General Physics
Physics 101
Final – Spring 2013
Wednesday – 5/1/13
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 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?

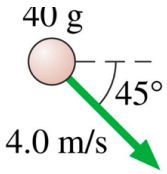
(a) 5.0 rad/s
(b) 1.0 x 10^2 rad/s
(c) 10 rad/s
(d) 2.5 rpm

2. Astronauts on the first trip to Mars take along a pendulum of length 56 cm. If the period on Mars is 2.45s, what is the free-fall acceleration on Mars?

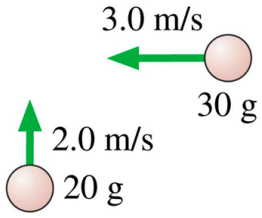
(a) 9.8 m/s
(b) 3.7 m/s^2
(c) 1.8 m/s^2
(d) 11 m/s^2

3. A 0.2 kg plastic cart and a 20 kg lead cart both roll without friction on a horizontal surface. Equal forces are used to push both carts forward a distance of 1 m, starting from rest. After traveling 1 m the kinetic energy of the plastic cart is_____ the kinetic energy of the lead cart.

(a) greater than
(b) less than
(c) equal to
(d) Impossible to compare to

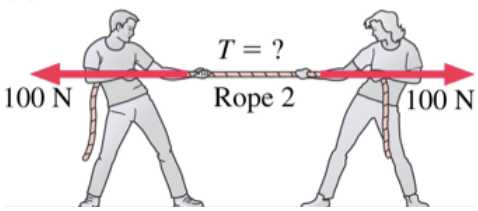


4. Three balls of clay are traveling as shown and hit simultaneously and stick together. What is the net momentum in the x direction after the collision?



(a) 0.022 Ns
(b) -0.022 kg m/s
(c) -0.073 kg m/s
(d) 0.20 kg m/s

5. Two people are playing tug-of-war, and are presently at a stand-still. What is the tension in the rope? Ignore the mass of the rope, and assume it is equally stretched.



(a) 200 N
(b) 100 N
(c) -200 N
(d) 0 N

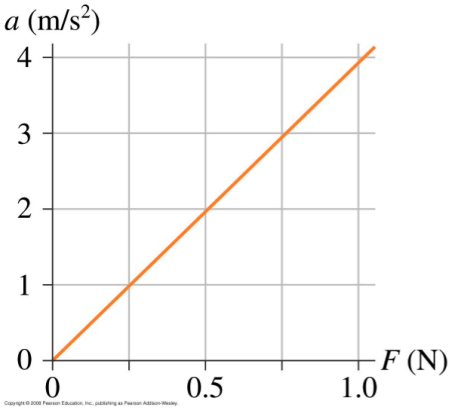
6. You drop a ball from rest on the moon, where the acceleration due to gravity is about 1/6 of that on the Earth. What is the velocity of the ball, when it strikes the ground 1.0 m below?

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

7. A block slides from rest down a frictionless ramp and achieves a velocity v at the bottom of the ramp. If you want to achieve a velocity that is $\sqrt{2}$ v , by what factor must you change the height of the ramp?

(a) $\sqrt{2}$
(b) 2
(c) 4
(d) ½

8. For the following acceleration vs. force graph, what is the object's mass?



(a) 4.0 kg
(b) 2.0 kg
(c) 1.0 kg
(d) 0.25 kg

9. A 250 kg flywheel (solid disc) with a diameter of 1.5 m is used to store energy. It is spinning with an angular speed of 125 rad/s, and expends some of its energy in 2.0 seconds, leaving it spinning with an angular speed of 40 rad/s. What is the average torque applied to the flywheel during this time?

(a) 1301 Nm
(b) 1.2×10^4 Nm
(c) -1.3 kNm
(d) -3.0×10^3 Nm

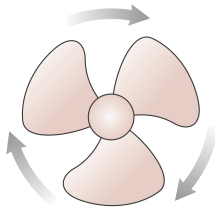
10. Sam (m=75 kg) straps on his skis and starts down a 50-m high, 30º frictionless slope. A strong head-wind exerts a horizontal force of 200 N on him as he skis down the 100 m long slope. Calculate the change in kinetic energy of Sam when he reaches the bottom of the slope.

(a) 5.4×10^4 J
(b) 1.9×10^4 J
(c) 7.4×10^4 J
(d) He never makes it to the bottom of the hill

11. You have a training cannon that fires a cannon ball with a speed of 100 m/s at a fixed angle of 60.0º above the horizontal. If the target lies at the same altitude as the cannon, how long would the cannon ball spend in the air? Ignore air resistance.

(a) 10.2 s
(b) 17.7 s
(c) 8.84 s
(d) 20.4 s

12. The fan blade shown is slowing down. What are the signs of ω and α?



(a) ω is positive and α is positive.
(b) ω is positive and α is negative.
(c) ω is negative and α is positive.
(d) ω is negative and α is negative.

