General Physics
Physics 101
Final – Fall 2013
Tuesday – 12/10/13
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:_____

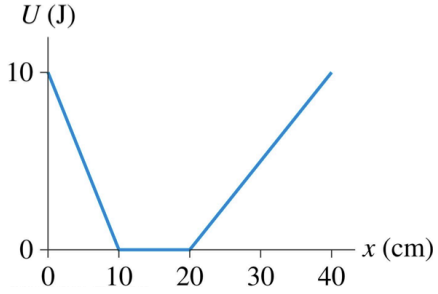
Part I. Multiple Choice (3 pts each)

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 particle has the potential energy shown. What is the x-component of the force on the particle at x=30 cm?

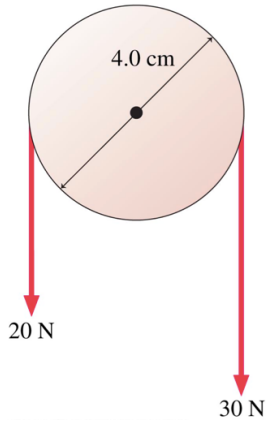


(a) 17 N
(b) -50 kg m/s^2
(c) 100 N
(d) -17 kg m/s

2. Astronauts on their first trip to Mars take along a pendulum that has a period on earth of 1.50 s. The period on Mars turns out to be 2.42 s. What is the free-fall acceleration on Mars?

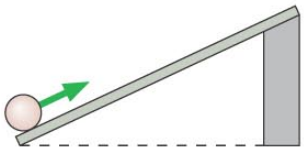
(a) 3.77 m/s^2
(b) 25.5 m/s^2
(c) 12.4 m/s^2
(d) 7.72 m/s^2

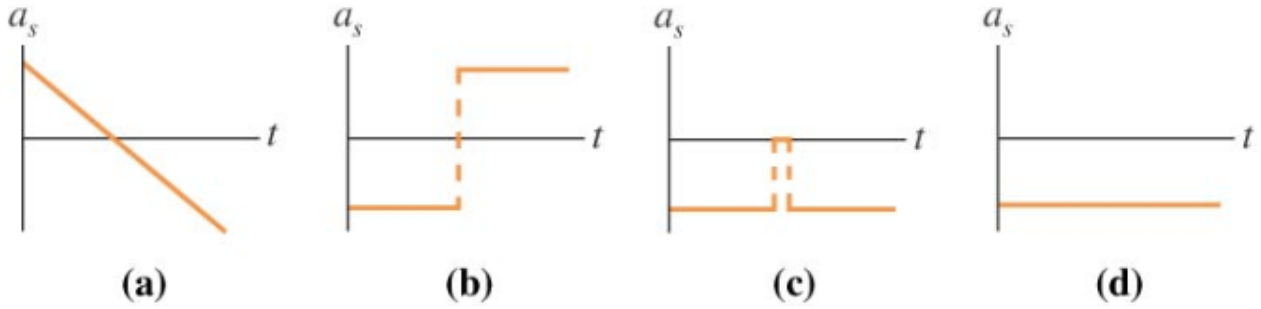
3. The 10 kg solid disc with a diameter of 4.0 cm has the forces applied as shown. What is the angular acceleration of the disc?



(a) -50 rad/s^2
(b) 25 rad/s^2
(c) -1.0 x 10^2 rad/s^2
(d) 0.0 rad/s^2

4. The ball shown rolls up the frictionless ramp and back down. Which is the correct acceleration graph?





5. A 620 g bird has a 60 g stick in its mouth (680 g total) that is coasting in the air horizontal to the ground at 30 m/s. If the bird releases the 60 g stick, what is the bird's velocity just after the stick leaves the bird's mouth.

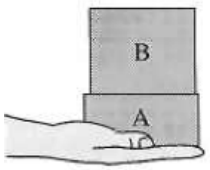
(a) 30 m/s
(b) 33 m/s
(c) 3.4×10^2 m/s
(d) 27 m/s

6. The volume of a sphere is calculated as 1 in^3. What is the volume in cm^3?

(a) 0.394 cm^3
(b) 0.06 cm^3
(c) 16.4 cm^3
(d) 2×10^1 cm^3

7. You have a 10 kg box is sitting in the bed of your truck. The truck traveling at 10 m/s comes to rest in 5.0 s, and the box does not slide. Which of the following statements is correct as the truck comes to rest?

