General Physics
Physics 101
Final – Spring 2014
Thursday – 5/1/14
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:

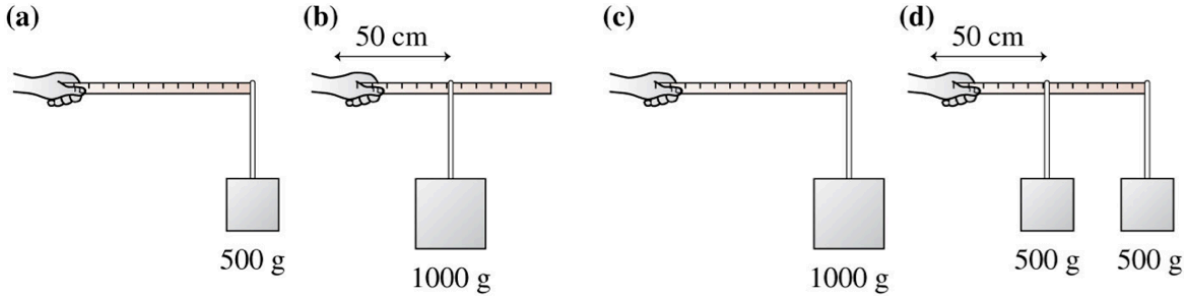
Please clearly circle one and only one answer for each of the following.
Show all of your work. Partial credit may be given if you include your work.

Questions:

1. An air-track glider attached to a spring oscillates between the 10 cm mark and the 60 cm mark on the track. The glider completes 10 oscillations in 33 s. What is the maximum speed of the glider?

(a) 0.48 m/s
(b) 0.96 m/s
(c) 0.83 m/s
(d) 1.9 rad/s

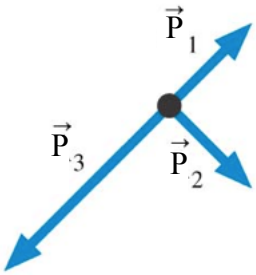
2. A student holds a meter stick straight out with one or more masses dangling from it. Which is the most difficult configuration for the student to keep the meter stick from rotating?

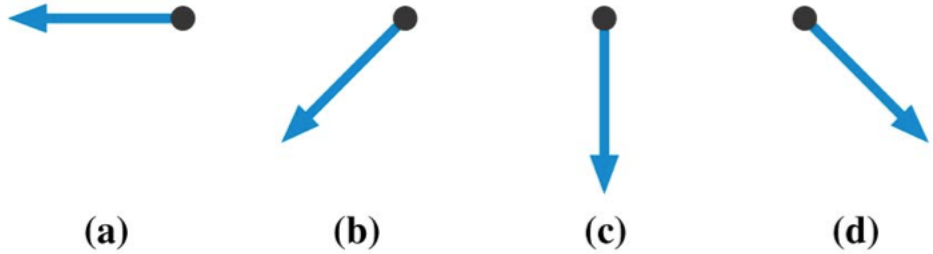


3. Bob can throw a 500 g rock with a speed of 30.0 m/s. He moves his hand forward 1.50 m while doing so. How much work does Bob do on the rock?

(a) 2.3×10^5 N
(b) 450 Nm
(c) 150 Nm
(d) 225 J

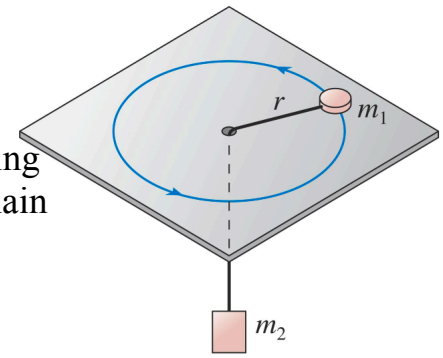
4. For the momentum vectors shown, which of the following vectors represents the total momentum?





5. A 5.0 kg block is launched up ramp with a 50 N/m spring. The block has a velocity of 5.0 m/s when it is climbed a vertical distance of 5.0 m from the launch point, what is the spring potential energy before launch?

