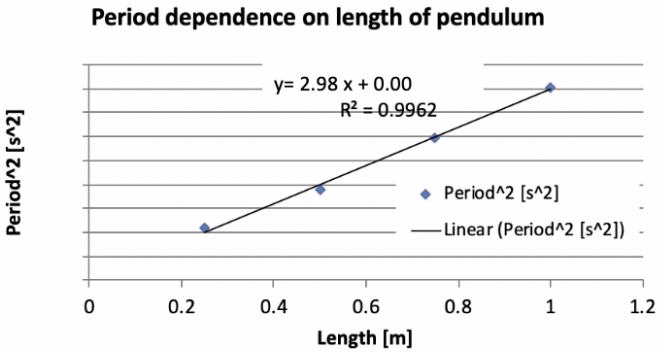
1. Two forces are applied to the disk as shown, with the r_1 = 1.0 m and r_2 = 2.0 m. What is the net torque on the disk?

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

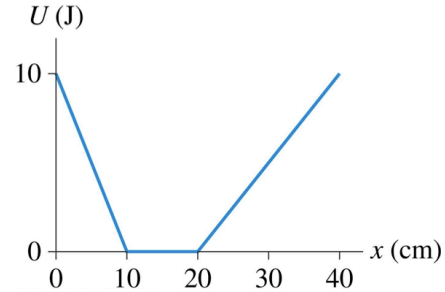
2. A gas cylinder holds O_2 at 150ºC, a pressure of 3.0 atm and a volume of 1.16 x10^{-3} m^3. The gas expands adiabatically until the pressure is halved. What is the final volume?

(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

3. 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

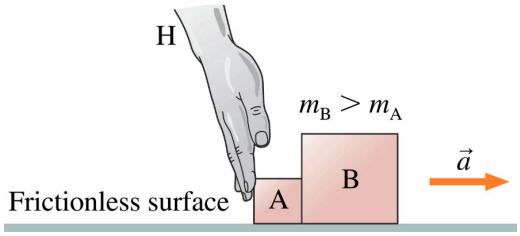


4. A particle has the potential energy shown. What is the x-component of the force on the particle at x=30 cm?

(a) 17 N
(b) -50 kg m/s^2
(c) 100 N
(d) -17 kg m/s

5. A ball is thrown toward a cliff of height h with a speed of 30 m/s and an angle of 60º above the horizontal. It lands on the edge of the cliff 4.0 s later. How high is the cliff?

(a) 182.3 m
(b) 26 m
(c) 42 m
(d) 34 m



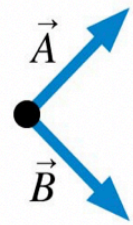
6. Two blocks m_A=5.00 kg and m_B = 10.0 kg are pushed on a frictionless surface with a force of 15.0 N as shown. Determine the net force (mag & dir) acting on mass A.

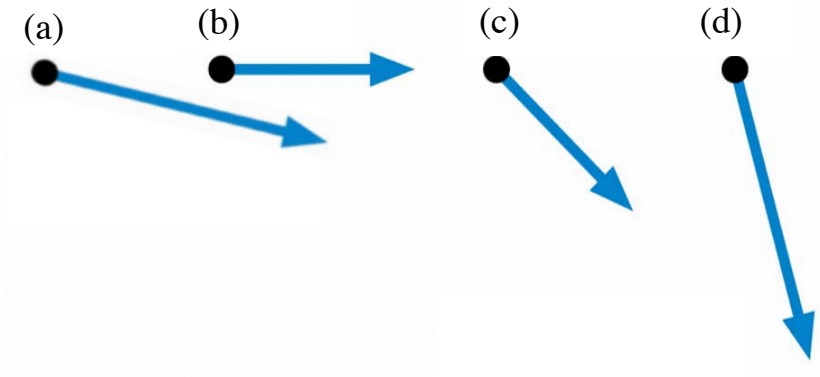
(a) 15.0 N
(b) 5.00 N
(c) 10.0 N
(d) – 5 N

7. 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

8. Which of the vectors could represent $\vec{A}+2\vec{B}$?





9. A spring with spring constant k is compressed by Δx, and launches a block across a horizontal, frictionless surface with a speed v_0. A second identical spring is compressed four times as much (4Δx). If the same block is launched across the frictionless surface, what is the velocity of block following the launch?

