General Physics
Physics 101
Final – Fall 2015
Wednesday – 12/16/15
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. You're 6.0 m from one wall of a house, and want to toss a ball to your friend who is 6.0 m from the opposite wall. The throw and catch occur 1.0 m above the ground and the peak of the roof is 6.0 m from the ground. What is the minimum vertical velocity that will allow the ball to clear the roof?

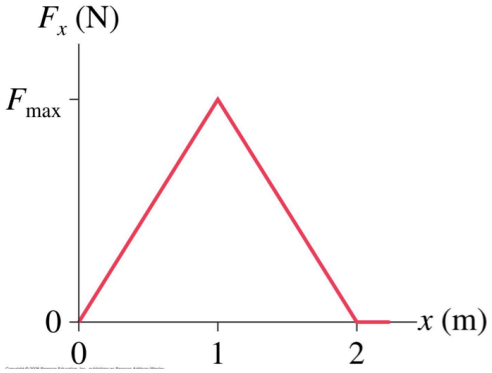
(a) 11 m/s
(b) 9.9 m/s
(c) 1.1 m/s
(d) need more information

2. 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. Ignoring bearing friction, how long did it take the flywheel to spin-up to its maximum counter-clockwise angular velocity of 125 rad/s?

(a) 1.25×10^3 s
(b) 0.80 ms
(c) 12.5 s
(d) Need more information

3. A 200 g block hangs from a spring with spring constant 10.0 N/m. At t=0.00 s the block is 20.0 cm below the equilibrium position moving upward with a speed of 100 cm/s. What is the block's Amplitude of oscillation?

(a) 14.1 cm
(b) 0.245 m
(c) 200 mm
(d) 6.00×10^{-2} m



4. 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

5. You and your trusty pendulum to the moon, by what would the period of the oscillation on the moon change by in comparison to the period on earth? Recall that the acceleration due to gravity on the moon is 1/6 of the value found on earth.

(a) 1/6
(b) $\sqrt{6}$
(c) 6
(d) $1/\sqrt{6}$

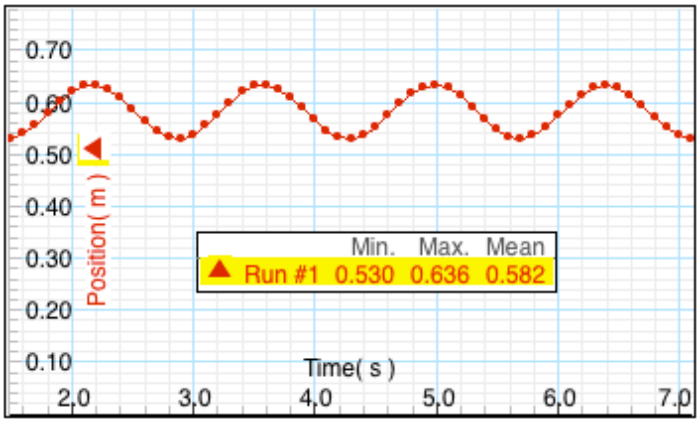
6. It takes the earth 1 year to orbit the sun, and 24 hours to complete one rotation on its axis. Which angular speed is smaller?

(a) The earth orbiting the sun.
(b) The earth rotating on its axis.
(c) They are the same.
(d) Need more information.

7. You push a 10.0 kg box with a constant horizontal 49.0 N Force over a distance of 10.0 meters across a carpeted floor. If the coefficient of kinetic friction between the floor and the box is 0.500 and the box moves with a constant velocity, what is the net work done by all forces acting on the box?

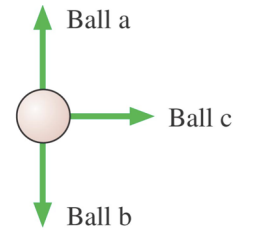
(a) 0.00 J
(b) 98.0 J
(c) 490 J
(d) 980 J

8. In the last lab, you took the following data for the position vs time of a 500 g mass oscillating on a spring. What is the approximate angular frequency for this oscillation?