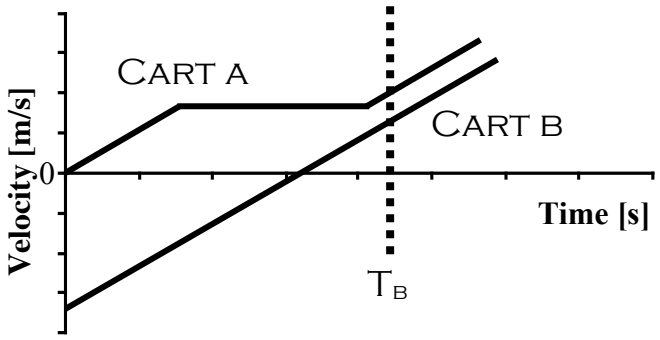
(a) 3.1×10^2 J
(b) 62 Nm
(c) 6.3×10^2 J
(d) Need more information



6. Mass m_1 on the frictionless table shown is connected by a string through a hole in the table to a hanging mass m_2. For m_2 to remain motionless, while m_1 spins with a speed v at radius r, which of the following is false?

(a) The system is not in equilibrium
(b) The tension in the string supplies a radially inward force on m_1
(c) The period of m_1 is constant
(d) The angular acceleration of m_1 is non-zero

7. For the following velocity vs. time graph, what is true?

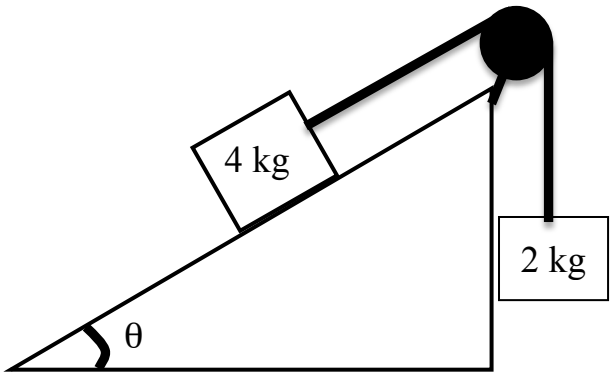


(a) CART A and CART B have the same acceleration at all times.
(b) In the beginning of the motion CART B has a negative increasing velocity.
(c) At time T_B, CART A and B have the same instantaneous velocity.
(d) CART B moves in the negative direction at some point in the motion

8. On the Price is Right™ you need to make it into the showcase shown down by spinning the big wheel. The solid wheel has a mass of 200 kg and a radius of 2.0 m and you apply a constant 50 Nm torque for 0.50 s to move the wheel. What is the change in angular momentum of the wheel?

(a) 25 kg m^2/s
(b) 50 J
(c) 1.0 x 10^2 kg m^2/s
(d) 13 Nms

9. A 4.0 kg box is on a frictionless 20º ramp and is connected via a massless string over a massless, frictionless pulley to a hanging 2.0 kg weight. If you gently release the box, which way will it move on the ramp?



(a) Up the ramp
(b) Down the ramp.
(c) It will not move.
(d) Need more information

10. A 1.0 kg toy-car traveling at 10 m/s approaches a 2.0 kg toy-car traveling at 5.0 m/s; they collide but not elastically. After the collision if the 1.0 kg car is at rest, what is the speed of 2.0 kg car?

(a) 10 m/s
(b) 0.0 m/s
(c) 20 m/s
(d) 5.0 m/s

11. 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?

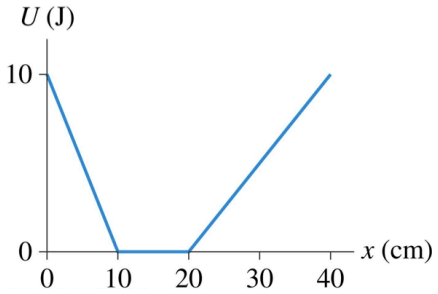
(a) 5.0 x 10^3 rad
(b) 5.0 rad
(c) 1.5 x 10^4 rad
(d) 5000 rad

12. A person standing at the edge of a cliff throws one ball straight up and another ball at an angle of 30º below the horizontal. Both balls are thrown with the same initial speed. Neglecting air resistance, the ball to hit the ground below the cliff with the greater speed is the one initially thrown