(a) $\sqrt{2}v_0$
(b) $2v_0$
(c) $4v_0$
(d) $v_0/\sqrt{2}$

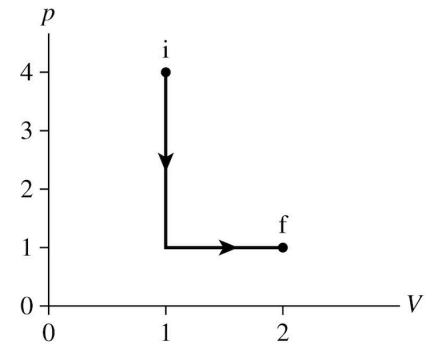
10. Which of the following statements is true?

(a) If two different massed objects sitting on a frictionless surface explode apart, it is possible for them to have the same velocity post explosion.

(b) For an object sitting at rest on the table, the normal force is not the third law pair of the force due to gravity.

(c) A positive work being done on an ideal gas means that the gas was expanded.

(d) The period of a pendulum cannot depend on amplitude.



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

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

12. 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) 0.26 m
(b) 0.20 m
(c) 3.5 m
(d) 4.0 m

13. 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?

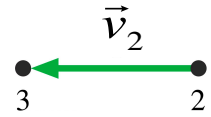
(a) The hoop
(b) The solid disc
(c) Both reach the bottom at the same time.
(d) Need more information.

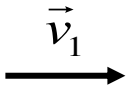
14. A velociraptor spots you 40 meters away and attacks, accelerating at 4.0 m/s^2 up to its top speed of 25 m/s. How far has the velociraptor traveled before it reaches its top speed? I assume you can run fast enough to escape… and that you started running when he spotted you.

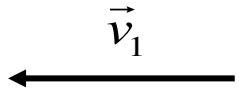
xkcd.com

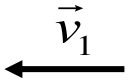
(a) 78 m
(b) 3.1 m
(c) 1.6 x 10^2 m
(d) 40 m

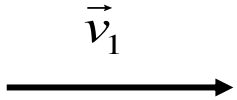
15. The figure shown shows two dots of a motion diagram and vector $\vec{v}_2$. Which of the following is a correct vector $\vec{v}_1$, if the acceleration vector points to the left?



(a) 

(c) 

(b) 

(d) 

16. You have a 10 kg box is sitting in the bed of your truck. The truck traveling at 10 m/s comes to rest in 5.0 s, and the box does not slide. What is the magnitude of the friction force between the bed of the truck and box?

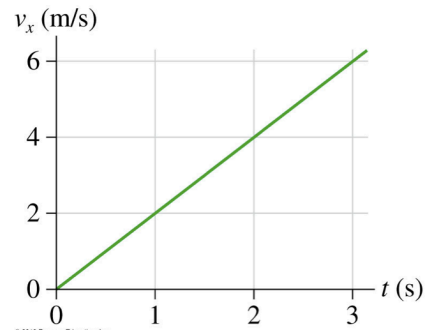
(a) 20 N
(b) 100 N
(c) 2.0 N
(d) Need more information

17. A process occurs in which a system's potential energy increase while the environment does work on the system. Ignoring thermal energy, does the system's kinetic energy…

(a) Increase
(b) Decrease
(c) Stay the same
(d) Not enough information to tell

18. A 3.0 cm diameter drill rotates from rest to an operational angular speed of 1000 rad/s, while it experiences an angular acceleration of 100.0 rad/s^2. What is the total angular distance traveled by the drill during this process?

(a) 5.0×10^3 rad
(b) 5.0 rad
(c) 1.5×10^4 rad
(d) 5000 rad



19. The following velocity versus time graph shows a particle moving along the x-axis. At $t_o = 0.0$s its initial position is $x_o =$ 2.0m at t = 3.0s, what is the particle's potion?

(a) 2.0 m
(b) 9.0 m
(c) 11.0 m
(d) 4.0 m/s^2

20. 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?

