General Physics
Physics 101
Final – Spring 2021
11:15 AM – Thursday (4/29) – 6 PM
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.

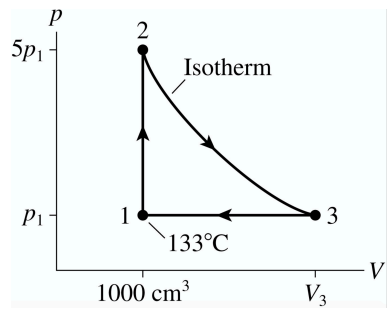
Signature:_____

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:



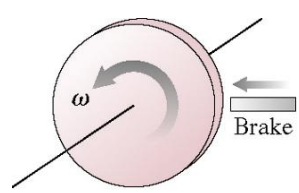
1. A piston contains 0.0300 mol of Helium that undergoes multiple thermodynamic processes shown in the figure and table. For the isobaric process, what is the magnitude of the heat transferred?

(a) 609 J
(b) 815 Nm
(c) 1.01 kJ
(d) 405 J

	p (atm)	T(°C)	V(cm^3)
Point 1	1.0	133	1000
Point 2	5.0	1757	1000
Point 3	1.0	1757	5000

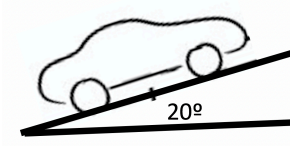
2. A mass-spring system is in simple-harmonic motion in the horizontal direction. If the mass is 0.25 kg, the spring constant is 12 N/m and the amplitude is 15 cm, what is the speed of the mass at a half-amplitude position?

(a) 0.65 m/s
(b) 0.28 m/s
(c) 0.15 m/s
(d) 0.90 m/s



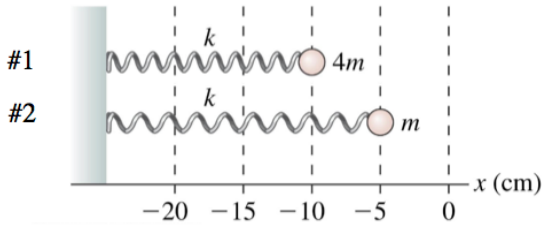
3. The 3.50 kg, 30.0-cm-diameter disk in the figure is spinning at 33.5 rad/s. How much friction force must the brake apply to the rim to bring the disk to a halt in 2.00 s ?

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



4. A 2.0 x 10^3 kg car with rubber tires is parked on a dry concrete hill that has a 20º slope. What is the magnitude of the friction force acting on the car?

(a) 2.0 x 10^4 N
(b) 1.8 x 10^4 kg m/s^2
(c) 6.7 kN
(d) Need more information

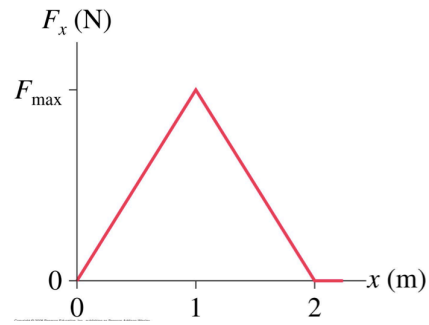


5. Two springs have been compressed from their equilibrium positions at x=0 cm (as shown). When released they will start to oscillate. Which has the larger maximum acceleration?

(a) 1
(b) 2
(c) They are the same
(d) Not enough information provided

6. A block floats on a cushion of air. It is pushed to the right with a force that remains constant as the block moves from 0 to 1 and from 1 to 2 the size of the force steadily decreases until it reaches half of its initial value. For the block which of the following is true?

(a) Slows down from 1 to 2
(b) Moves at a constant speed from 0 to 1
(c) Speeds up from 1 to 2
(d) From 0 to 1, speeds up at first and then has a constant speed



7. 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 x = 0 m to $v_x = 6.0$ m/s at x = 2.0 m, what is Fmax?

(a) 8.0 N
(b) 4.0 J/m
(c) 9.0 kg m/s^2
(d) 16.0 N

8. You drop a ball from rest on the moon, where the acceleration due to gravity is about 1/6 of that on the Earth. What is the velocity of the ball, when it strikes the ground 1.0 m below?