(a) upward
(b) 30º below the horizontal
(c) neither—they both hit at the same speed
(d) not enough information given

13. You are extremely bored during summer break, so you decide to attach a graphing calculator to a rubber band and repeatedly bounce it up and down vertically. When the rubber band is at its minimum stretch away from your hand

(a) the calculator's velocity is downward but its acceleration is upward.
(b) the calculator's velocity is zero but its acceleration is upward.
(c) the calculator's velocity is upward but its acceleration is downward.
(d) the calculator's velocity is zero but its acceleration is downward.



14. 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

15. A student derives an equation of the form $\frac{a}{2v^2}$.
What are the combined SI base units for this equation?

(a) $\frac{1}{m}$ (b) $\frac{m^3}{s^5}$

(c) $\frac{1}{s}$ (d) m

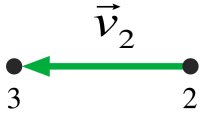
16. The left end of a spring is attached to a wall. When Bill pulls on the right end with a 200 N force, he stretches the spring by 20 cm. The same spring is then used for a tug-of-war between Bill and Carlos. Each pulls on his end of the spring with a 200 N force. How far does the spring stretch now?

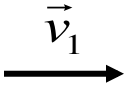
(a) 10 cm
(b) 20 cm
(c) 40 cm
(d) 80 cm

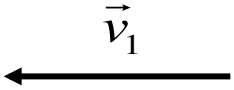
17. A person swings on a swing. When the person sits still, the swing oscillates back and forth at its own natural frequency. If, instead, the person stands on the swing, the new natural frequency of the swing is

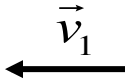
(a) smaller.
(b) the same.
(c) greater.
(d) not possible to predict without further information.

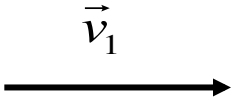
18. The figure shown shows two dots of a motion diagram and vector $\vec{v}_2$. Which of the following is a correct vector $\vec{v}_1$, if the acceleration vector points to the left?



(a) 

(c) 

(b) 

(d) 

19. 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?

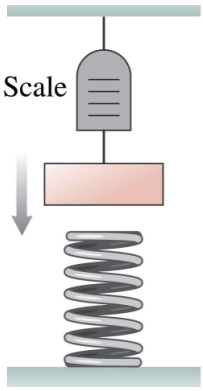
(a) 558140.6 Js
(b) 1.39×10^5 W
(c) 279 kW
(d) 5.58×10^5 W

20. If you spin a 0.50 kg ball on the end of a 2.0 m long string in a horizontal circle with twice the critical speed. What is the tension in the string?

(a) 9.8 N
(b) 4.9 N
(c) 20 N
(d) 8.8 N

21. An object is held in place by friction on an inclined surface. The angle of incline is increased until the object starts moving. If the surface is kept at the angle, the object…

(a) slows down.
(b) moves at uniform speed.
(c) speeds up.
(d) none of the above



22. 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) 50.0 N
(b) 146 N
(c) 246 N
(d) 196 N

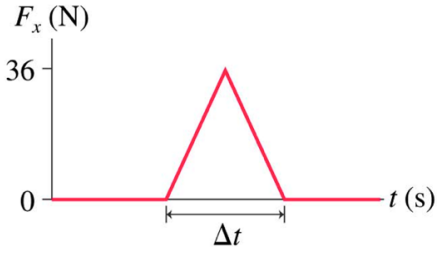
23. A baseball is thrown from the upper deck at Progressive Field in the horizontal direction with a velocity of 10 m/s. If the ball falls a distance of 30 m into the field below, how far did the ball travel horizontally during its motion?

(a) 61 m
(b) 25 m
(c) 49 m
(d) 30 m

24. A crane lowers a steel girder into place using a long steel cable, and the girder is slowing down as it reaches its final destination. Which of the following statements is correct?