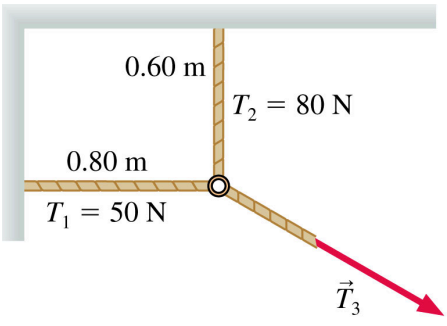
(a) 4.5 rad/s
(b) 0.72 rad/s
(c) 2.2 rad/s
(d) 9.0 rad/s

9. The three balls shown have equal masses and are fired with equal speeds from the same height above the ground. Which ball hits the ground with the largest speed?

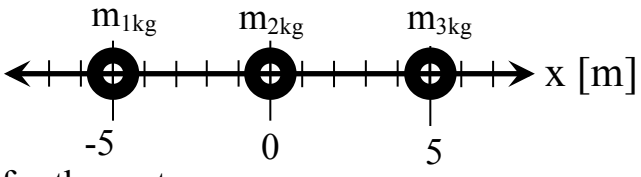


(a) Ball a
(b) Ball b
(c) Ball c
(d) All speeds are the same

10. The three ropes shown are tied to a very light ring. Two of these ropes are anchored to the walls at right angles with the tensions shown. What is the angle that the third rope pulls with?



(a) 58º below the horizontal
(b) 32º below the horizontal
(c) 53º below the horizontal
(d) 37º below the horizontal



11. Three particles of mass 1.0 kg, 2.0 kg and 3.0 kg are located as shown. Calculate the location of the center of mass for the system.

(a) 0.0 m
(b) 1.7 m
(c) -3.3 m
(d) 3.3 m

12. An ice-cube slides from rest down a 30º ramp. If it takes 300 ms for it to slide, how long is the ramp?

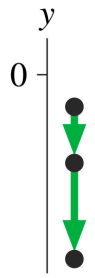
(a) 0.22 m
(b) 44 cm
(c) 74 cm
(d) 3.0 x 10^2 m

13. A bicycle wheel is spinning with an angular velocity of 12 rad/s and experiences an angular acceleration of -0.050 rad/s^2. After 20 seconds, what is the angular velocity of the wheel?

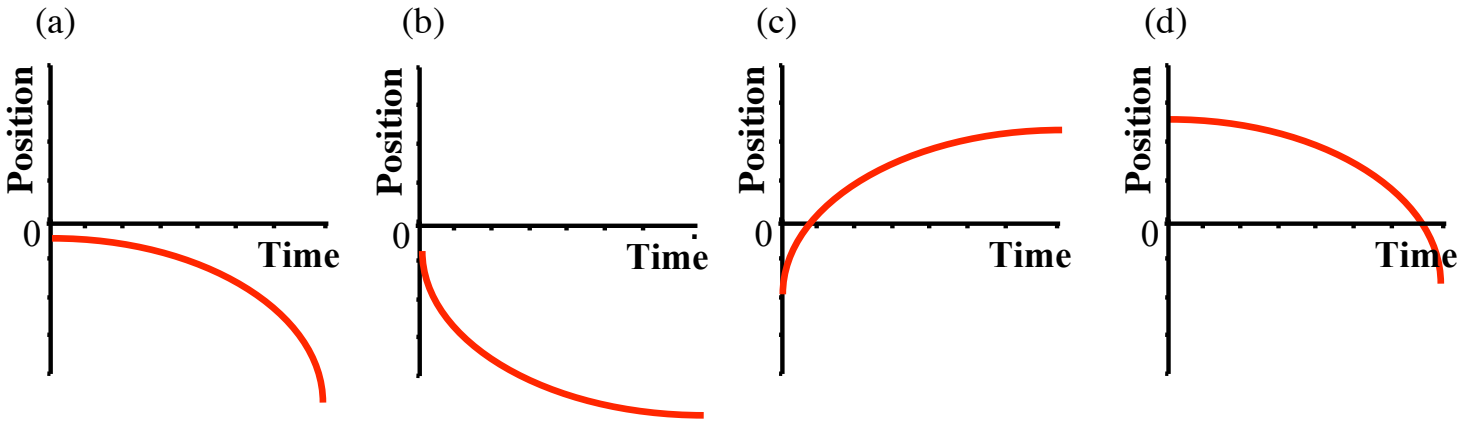
(a) 1.0 rad/s
(b) 1.1 rad/s
(c) 2.0 rad/s
(d) 11 rad/s