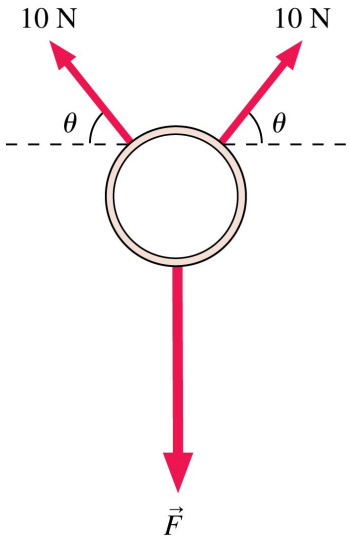
(a) 10 cm
(b) 20 cm
(c) 40 cm
(d) 80 cm

21. A rocket has a motor than can produce 3.0 x 10^5 N of thrust vertically causing it to accelerates at a_y =5.2 m/s^2. Ignoring air resistance, what is the mass of the rocket?

(a) 57692 kg
(b) 6.5 x 10^4 kg
(c) 5.8 x 10^4 kg
(d) 2.0 x 10^4 kg

22. A 1.0 m diameter vat of liquid is 2.0 m deep. The pressure at the bottom of the vat is 1.3 atm. What is the density of the liquid in the vat?

(a) 1.5 x 10^3 kg/m^3
(b) 6.6 x 10^3 kg/m^3
(c) 1.3 x 10^4 kg/m^3
(d) 3.1 x 10^3 kg/m^3



23. A mass-less ring, seen from above, is pulled on by three forces with theta equal to 30º. The ring is not moving. How big is the force *F*?

(a) 10 N
(b) 17 N
(c) 8.7 N
(d) 20 N

24. The volume of a sphere is calculated as 1 in^3. What is the volume in cm^3?

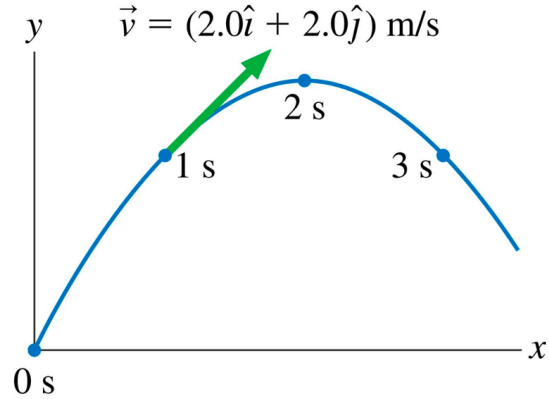
(a) 0.394 cm^3
(b) 0.06 cm^3
(c) 16.4 cm^3
(d) 2×10^1 cm^3

25. A 20.0 kg child slides down a 3.00 m high playground slide. She starts from rest, and her speed at the bottom is 3.0 m/s. How much work is done by friction during the slide?

(a) -6.8×10^2 J
(b) + 498 J
(c) – 0.50 kJ
(d) $+5.9 \times 10^2$ J

26. A 1.0 kg ball is spinning on a 1.0 m long string in a circle in uniform circular motion. What is the tension in the string when the ball is at the top of its motion, if the centripetal force is 25N?

(a) 15 N
(b) 245 N
(c) 25 N
(d) 35 N

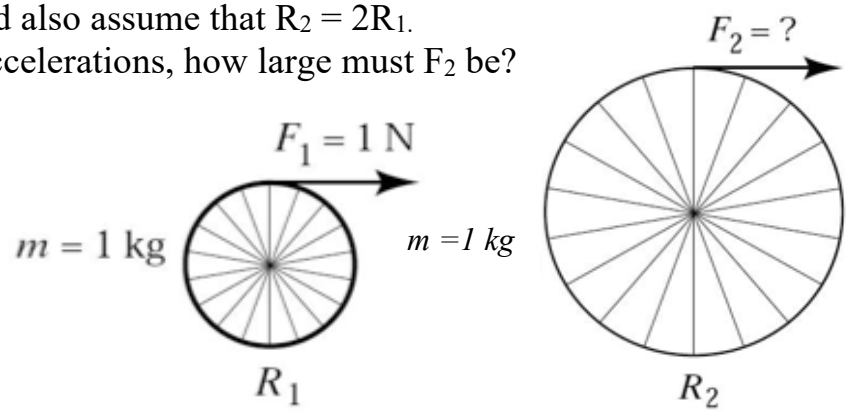


27. A physics student on the planet Exidor throws a ball, and it follows the parabolic trajectory shown. The velocity vector for t=1 second is also shown. From this information, what is the launch velocity?