13. A car traveling to the west at a speed of 10.0 m/s travels a displacement of 100 m to the west while it experiences a constant acceleration for 20.0 seconds. What is the acceleration of the car during this motion?

(a) 0.5 m/s^2 to the west
(b) 1.50 m/s^2 to the east
(c) 9.00 m/s^2 to the west
(d) 5.00 x 10^{-1} m/s^2 to the east

14. You and a friend are playing with air-hockey pucks (all 1D). You send the 1.0 kg puck with a velocity of 1.0 m/s and your friend sends the 2.0 kg puck in the opposite direction with a velocity of -2.0 m/s. Assuming the pucks bounce off each other, what is the speed of the 2.0 kg puck following the collision?

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

15. You were extremely bored during spring 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.

16. Which of the following statements is true?

(a) An object in uniform circular motion is experiencing no acceleration.

(b) The total mechanical energy of a conservative system can change.

(c) It is not possible for a moving object to collide with a second stationary object, and have both be at rest after the collision.

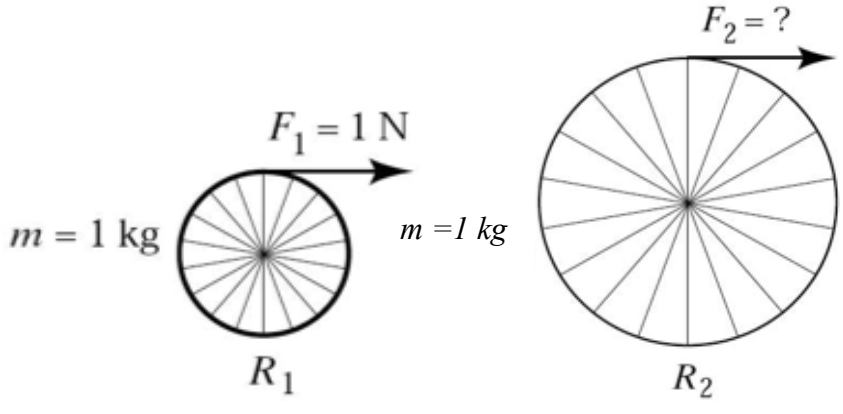
(d) The velocity is always zero at the turn around point of projectile motion.

17. A 2.0 kg block oscillates on a horizontal spring with a spring constant of 4.0 N/m. If the speed of the block is 2.0 m/s when it is displaced 2.0 m from equilibrium, what is the amplitude of oscillation?

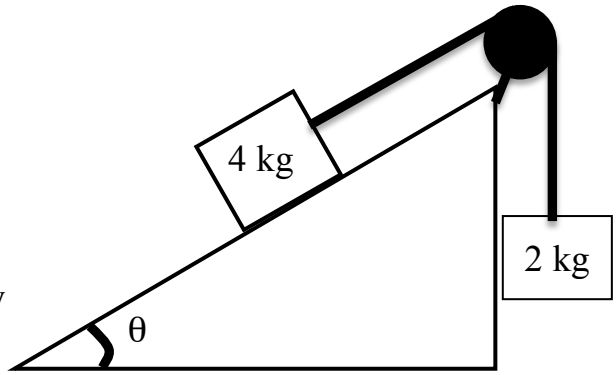
(a) 6.0 m
(b) 5.7 m
(c) 2.4 m
(d) 3.5 m

18. 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



19. A 4.0 kg box is on a frictionless 40º 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) Down the ramp
(b) Up the ramp
(c) It will not move
(d) Need more information

20. What are the components of the total displacement for the following motion?

I. Crawling with components $\left(10\hat{i}+20\hat{j}\right)m$

II. Walking west for 20 m

III. Running north for 10 m

(a) $\left(-10\hat{i}+30\hat{j}\right)$

(b) $(30m\ E, 30m\ N)$

(c) 30 m to the North, 10 m to the West

(d) $\left(20\hat{i}+0\hat{j}\right)m$

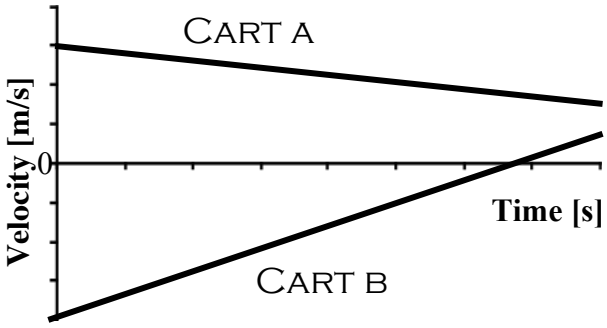
21. You are whirling a bucket of water in a vertical circle at a speed of 4.0 m/s and at a radius of 0.75 m. If the normal force exerted on the water is 2.0 N when it is at the top of its motion, what is the mass of the water in the bucket?