14. In Ridiculous 6, Tommy Stockburn fires an arrow straight up in the air, and he catches it in his mouth 3.0 seconds later. How high did the arrow travel into the air? Assume the launch and landing point are the same point.

(a) 44 m
(b) 1.1 m
(c) 11 m
(d) Need more information



15. Which of the following position versus time graphs could represent the motion diagram shown.



16. The Kessel Run involves flying a spaceship through a cluster of blackholes known as the Maw. Ignoring any alterations to the space-time continuum, the Maw has an area of 42 square parsecs. If 1 parsec is 3.085×10^{16} meters, what is the SI equivalent value of this area?

(a) 1.295×10^{18} m^2
(b) 9.5×10^{32} m^2
(c) 4.0×10^{34} m^2
(d) 1.3×10^{18} m^2

17. An 8.0 cm diameter, 400 g, solid sphere is released from rest at the top of a 2.1 m long, 2.5º incline (0.89 m vertical fall). It rolls without slipping to the bottom of the ramp. What is the sphere's angular speed at the bottom of the ramp?

(a) 88 rad/s
(b) 3.5 rad/s
(c) 1.4×10^2 rad/s
(d) 33 rad/s

18. A 2.50 kg coconut is traveling to the east at 5.00 m/s. It explodes and splits into two pieces (1.50 kg and 1.00 kg) and the 1.50 kg piece travels to the north at 2.50 m/s. What is the x-velocity of the 1.00 kg piece of the coconut post explosion?

(a) 8.75 m/s
(b) 3.75 m/s
(c) 12.5 m/s
(d) 8.33 m/s

19. A mass-spring system (m=2.00 kg and k=8.00N/m) oscillates with a 0.25 m amplitude. Which of the following could be an equation of motion for the system? Units inside sine/cosine are suppressed.

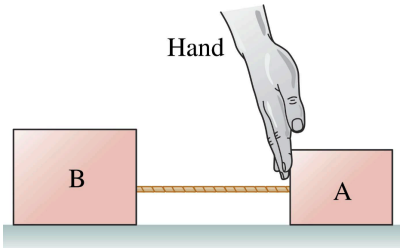
(a) $v(t) = (0.25\ m) \sin (2.0\ t)$
(b) $x(t) = (0.25\ m) \cos (4.0\ t)$
(c) $v(t) = -(0.25\ m/s) \sin (2.0\ \pi\ t)$
(d) $a(t) = -(1.0\ m/s^2) \cos (2.0\ t)$

20. A crane lowers a steel girder into place. The girder moves with a decreasing speed. Consider the work done on the beam by gravity (W_G) and the work done by the tension in the cable (W_T). Which of the following statements is false?

(a) $|W_G| < |W_T|$
(b) W_{net} is negative
(c) W_{nc} is negative
(d) W_G is negative

21. Sam (m=75 kg) straps on his skis and starts down a 50-m high, 30º frictionless slope (100 m displacement). A strong headwind exerts a horizontal force of 200 N on him as he skis. What is Sam's kinetic energy when he reaches the bottom of the slope?

