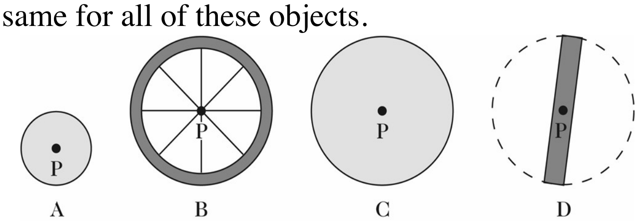
Physics 1050-01,02 - Final exam   Name______________________

Allowed: calculators, pens, pencils, 2 pages of equations and notes.
Not allowed: books, additional notes, smart phones, etc.
The exam will end at 1:50 (total time is 110 minutes). 143 total points.

A. Multiple choice: circle the most appropriate answer (4 points each)

1. Two children, Iris and Oliver, ride on a merry-go-round. Iris is near the inside of the circle, while Oliver is at the outside edge. Which is a true statement?
   a. Iris has a greater angular velocity
   b. Oliver has a greater angular velocity
   c. Iris and Oliver have the same centripetal acceleration
   d. Iris and Oliver have the same angular acceleration
   e. none of the above

2. The figure below shows scale drawings of four objects, each of the same mass and uniform thickness, with the mass distributed uniformly. Which one has the *greatest* moment of inertia when rotated about an axis perpendicular to the plane of the drawing at point P?
   a. A
   b. B
   c. C
   d. D
   e. the same for all of these objects.

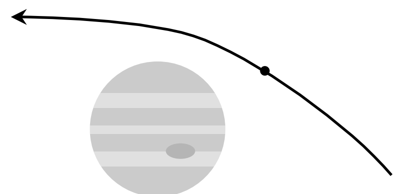


3. Consider a uniform hoop of radius R and mass M rolling without slipping. Which is larger, its translational kinetic energy or its rotational kinetic energy?
   a. translational kinetic energy is larger
   b. rotational kinetic energy is larger
   c. both are equal
   d. you need to know the speed of the hoop to tell
   e. you need to know the radius of the hoop to tell

4. When you ride a bicycle, in what direction is the angular velocity of the wheels?
   a. to your left
   b. to your right
   c. forwards
   d. backwards
   e. it changes with time

5. Consider a spacecraft flying past Jupiter with its rockets turned off. As it gets closer to Jupiter during the approach, which are true about the magnitudes of the angular (ω) and translational (v) velocities? (Both are relative to the center of Jupiter.)

a. both ω and v decrease
b. both ω and v stay the same
c. both ω and v increase
d. ω increases and v decreases
e. ω increases and v stays the same

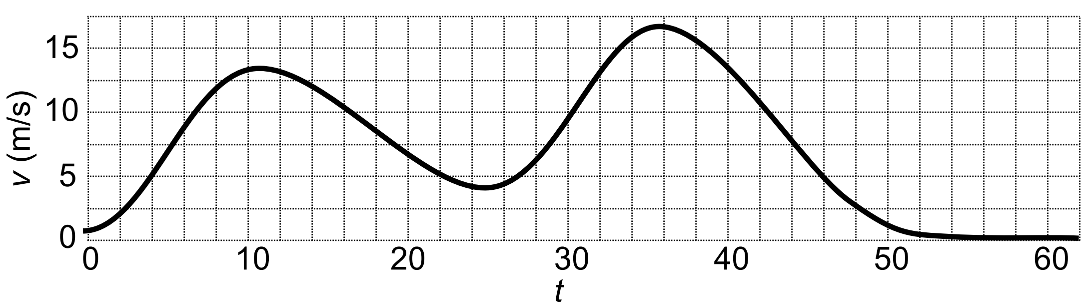


6. Consider an object on a horizontal spinning disk. In what situation does the object's net acceleration vector point outwards, away from the axis of rotation?

a. when the angular velocity is constant
b. when there is a large angular acceleration
c. when there is a large angular deceleration
d. when the disk is spinning backwards
e. never; the net acceleration never points outwards

7. The following graph shows the *speed* of a rollercoaster as a function of time. Which of the following is true?

a. the rollercoaster was going uphill at t = 30 s
b. the rollercoaster went backwards at t = 40 s
c. the momentum of the rollercoaster was conserved
d. the rollercoaster's kinetic energy was higher at t = 36 s than at t = 26 s
e. all of the above



8. A heavy truck bumps into a small car. Which of the following is true?

a. the force of the truck on the car is *greater than* the force of the car on the truck
b. the force of the truck on the car is *equal to* the force of the car on the truck
c. the force of the truck on the car is *less than* the force of the car on the truck
d. which force is greater depends on the truck and car initial velocities
e. which force is greater depends on whether the road is level or sloped

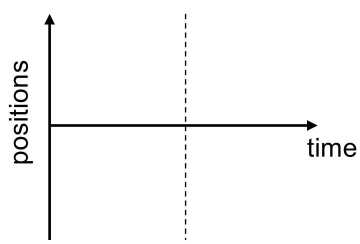
9. By analyzing the units, which of the following equations could describe the power produced by a windmill? r is the blade radius in m, ρ is the air density in kg/m^3, v is the wind velocity in m/s.
   a. $P = \pi r^2 v^2/2$
   b. $P = \pi\rho r^2 v^2/2$
   c. $P = \pi\rho r^2 v^3/2$
   d. $P = \pi\rho r v^4/2$
   e. $P = \pi\rho r^3 v^3/2$