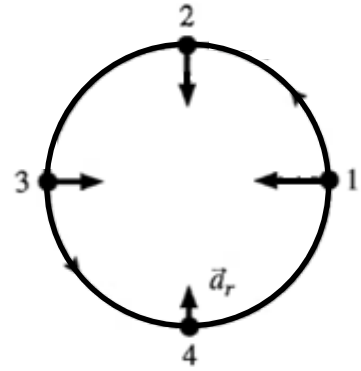
(a) 3.3 m/s
(b) -1.8 m/s
(c) -4.4 m/s
(d) 1.3 m/s

9. Calculate the moment of inertia of a 1.0 kg meter stick oscillating about its 0.30 m mark

(a) 0.12 kg m^2
(b) 0.29 kg m^2
(c) 0.33 kg m^2
(d) 0.37 kg m^2

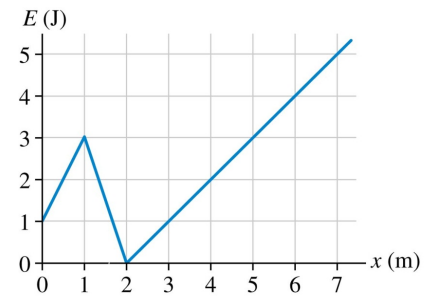
10. Planet Z is 10,000 km in diameter. The free-fall acceleration on Planet Z is 8.0 m/s^2. What is the mass of planet Z?

(a) 1.2×10^{24} kg
(b) 1.1×10^{25} kg
(c) 1.2×10^{19} kg
(d) 3.0×10^{24} kg



11. 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



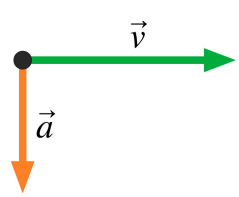
12. A particle with the potential energy shown is moving to the right. It has 1.0 J of kinetic energy at x=1.0 m. In the region 1.0 m<x< 2.0 m, the particle is

(a) decreasing in speed.
(b) increasing in speed.
(c) moving at constant speed.
(d) impossible to determine.

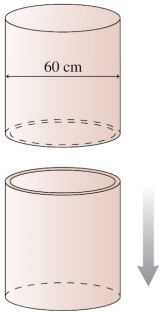
13. You calculate a volume in lab that is 10 in^3.
What is the SI equivalent value of this volume?

(a) 163.9 cm^3
(b) 6.1 x 10^4 m^3
(c) 0.25 m^3
(d) 1.6 x 10^{-4} m^3

14. The particle shown follows a…



(a) Parabolic trajectory
(b) Straight-line trajectory
(c) Circular trajectory
(d) Not possible to tell



15. The two 60-cm diameter cylinders shown are closed at one end and open at the other, are joined to form a single cylinder then the air inside is removed. How much force is necessary to separate the two cylinders?

(a) 1.1×10^2 kN
(b) 2.9×10^4 N
(c) 5.7×10^4 N
(d) 0.28 N

16. A 1000 kg car traveling at +10 m/s collides with a 2000 kg truck traveling at 20 m/s in the opposite direction. What is the velocity of the truck and car after the collision, assuming the collision is inelastic?

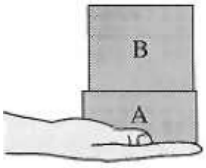
(a) 0.0 m/s
(b) -17 m/s
(c) 25 m/s
(d) -10 m/s

17. A rocket ship in deep space is traveling at -10 m/s and is caught in a tractor beam which causes the ship to slow. If the ship has a displacement of +10 m after 1.0 minute, what is the acceleration of the ship?