(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) $\vec{v} = (2.0\hat{i} + 4.0\hat{j})\, m/s$

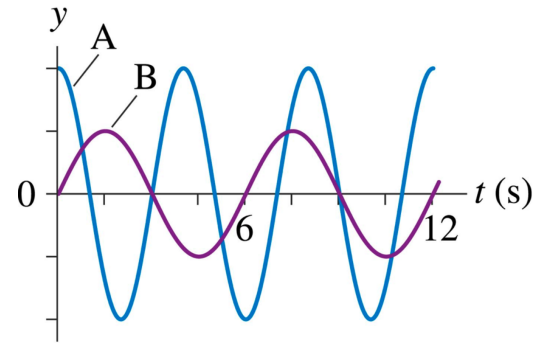
28. Two wheels with fixed hubs, each having a mass of 1.0 kg, start from rest, and have the forces shown below applied to them. Assume the hubs and spokes are mass-less, so that the rotational inertia is $I=mR^2$ and also assume that $R_2 = 2R_1$.
In order to impart identical angular accelerations, how large must F_2 be?

(a) 0.25 N
(b) 0.50 N
(c) 2.0 N
(d) 4.0 N



29. One billiard ball is shot east at 2.0 m/s. A second identical billiard ball is shot west at 1.0 m/s. The balls have a glancing collision, not a head-on collision, deflecting the second ball by 90º and sending it north at 1.41 m/s. Assume the mass of each ball is 0.16 kg. What is the speed of the first ball in the x-direction post collision?

(a) 1.7 m/s
(b) 1.0 m/s
(c) 1.4 m/s
(d) Not enough information given



30. The two graphs shown are for two different vertical mass-spring systems. For A, what is the first time after the t=0 where the energy is all potential?

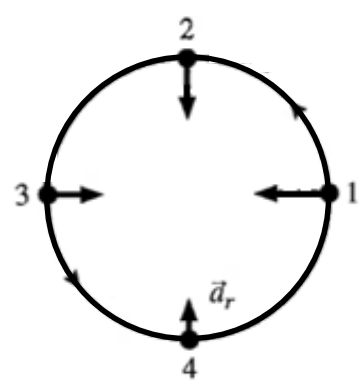
(a) 4.0 s
(b) 3.0 s
(c) 2.0 s
(d) 1.5 s

31. To create ice at 0.00 ºC, how much heat energy must be removed from 0.250 kg of water at 20.0 ºC?

(a) 2.09×10^4 J
(b) 6.24×10^5 J
(c) 1.04×10^5 J
(d) 5.86×10^5 J

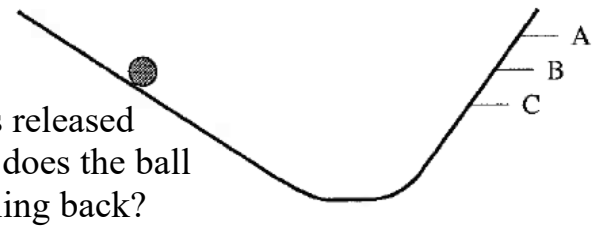
32. A 100 g bullet is traveling at 1000 m/s strikes the edge a 1.0 m diameter spinning disc spinning about its center ($I = 10$ kg m^2). If after the collision the bullet and disc are at rest, what is the angular speed of the disc prior to the collision?

(a) 5.0 rad/s
(b) 1.0×10^2 rad/s
(c) 10 rad/s
(d) 2.5 rpm



33. The following figure shows the radial acceleration vector at four successive points on the trajectory of a particle rotating counter-clockwise. What is the sign of the angular acceleration?

(a) Postive
(b) Zero
(c) Negative
(d) Imposible to determine



34. For the following frictionless track, a ball is released from rest at the position shown. To what point does the ball make it right before reversing direction and rolling back? Position B is the same height as the starting position.

(a) A
(b) B
(c) C
(d) Need more information.