10. You carry a 25 kg rock for 10 m on level ground at a constant 2 m/s, without lifting or lowering the rock. How much work do you do on the rock?
   a. 0 J
   b. 50 J
   c. 250 J
   d. 490 J
   e. 2450 J

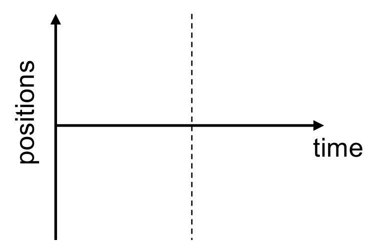
Short answer (6 points each)

11. Consider a collision between two gliders on an air track, as in lab 6. Glider 1 weighs 0.5 kg and starts with $x_1 < 0$ and positive velocity. Glider 2 weighs 0.1 kg and starts stationary at $x_2 = 0$. Sketch graphs of *both* of their positions over time for (a) an elastic collision and (b) an inelastic collision in which they stick together. The dashed line represents the time of collision. *Label which line corresponds to which glider.*

(a) elastic collision

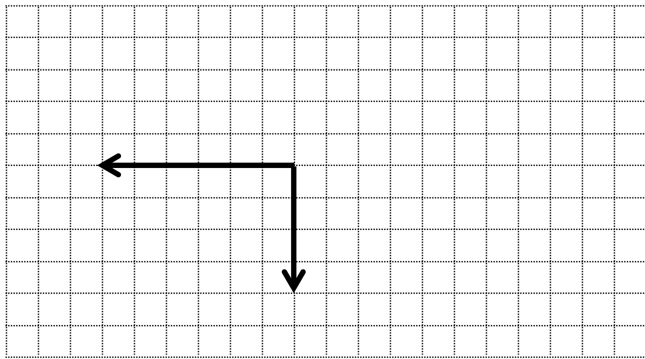


(b) inelastic collision

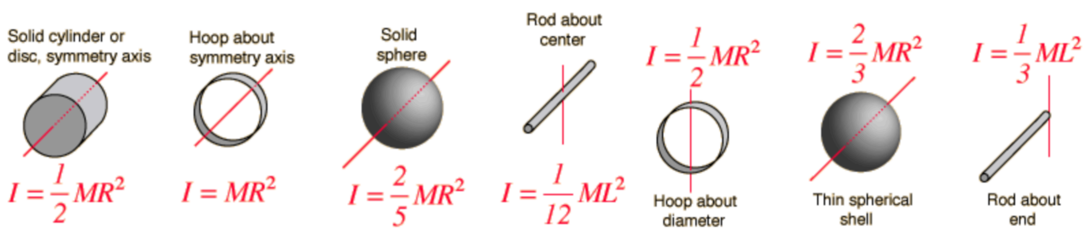


12. The International Space Station (ISS) orbits the Earth without falling and crashing into the Earth. How does it do this?

13. Two vectors are shown in the following picture. Draw a third one that will make the sum of the three vectors equal to zero.



Longer answer (5 points per problem part)
Give all answers with 3 significant figures and don't forget the units.



14. A wheel of *diameter* 0.70 m rolls on the floor without slipping. A point at the top of the wheel moves with a speed 2.0 m/s relative to the floor. (a) At what speed is the central axis of the wheel moving relative to the floor? (b) What is the angular speed of the wheel?

(a)

(b)

15. A wheel starts from rest and has a uniform angular acceleration of 4.0 rad/s^2. After the wheel completes its first revolution, how long does it take for it to make its *second* complete revolution?

16. Your not-so-smart friend rolls a 7 kg bowling ball from the top of Capitol Hill. It rolls until it stops at a fence just above the freeway, which is a 50 meter descent. Its velocity is 0 when it starts and 21 m/s just before it stops. The ball's radius is 11 cm. Just before it stops, what is (a) its translational kinetic energy, (b) its rotational kinetic energy, and (c) the total amount of energy that was converted to heat?

(a)

(b)

(c)

17. A car wheel uses drum brakes which push outwards on the inside of the wheel rim. The wheel has an inner radius of 0.10 m, an outer radius of 0.25 m, and a moment of inertia of 1.8 kg m^2. The brakes push with a force of 2000 N and the coefficient of kinetic friction is 0.40. (a) how much torque do the brakes apply to the wheel? (b) if the car is on a lift so that the wheel is spinning freely without touching the road, what is the wheel angular deceleration? (c) what is the car deceleration if the car weighs 1000 kg and similar brakes operate in all 4 wheels (neglect the wheel inertia here)?

(a)

(b)

(c)

18. A person throws a 0.2 kg ball horizontally off of a 40 m high cliff at 15 m/s. (a) How long does it take the ball to hit the ground? (b) How far away from the cliff base does the ball land? (c) What is the magnitude of the ball's *total* velocity when it hits the ground?

(a)

(b)

(c)

19. After jumping from a plane, a 65 kg skydiver falls at terminal velocity, which is about 60 m/s. (a) How much power is transferred from the skydiver to the air due to air resistance? He then opens a parachute, which takes 1.8 seconds to slow him down to 5 m/s. (b) What is the total impulse on him during parachute opening? (c) What is the direction and magnitude of his average acceleration as the parachute opens?

(a)

(b)

(c)

20. A person decides to use a flywheel to store energy. The flywheel has mass m, all of which is located at the rim. It has radius r and is held together by n spokes. Each spoke can withstand tension T before breaking. It is spun faster and faster until the spokes break. (a) What was its angular velocity just before it broke apart? (b) What was its energy just before it broke apart?

(a)

(b)