(a) 40 m/s
(b) 0.67 m/s^2
(c) -0.33 m/s^2
(d) 0.34 m/s^2

18. Which configuration has the largest centripetal force?

(a) m, v, r
(b) 2m, v, ¼r
(c) ½m, 2v, ½r
(d) 2m, 2v, 2r



19. Block A and B are lifted with uniform acceleration. Which of the following net force equations is not correct?

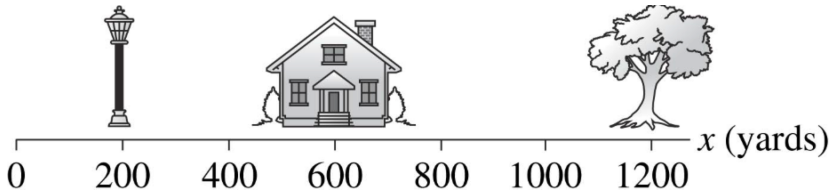
(a) $\sum F_B = m_B a = F_{AonB} - m_B g$

(b) $\sum F_A = m_A a = -F_{BonA} - m_A g + F_{HonA}$

(c) $\sum F_{tot} = (m_A + m_B)a = F_{HonA} - m_A g - m_B g$

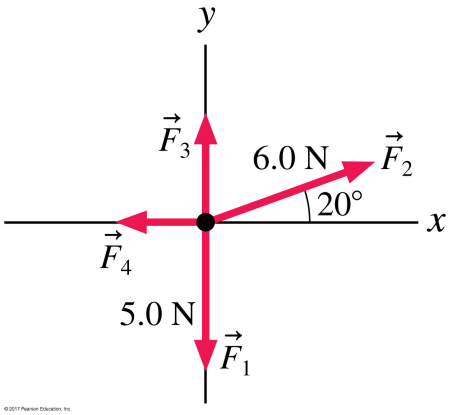
(d) They are all correct

20. Larry leaves home at 9:05 and runs at a constant speed to the lamppost. He reaches the lamppost at 9:07, immediately turns around and runs to the tree. Larry arrives at the tree at 9:10. What is Larry's average velocity for the entire run?



(a) +120 yd/min
(b) -200 yd/min
(c) +333 yd/min
(d) +280 yd/min

21. Four forces in Newtons (N) are exerted on the object shown. The net force on the object is 4.0 N$\hat{\imath}$. What is the magnitude of F_3?



(a) 1.6 N
(b) 2.9 N
(c) 7.0 N
(d) Impossible to determine

22. Which of the following statements is true.

(a) In an adiabatic expansion, $T_f > T_i$
(b) The friction force always points in the opposite direction of motion
(c) The center of mass of an object always lies within the object
(d) In elastic collisions momentum and kinetic energy are always conserved

23. A mass-spring system oscillates with a frequency of 5.0 Hz. If the mass is 5.0 kg, what is the value of the spring constant?

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

24. 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) 1.0×10^5 J
(b) 6.2×10^5 J
(c) 5.9×10^5 J
(d) 2.1×10^4 J

25. Two cylinders of the same radius and mass roll from rest down an incline. Cylinder A has its weight uniformly distributed while cylinder B has most of its weight concentrated at the rim. 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.

26. 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) + 5.9×10^2 J

27. 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.

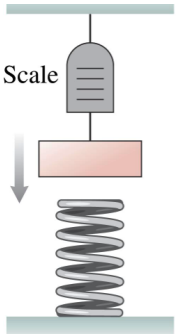
(a) $x(t) = (0.50 \text{ m}) \cos (2.00 t)$
(b) $v(t) = -(3.14 \text{ m/s}) \sin (2.00 \pi t)$
(c) $x(t) = (2.0 \text{ m}) \cos (2.00 \pi t)$
(d) $a(t) = -(1.57 \text{ m/s}^2) \cos (1.00 t)$

28. A rifle is aimed horizontally at a target 45.0 m away. The bullet hits the target 2.3 cm below the aim point. What was the bullet's speed as it left the barrel?

(a) 656.8 m/s
(b) 1.3×10^3 m/s
(c) 0.66 km/s
(d) 66 m/s

29. A crane lowers a steel girder into place. The girder moves with constant speed. Consider the work done by gravity (W_G) and the work done by the tension in the cable (W_T). Which of the following description is correct?

(a) W_G is negative and W_T is positive
(b) W_G is positive and W_T is negative
(c) W_G is positive and W_T is positive
(d) W_G is negative and W_T is negative



30. You gently lower a 20.0 kg object attached to a scale onto a spring (k=500 N/m). What is the reading on the scale in Newtons, when the spring is gently compressed by 10.0 cm?