(a) The box is in static equilibrium
(b) The box is in dynamic equilibrium
(c) The box is not in equilibrium
(d) The box is in unstable equilibrium



8. Block A and B are 5.0 kg and 10.0 kg respectively. As shown, these blocks are lifted with a uniform acceleration of +2.0 m/s^2. What is the magnitude of the force of block A on block B?

(a) 1.2 x 10^2 N
(b) 20 N
(c) 78 N
(d) 59 N

9. A process occurs in which a system's potential energy increase while the environment does work on the system. Does the system's kinetic energy… Ignore Thermal Energy.

(a) Increase
(b) Decrease
(c) Stay the same
(d) Not enough information to tell

10. 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. What is the max velocity of the student after release?

(a) 1.8 m/s
(b) 3.6 m/s
(c) 5.4 m/s
(d) 9.0 m/s

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

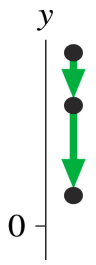
12. A hollow sphere and a solid disc of the same radius and mass roll from rest down an incline. Which reaches the bottom of the incline first?

(a) The hollow sphere
(b) The solid disc
(c) Both reach the bottom at the same time.
(d) Need more information.

13. A 10 kg block is thrown vertically downward with an initial speed of 2.0 m/s from the top of a tall tower. If it takes 10 seconds to reach the ground, how high is the tower?

(a) 5.1×10^2 m
(b) 470 m
(c) 69 m
(d) 490 m

14. For the following diagram, what is true.



(a) Velocity is decreasing
(b) Velocity is positive
(c) Acceleration is negative
(d) Position is negative

15. 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 rad/s^2
(d) 7.5 rad/s^2

16. 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?

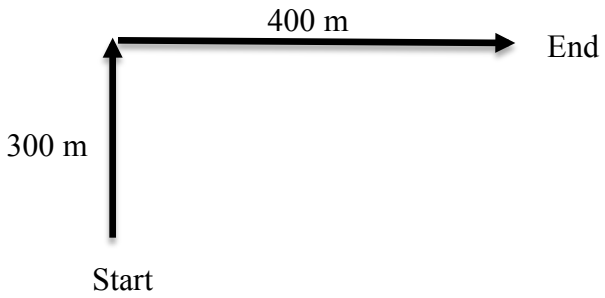
(a) 3.0 m/s
(b) 1.3 m/s
(c) 1.0 m/s
(d) 0.0 m/s

17. You are dragging your 25 kg kid brother at constant velocity on a blanket pulling at an angle of 30º above the horizontal with a force of 100 N over a distance of 20 m. If you pull for 1.0 minute, how much power have you expended dragging your brother?

(a) 1.7 kW
(b) 29 J/s
(c) 17 W
(d) 33 W

18. Jimmy and Jenny are playing on a 1.8 m long see-saw with pivot point at its center. Jimmy has a mass of 50 kg and Jenny has a mass of 40 kg. If Jenny sits 0.80 m from the pivot point, how far does Jimmy have to sit from the pivot point to balance the see-saw?

(a) 0.32 m
(b) 0.44 m
(c) 0.64 m
(d) 1.0 m



19. In the middle of a field, you walk in a straight line 300 m to the north and then 400 m to the east. What total distance did you travel?

(a) 100 m
(b) 500 m
(c) 700 m
(d) 220 m

20. An object moves with simple harmonic motion. If the amplitude and the period are both doubled, the object's maximum speed is:

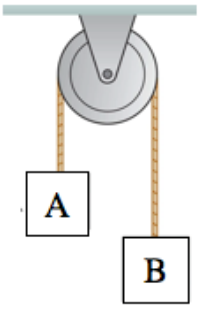
(a) Doubled
(b) Halved
(c) Quadrupled
(d) Unchanged

21. 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 force (assumed to be constant) does Bob apply to the rock?

(a) 1.5×10^5 N
(b) 150 N
(c) 338 N
(d) 225 Nm

22. A 1000 kg safe is 2.0 m above a heavy-duty spring when the rope holding the safe breaks. The safe hits the spring and compresses it by 50 cm. What is the spring constant of the spring?

(a) 156800 Nm
(b) 2.0×10^5 N/m
(c) 2.0×10^4 N/m
(d) 1.6×10^5 N/m



23. For the Atwood's machine shown m_A = 2.0 kg and m_B=1.0 kg
What is the acceleration of the system when released?

(a) 3.3 m/s^2
(b) 4.9 m/s^2
(c) 6.5 m/s^2
(d) 29 m/s^2

24. A 0.20 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 for a time of 1s, starting from rest. After the force is removed at 1 s, the momentum of the plastic cart is _____ the momentum of the lead cart.