(a) 47 kJ
(b) 27 kNm
(c) 5.4×10^4 J
(d) 19×10^3 kg m^2/s^2



22. Block A and B, with masses 1 kg and 2 kg respectively, are connected via a massless string. If the hand exerts a 9 N force on block A, what is the force exerted on mass B by the string?

(a) 12 N
(b) 9 N
(c) 6 N
(d) 3 N

23. 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

24. You are holding a 5.0 kg block in your hand and are moving it vertically while applying an upward force of 75 N. What is the net acceleration of the block?

(a) 15 m/s^2
(b) 9.8 m/s^2
(c) 25 m/s^2
(d) 5.2 m/s^2

25. A 1.0 kg toy car traveling at 2.0 m/s approaches a 3.0 kg toy car that is stationary. Assuming they collide elastically, what is the velocity of the 1.0 kg car post-collision?

(a) 0.50 m/s
(b) 1.0 m/s
(c) -1.0 m/s
(d) -2.0 m/s

26. A 2.0 kg, 20 cm diameter turntable rotates at 100 rpm on frictionless bearings. A 500 g block falls from above, landing on the turntable at the edge. What is the angular velocity of the turntable/block after this event?

(a) 6.981 rad/s
(b) 50 rpm
(c) 2.0 x 10^2 rad/min
(d) 67 rpm

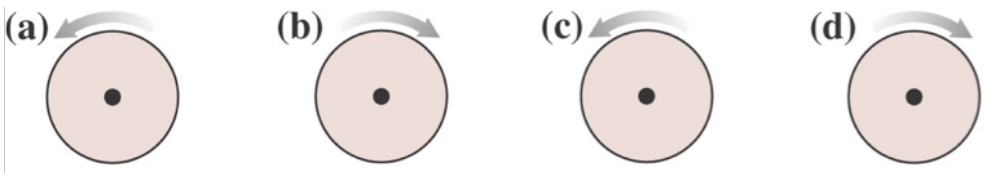
27. A block floats on a cushion of air. It is pushed to the right with a force that remains constant as the block moves from 0 to 1 and from 1 to 2 the size of the force steadily decreases until it reaches half of its initial value. For the block which of the following is true?

(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 2, speeds up at first and then has a constant speed

28. A wooden block of 2.0 kg slides up a wooden ramp angled at 20º above the horizontal. As the block slides back down the ramp, what is the magnitude of the net force acting on the block? Please include friction.

(a) 10 N
(b) 2.5 N
(c) 3.0 N
(d) 16 N

29. Which of the following disc has a negative torque being applied?



Speeding up | Slowing down | Slowing down | Constant speed

30. The normal force equals the magnitude of gravitational force as a roller coaster car crosses the top of a 40 m diameter loop-the loop. What's the car's speed at the top of the loop? Assume the car is upside-down at the top of the loop.

(a) 19.79 m/s
(b) 28 m/s
(c) 20 m/s
(d) 14 m/s

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 2.0 kg block is pulled from rest over a wooden floor with a force of 20 N over a distance of 1.0 m. The net work applied to the block is 10 J.

(a) What is the work done by the pull force?

(b) What is the final velocity of the block?

(c) What is the work done by friction?

(d) After the pull has ended, what is the net force acting upon the system?
No calculations are necessary, but words and a force diagram showing all forces acting on the system are.

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

Trying to determine the mass of a cow, you decide to drop it on a large spring. The cow falls a vertical distance of 1.00 m before it hits the spring.

(a) Just before the cow hits the spring, what is the velocity of the cow?

(b) If the spring constant of the spring is 5.29 kN/m and the spring is compressed by 1.0 m, what is the mass of the cow?

The nimble cow jumps off the spring and hits the ground, causing four deep hoof-prints to be made in the ground. The cow trots away unharmed.

(c) While the cow was impacting the ground, was the force of the cow on the ground larger or smaller than the force on ground on the cow? Explain.