(a) 196 N
(b) 246 N
(c) 146 N
(d) 50.0 N

31. 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?

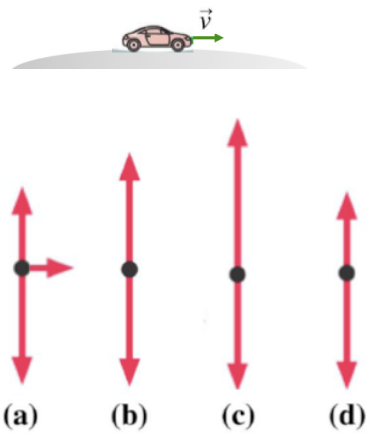
(a) -1.2 rad/s^2
(b) - 2.0 rad/s^2
(c) 2.4 rev/s^2
(d) 7.5 m/s^2

32. Two carts of identical mass are put back-to-back on a track. Cart A has a spring-loaded piston; Cart B is entirely passive. When the piston is released, it pushes against cart B, and.

(a) A is put in motion but B remains at rest.
(b) Both carts are set into motion, with A gaining more speed than B.
(c) Both Carts gain equal speed but in opposite direction
(d) B is put in motion, but A remains at rest.

33. A fly wheel, a 250 kg solid cylinder with a diameter of 1.50 m, is spinning at 126 rad/s is connected to a machine to which it will deliver energy. If half the energy stored in the flywheel is delivered in 2.00 seconds, what is the power delivered to the machine?

(a) 558140.6 Js
(b) 1.39 x 10^5 W
(c) 279 kW
(d) 5.58 x 10^5 W



34. A car runs out of gas just before the top of a hill. It rolls over the top of the hill and starts down the other side. At the very top of the hill, which of the free-body diagram is correct? Friction and drag force are negligible.

35. A 2.0 kg ball traveling to the left at a speed of 2.0 m/s collides elastically with a 1.0 kg ball traveling to the right at a speed of 3.0 m/s. What is the velocity of the 2.0 kg ball after the collision?

(a) -3.6 m/s
(b) 1.3 m/s
(c) 4.7 m/s
(d) -2.6 m/s

36. A cable is pulling upwards on a beam with 300 N, as the beam is lowered into place. If the upward acceleration of the beam is 5.2 m/s^2, what is the beam's mass?

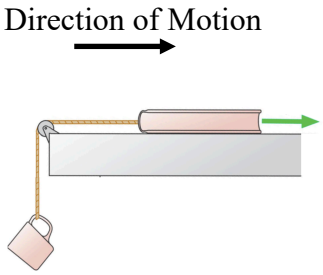
(a) 20 kg
(b) 58 kg
(c) 65 kg
(d) 60 kg

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.



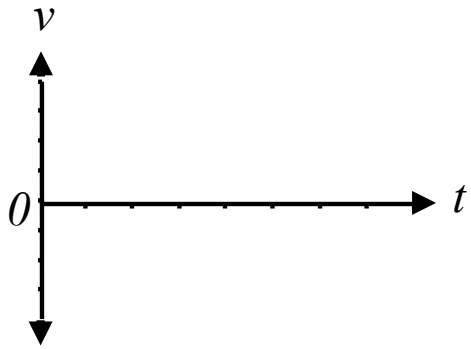
Question 1. Grade this problem? Yes or No (circle one)

The 1.0 kg physics book shown is connected by a string to a 500g coffee cup. The book is given a push along the horizontal surface and released with a speed of 3.0 m/s. Ignore friction.

(a) What is the acceleration of the book after the push is released?

(b) How much work is done on the book as it comes to rest?

(c) Sketch a velocity vs time plot that could represent the motion of the book after release? Explain in words the shape and meaning of the graph.



(d) What is the tension in the string while the book is sliding?

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

A 1.0 kg puck is launched up a 30º frictionless ramp traveling 2.0 m along the ramp attaining a speed of 4.0 m/s as it leaves the top of the ramp.