35. 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) 0.86 m/s
(b) 1.1 m/s
(c) 1.4 m/s
(d) 2.9 m/s

36. A horizontal mass-spring system with a mass of 1.00 kg has an equation of motion of $x(t) = (3.14\text{ m}) \cos (2.00\text{ t})$. 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

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)

An 83 kg student hangs from a bungee cord with a spring constant of 270 N/m, which stretches 3.0 m when the system is in equilibrium.

(a) The student is pulled down to a point where the cord is 5.0 m longer than its unstretched length, then released. What is the maximum velocity?

(b) What is the frequency of oscillation for the student?

(c) State the position with respect to the equilibrium position where the maximum acceleration occurs and explain why this is the case using theory.

(d) What is the displacement from equilibrium when the velocity is half of the maximum velocity found in (a)?

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

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. Ignore bearing friction.

(a) How long did it take the flywheel to spin-up to its maximum counter-clockwise angular velocity of 125 rad/s?

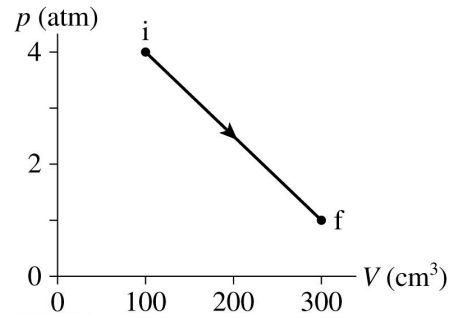
(b) Through what angle did the flywheel turn through during this time?

(c) If the flywheel is disconnected from the motor that "spun it up" and freely rotates, is the net torque on the wheel +, - or 0? Explain using words and equations.

(d) If the spinning wheel is then connected to a machine, which expends half of its energy in 2.0 seconds, what is the average power used during the 2.0 seconds?

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

The figure shows a thermodynamic process followed by 0.015 mol of Argon (Ar).



(a) Using the graph, determine the initial temperature of the gas.

(b) What is the change in thermal energy of the gas, if the final temperature is 244 K?

(c) What is the work done on the gas during this process?

(d) Explain whether the heat transferred to the gas is +, - or zero. Please justify your answer with theory and words.

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

You want to ride your mountain bike up a steep hill (the total system mass is 100 kg).

(a) If you exert 1.0×10^3 N of force on average on the path over a displacement of 2.0 km, how high is the mountain?

(b) There is a second path that leads up the mountain that requires twice the displacement to be traveled, explain using theory/words whether the average force required to climb the hill is the same, greater or less than the answer force used in (a).

Sick of riding the bike, you launch it off the mountain with an initial speed of 10 m/s.
(c) What is the impact speed of the bike as it lands at the bottom of the mountain?

(d) A 74cm diameter tire falls off the bike and rolls along the level ground with a constant speed making 20 rotations per minute. If it makes 20 revolutions, how far did the wheel travel?

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

The object of table shuffle board is to slide the 350 g pucks across the table to a point near the end of the table without falling off. In order to decrease friction, the table is sprinkled liberally with shuffleboard wax. It's not quite friction free though.

(a) You launch a puck with an initial velocity of 4.0 m/s and it comes to rest after 2.0 seconds while experiencing a constant -2.0 m/s^2 acceleration. What distance did the puck travel?

(b) What is the coefficient of friction between the puck and the table?

You launch a second puck and it travels down the level table and flies off the table with a velocity of 1.0 m/s and it lands on the floor below after falling 1.2 m.
(c) What is the flight time of the puck?

(d) As the puck impacts the floor, the floor dents significantly and the puck is not damaged. Is the magnitude of the impulse experienced by the puck bigger, smaller or the same as the impulse experienced by the floor? Be sure to just justify your answer with words and theory.

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

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.

(a) What is the magnitude and direction of the friction force acting on the truck?
Be sure to explicitly state the direction of the force.

(b) If the angle of the slope was increased by a few degrees, the truck would still be stationary. Explain how this is possible in terms of the friction force. No new calculations are necessary, but words are required.

(c) A big drum of oil was "accidently" spilled on the hill and the truck begins to slide. If the coefficient of kinetic friction between the tires and the road are 0.10, what is the net force (mag + dir) experienced by the truck?

(d) At the bottom of the hill the truck collides inelastically with a car. If the truck was traveling at 10 m/s before the collision, and after the collision the car/truck system travels at 7.0 m/s, what is the mass of the car?