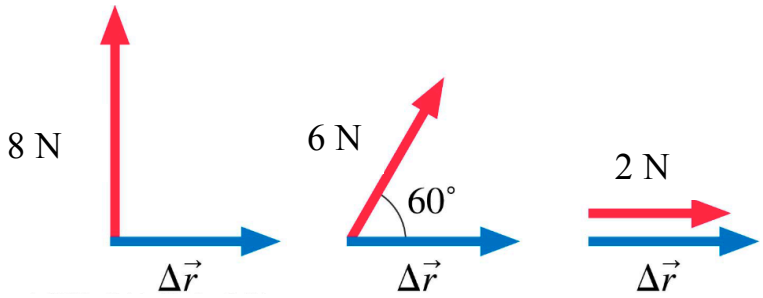
(a) The work done by tension in the cable is positive
(b) The force of gravity is greater than the tension force
(c) The net work on the girder is negative
(d) The work done by gravity is negative

25. If a block experiences an impulse of 0.036 Ns as shown, how long did the collision take?



(a) 1.0×10^{3} s
(b) 0.50 ms
(c) 2.0×10^{-3} s
(d) 1.0 ms

26. Which force does the most work?



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

27. A rocket in deep space is traveling at +10 m/s and fires its thrusters for 1.0 minute causing a constant acceleration of -1.0 m/s^2. What is the total displacement of the rocket during this motion? Ignore the mass loss of the rocket.

(a) -1.2×10^3 m
(b) 9.5 m
(c) 2.4×10^3 m
(d) 1.2 km

28. 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

29. A constant force applied to A causes A to accelerate at 5 m/s^2. The same force applied to B causes B to accelerate at 3 m/s^2. What is the ratio of m_A / m_B of the masses of A to the mass of B?

(a) 5/3
(b) 1/15
(c) 15/1
(d) 3/5

30. 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

Part II. Short answer problems (12 pts each)

Instructions:

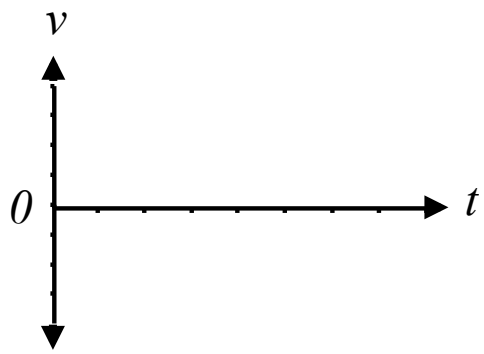
Solve four of the following six problems. If you try to solve all six problems, please clearly indicate which problems you wish to have graded. If you do not indicate this, I will assume you want me to grade problems one, two, three and four.

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)**

You would like to stick a 10.0 g wet spit wad on the ceiling, so you toss it straight-up with a speed of 10.0 m/s and it takes 100 ms for the spit wad to hit the ceiling.
(a) What is the velocity of the spit wad right before it hits the ceiling?

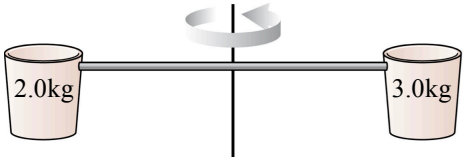
(b) Sketch a velocity vs time plot that could represent the motion of the spit wad as it travels towards the ceiling? Please explain the shape & meaning of the graph.



(c) As the spit wad comes to rest on the ceiling, what impulse does it experience as it impacts the ceiling? Be sure to explicitly state the direction the impulse acts.

(d) When the spit wad collides with the ceiling, does the ceiling or the spit wad experience a larger force? Explain using words and possibly equations. No calculations are necessary. Clearly the spit wad went SPLAT.

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



Two buckets can spin around in a horizontal circular on frictionless bearings as shown -"clearly" the rigid connecting bar is of negligible mass. The buckets are separated by 2.0 m and rotate about the middle of the bar.

(a) You apply a constant force to the bar for 0.50 s over ¼ of a rotation, at a distance of 0.50 m from the axis of rotation. This causes the buckets to spin from rest to a constant angular speed. What is the angular acceleration of the buckets?

(b)What is the total inertia of the system?

(c) What is the magnitude of the force that was applied to the system? Assume the force was applied perpendicular to the bar.