(a) What was the launch speed of the puck?

The puck now undergoes beautiful projectile motion leaving at 4.0 m/s, 30º above the horizontal.

(b) How long after leaving the ramp, does the puck reach its maximum vertical height?

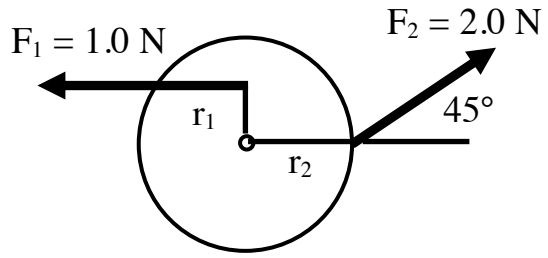
The puck hits a well-placed tree, and starts to fall vertically. You catch it and it experiences a net force of 100 N upward.

(c) What is the force between your hands and the puck as you catch it?

(d) Was momentum conserved in this catch?
Explain with theory/words. No calculations required.

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

Two forces with $r_1 = 1.0$ m and $r_2 = 2.0$ m are applied to a 2.0 kg solid disc with radius 2.0 m.



(a) What is the net torque on the disc?

(b) What is the angular acceleration of the disc?

The disc is spinning with an angular velocity of 2.0 rad/s at the moment the forces being applied are removed. As usual, we paid good money for no-friction bearings.
(c) Do all points on the disc have the same angular velocity?
Explain. No calculations are necessary

A hoop with inertia of 4.0 kg m^2 about its center of mass is dropped onto the disc, and it spins about its center of mass (as does the disc).
(d) What is the angular velocity of the system after the hoop is spinning with the disc?

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

A 0.16 kg. billiard ball is shot east at 2.0 m/s by striking it with a pool cue with a 1.0 kN force.

(a) Through what distance was the force applied from the cue to the ball?

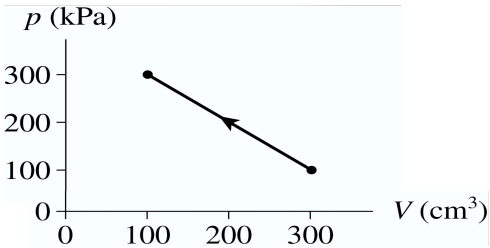
A second 0.16 kg. billiard ball is shot west at 1.0 m/s towards the first ball. The balls have a glancing collision, not head-on, deflecting the second ball by 90º and sending it north at 1.41 m/s.

(b) What is the velocity of the first ball in the x-direction post collision?

(c) What is the velocity of the first ball in the y-direction post collision?

(d) In this collision which ball experiences a larger impulse during the collision? Explain your answer with words and theory, no calculations are necessary.

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



(a) How much work is done on the gas in the process shown?

(b) If the initial temperature is 23ºC how many moles of the gas are in the container?

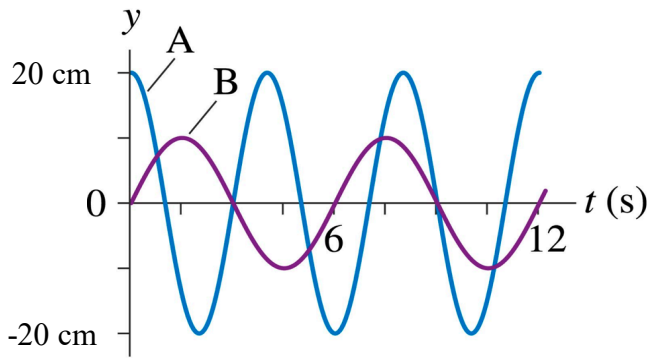
(c) What is the final temperature of the gas?

(d) Is the heat added in this process positive, negative or zero. Please explain using theory, equations and words. No further calculations are required.

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

A mass-spring system (A) oscillates as shown.

(a) What is the max velocity and at what time does it occur first as positive?



(b) If the spring constant is 100 N/m, what is the total energy in the system?

(c) Graph (B) shows the oscillation of a pendulum, what is its length?

(d) If you change the amplitude of oscillation of the pendulum, will the period change? Explain using words, equation(s) and theory.