(a) 0.17 kg
(b) 64 g
(c) 94 g
(d) 0.91 kg

22. A 500 g, 8.0 cm diameter empty can rolls across the floor at 3.0 m/s. What is the can's kinetic energy?

(a) 1.5 J
(b) 2.3 J
(c) 3.4 J
(d) 4.5 J

23. For the following velocity vs. time graph, what is false?



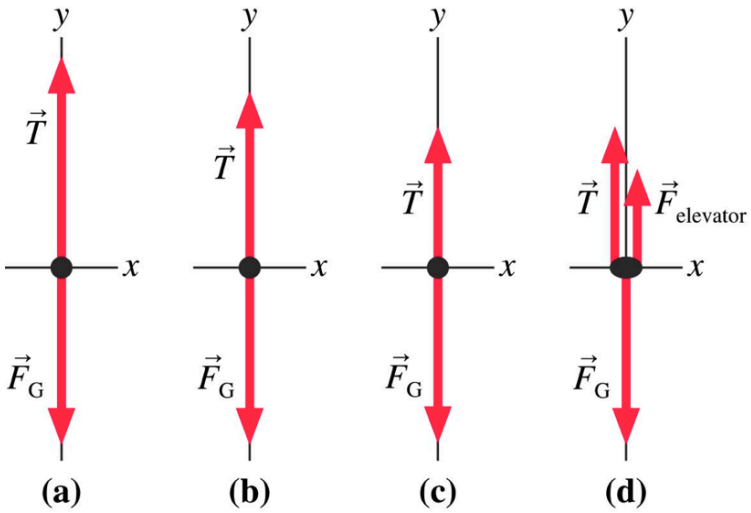
(a) CARTS A and B never have the same acceleration at some point in the motion.

(b) Neither CART A or B change direction during the motion.

(c) CART A has a positive decreasing velocity at some point in the motion.

(d) CART B moves in the negative direction at some point in the motion.

24. An elevator suspended by a cable is moving upward and slowing to a stop. Which free-body diagram is correct?



25. Ball A at a constant speed on a level table 1.0 m above the floor, and ball B rolls on the level floor directly under the first ball and with the same speed and direction. When ball A rolls off the table and hits the floor,

(a) Ball B is ahead of Ball A.
(b) Ball A and Ball B collide.
(c) Ball A is ahead of Ball B.
(d) Need more information.

26. A horizontal spring (k= 100 N/m) is compressed 20 cm and used to launch a 2.5 kg box across a frictionless, horizontal surface. After the box travels some distance, the surface becomes rough. The coefficient of kinetic friction of the box on the surface is 0.15. How far does the box slide across the rough surface before stopping?

(a) 0.54 m
(b) 0.27 m
(c) 0.081 m
(d) 0.036 m

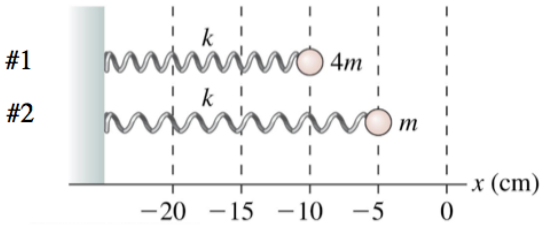
27. A student derives an equation of the form $\frac{a^2}{t}$.

What are the combined SI base units for this equation?

(a) $\frac{m}{s^3}$ (b) $\frac{m^2}{s^5}$

(c) $\frac{m^2}{s}$ (d) $\frac{m^2}{s^3}$

28. 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 speed?



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

29. Calculate the moment of inertia for 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

30. You are pushing a box across the floor with a force of 100 N at an angle of 60º above the horizontal. Friction is acting in the opposite direction of motion with a magnitude of 50 N. After the box has traveled 2.0 m, what is the net work done on the box?

(a) 0.0 Nm
(b) 1.0 x 10^2 J
(c) 2.0 x 10^2 J
(d) 73 Nm

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 10-m long glider with mass of 680 kg (including the passengers) is gliding horizontally through the air at 30 m/s when a 60 kg skydiver drops out by releasing her grip on the glider (the glider + passengers remaining are 620 kg).

(a) What is the glider's velocity just after the skydiver lets go? You must justify your answer using momentum conservation (words and/or calculations)

(b) The skydiver begins to undergo free fall (we'll ignore air-resistance). Once she has fallen a vertical displacement of 100 m, what is her speed?

(c) How long did it take the skydiver to fall this distance?

(d) The skydiver deploys her parachute, which causes her to slow to half of her speed found in (b), which happens in 50 ms. What is the average impulse exerted on the skydiver during this deployment? Be sure to indicate a direction.