You now turn on a rain machine, which vertically drops water into the buckets.

(d) Do the buckets speed up or slow down? Explain/justify your answer with words and equations, but no calculations are required.

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

A cannon in a pirate ship fires a 5.0 kg cannon ball towards an enemy ship. The ball leaves the cannon with a speed of 20 m/s an angle of 10° above the horizontal.
(a) If the cannon is on wheels, what happens to it as it is launching the ball? Explain what happens and justify physically why this occurs.

(b) As the ball leaves the cannon, how long does it take for it to reach its maximum height?

(c) A second shot is launched horizontally at 20 m/s and as the 5.0 kg ball is leaving the cannon a 4.0 kg cannon ball traveling at -10 m/s collides with it. Assuming an elastic collision and all 1D (lies), what is the velocity of the 5.0 kg ball post collision?

(d) As the battle rages on, the ship begins to tilt. Two cannon balls with the same shape and radius, but with different mass, start rolling down the titled deck. Which attains the larger velocity at the end of the titled deck? Words and equations are necessary in your response, but calculations are not.

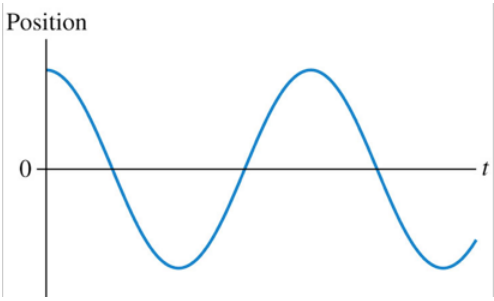
Question 4. **Grade this problem? Yes or No (circle one)**

A mass-spring system is set horizontally and allowed to oscillate. The equation of motion for the oscillation is given as $x(t) = (0.25\ \text{m}) \cos(4.0\ t)$.

(a) What is the mass in this system if the spring constant is 50 N/m?

(b) When the mass is located at the half-amplitude position, what is its speed?

(c) On the graph identify a location where the velocity is a maximum positive value. Words are necessary to explain your choice.



(d) If you wanted to create a pendulum with this mass and a string, how long would the string have to be if you wanted the same oscillation period as the mass-spring system?

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

Sam straps on his skis (m_{tot} = 75 kg) and starts from rest down a 50-m high, 30º frictionless slope (100 m long) . A strong headwind exerts a horizontal force of 400 N on him as he skis. Ignore the friction between the snow and skis for (a) – (c).

(a) Determine the work done by the wind as Sam travels down the slope.

(b) Determine the final kinetic energy of Sam when he reaches the bottom of the slope.

(c) Explain whether the total energy of the system, gravitational energy and kinetic energy are increasing, decreasing or remaining the same. Theory/equations are required in your explanations along with your answers.

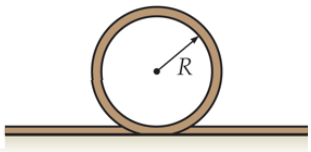
(d) At the bottom of the hill, Sam now travels over a level piece of ground that has friction due to slush (melted snow). If he stops over a distance of 4.0 m, what is the coefficient of friction between the skis and the slush? Assume the wind has stopped.

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

Blocks of mass 3.0 kg, 2.0 kg and 1.0 kg are lined up in a row on a frictionless table. All three are pushed forward by a force applied to the 3.0 kg block. The entire system accelerates at 2.0 m/s^2, and the blocks stay together during the push.

(a) Determine the force (mag + dir) that the 1.0 kg block exerts on the 2.0 kg block.

(b) The 1.0 kg block reaches the end of the table and slides down a frictionless ramp and goes through a 1.0 m diameter loop-da-loop. If the mass is traveling at 3.0 m/s at the top of the loop, what is the normal force experience by the block?



(c) Using Energy conservation determine the speed of the block when it reaches the bottom of the frictionless loop.

(d) The 1.0 kg block now collides with a 2.0 kg block, which is at rest, and they move off stuck together. For the 1.0 kg block, what is the fraction of its velocity after the collision, in comparison to its velocity before the collision? Words and equations are necessary in your result, but no calculations are required.