(d) The cow quite pleased with itself starts running in a circle, and makes one complete revolution of the 10 m radius pen in 60 seconds. What is the average velocity of the cow as it completes its lap?

Question 3. **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. The student is pulled down to a point where the cord is 5.0 m longer than its unstretched length, then released.

(a) What is the amplitude of the subsequent oscillation?

(b) What is the max velocity of the student after release and where does it occur?

(c) What is the speed of the student at a half-amplitude position?

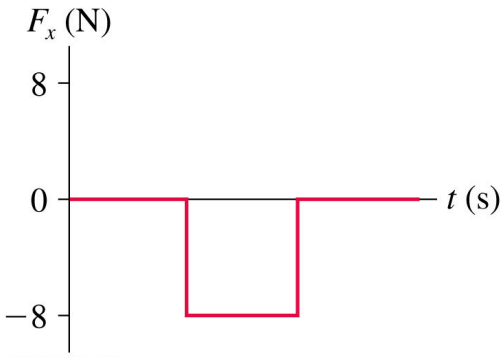
(d) If the next student for the bungee jump is twice as massive than the first and the spring constant and the 5.0 m stretch is the same, is the total energy increased, decreased, or the same? No calculations are necessary, but words and equations will help.

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

You fire a 50.0 g bullet into a 10.0 kg block of wood that sits on a rough surface. The bullet leaves the gun with an initial speed of 300 m/s. The bullet and the block collide. Immediately after the collision, the block has a velocity of 1.00 m/s, and the bullet travels away free of the block. Assume that all motion is in one-dimension.

(a) What is the velocity of the bullet after it leaves the block?

(b) What impulse does the bullet experience during the collision??

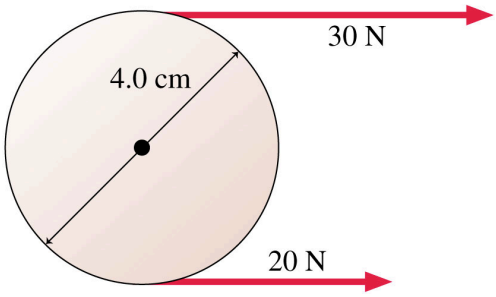


(c) In the collision is the total mechanical energy conserved? Explain.

(d) Immediately after impact the block travels a distance of 50 cm, before coming to rest. What is the force (magnitude and direction) acting on the block?

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

A solid disc experiences the forces shown.



(a) What is the net torque about the axle?

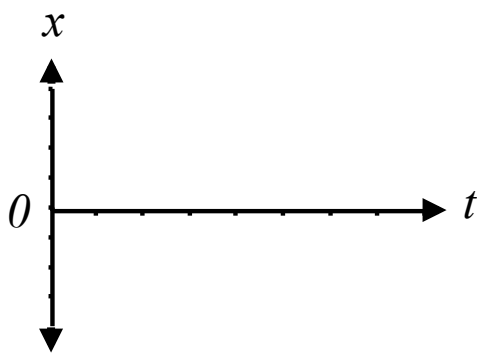
(b) If the disc changes its angular momentum by 10 kg m^2/s, how long were the forces applied?

(c) If the angular speed changes from 10 rad/s to 20 rad/s, what is the inertia of the disc?

(d) As the disc speeds up, is the tangential acceleration the same at all points on the disc? Explain using equations and words.

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

During week 3 lab, you launched a ball from rest to a horizontal speed of 9.0 m/s moving to the right.



(a) Sketch a position vs time plot that could represent the motion of ball as it is launched. Please explain the shape & meaning of the graph.

(b) Post launch the ball falls an unspecified distance and impacts the ground with a speed of 10 m/s. What vertical distance did the ball fall?

(c) How long did it take the ball to fall?

(d) The ball lands on the ground spinning with a tangential speed equivalent to the impact speed (10 m/s). If the ball has a radius of 2.0 cm, and it comes to rest after making 20 revolutions, what is the magnitude of the angular acceleration, the ball experiences?