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

"A group of Boy Scouts in Des Moines, Iowa, built a cannon capable of launching a ping pong ball through a watermelon at supersonic speeds". It was reported that the ball was traveling 880 miles an hour after it exited the 10.0 ft (120 in) long PVC pipe.
http://www.wtsp.com/news/watercooler/article/313560/58/Boy-scouts-vaporize-watermelon
The ball weighs 3.00 g, and we'll assume a constant force from the cannon.

(a) What was the change in kinetic energy of the ball from launch to exiting the tube?

(b) What was the net force applied to the ball during the launch?

(c) If the air resistance experienced by the ball during the launch is on average 50 N in the opposite direction of motion, how much work is done by the cannon on the ball during the launch?

(d) As the ball strikes the watermelon is the force on the watermelon from the ball bigger, smaller or the same as the force on the ball from the watermelon. Words are necessary in your justification, but no calculations are required.

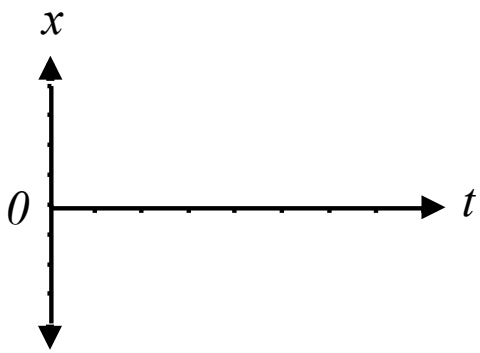
Question 3. Grade this problem? Yes or No (circle one)

You are using your 2000 kg truck to push a 1000 kg car that ran out of gas on a level bit of road. The truck is pushing the empty car and the system accelerates at 1.0 m/s^2. For simplicity we'll ignore rolling friction and air resistance.

(a) What is the force (mag + dir) of the car acting on the truck?

(b) You start pushing the car up a hill and the truck and car move with a constant velocity. If the hill has an angle of 20º with respect to the horizontal, what is the new force of the truck acting on the car?

You get to the top of the hill, and the car starts to travel down the other side of the hill on its own (whoops).
(c) Sketch a position vs time plot that could represent the motion of car as it travels down the hill. Please explain the shape & meaning of the graph and define down the hill as the positive direction.



(d) Discuss the normal force acting on the car at the bottom of the valley before it immediately starts to go up the next hill, and whether it is greater than or less than the weight of the car. Words are necessary in your answer, and calculations and a force diagram could help but are not required.

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

In the laboratory, you take data on a horizontal mass-spring system where you know the mass of the system is 500 g. The computer gives you a fit equation for the position as a function of time of $x(t) = (50 \text{ cm}) \cos(\pi t)$.

(a) What is the spring constant for the system?

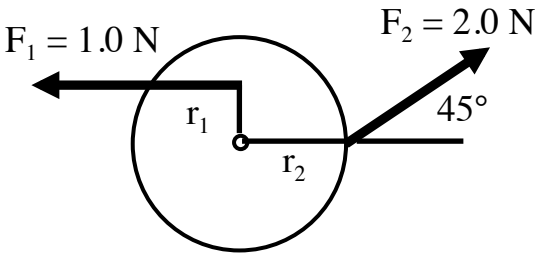
(b) What is the total energy in the system?

(c) Where is the acceleration a maximum? Explain your answer using the concepts of force including words and possibly pictures/equations

(d) What is the position of the mass with respect to equilibrium when it is traveling with a velocity that is half of v_{max}? A numerical answer is required.

Question 5. 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.



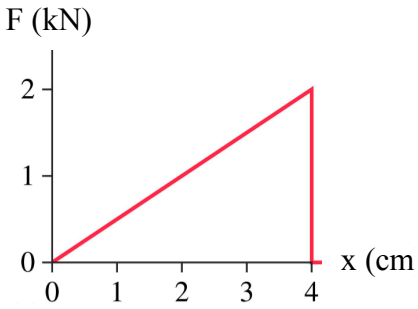
(a) What is the net torque on the disc?

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



A 500 g hockey puck, initially at rest, on a horizontal sheet of ice, experiences the force from a hockey stick as shown.

(a) What is the velocity of the particle after traveling 4.0 cm?

(b) Is the force that is applied conservative or non-conservative force? Justify your answer with words and possibly equations.

The 500 g puck now collides with a 250 g puck, which is initially at rest.

(c) If the 250 g puck leaves the collision with a velocity of 5.0 m/s, what is the final velocity of the 500 g puck? It is not clear whether this is an elastic collision.

(d) The 250 g puck now travels across a rough patch of ice, and experiences an acceleration of -2.0 m/s^2. What is the coefficient of friction between the puck and "rough patch"?