(a) greater than
(b) less than
(c) equal to
(d) not possible to compare

25. You throw a rock into the air with a velocity v, and it reaches a maximum vertical distance of 2.0 m. If you double the throw velocity, how high does the rock go now?

(a) 8.0 m
(b) 4.0 m
(c) 2.8 m
(d) 2.0 m

26. Which of the following statements is false?

(a) Two vectors of unequal magnitude cannot add to zero.

(b) In projectile motion, the kinetic energy can be non-zero at the max height.

(c) The unit "candela" is not an SI base unit.

(d) In a conservative system, the total mechanical energy is always constant.

27. A 4000 kg truck is parked on a 15º slope and the coefficient of static friction between the tires and the road is 0.90. How big is the friction force on the truck?

(a) 34078 N
(b) 3.8×10^4 N
(c) 3.4×10^4 N
(d) 10 kN

28. A horizontal mass-spring system with a mass of 1.00 kg has an equation of motion of x(t) = (3.14 m) sin (2.00 t). What is the maximum kinetic energy of the mass?

(a) 19.7 J
(b) 6.28 J
(c) 3.14 J
(d) Need more information

29. A 2.0 kg meter stick is rotating with angular speed of 20 rpm about its center of mass. If a 1.0 kg half-meter stick is dropped on top of the meter-stick, what is the new angular speed?

(a) 16 rpm
(b) 80 rpm
(c) 18 rpm
(d) 10 rpm

30. As you turn a 50 m radius corner in your car, you continue to move forward and as the car turns, you strike the door. As you are now a "scholar" of physics, you know that the force required to turn you is 100 N, and your mass is 75 kg. With what angular speed were you traveling as you were experiencing this force?

(a) 0.0 rad/s
(b) 0.027 m/s
(c) 8.2 rad/s
(d) 0.16 rad/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.

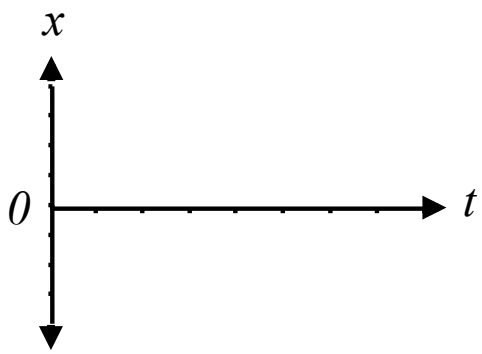
Please show all of your work, including equations without numbers.
Please provide units with all answers.
Partial credit may be given if you include your work.

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

xkcd.com

A velociraptor spots you 40 meters away and attacks, accelerating from rest at -4.0 m/s^2 up to its top speed of 25 m/s.
(a) How long has the velociraptor traveled before it reaches its top speed?

(b) Sketch a position vs time plot that could represent the motion of the velociraptor while it accelerates to its top speed. Please explain the shape & meaning of the graph.



(c) You make it into the next room and slam a 20 kg, 1.0 m wide door by applying a constant 10 N force at the edge of the door at an angle of 70º between the force and the radius. What is the torque you apply to the door?

(d) The 50 kg velociraptor screeches to a halt over a distance of 3.0 m, what is the magnitude of the friction force between the floor and the velociraptor?

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

Unsurprisingly, A "Sharknado" has been spotted*. Two sharks are ejected from the "Sharknado" and are connected by an aluminum pipe (which we'll assume is massless, and is properly secured to each shark). One shark is 1000 kg and the other is 2000 kg, and distance between each shark is 2.0 m. *Sharknado IV, the search for more money.

(a) Where is the center of mass of the two-shark system?

(b) If the two-shark system is rotating counter-clockwise about its center of mass, what is the total moment of inertia of the two-shark system?
Treat the sharks as point particles.

(c) Which shark is experiencing a larger centripetal acceleration? No calculations are necessary, but words and equations are expected.

(d) If the two-shark system is rotating counter-clockwise at 10 rad/s, what torque (mag dir) will bring the sharks to a halt in 5.0 seconds?

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

A student is asleep on the top bunk, which is 2.20 m from the floor.

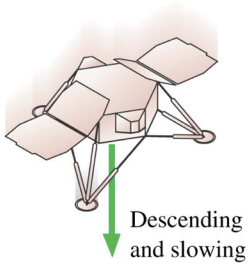
(a) If he roles off the bed with an initial horizontal velocity of 1.10 m/s, what is his impact speed when he reaches the floor?

(b) How long did it take to reach the floor?

(c) Draw a complete motion diagram for his flight (bed to floor).

(d) When the student collides with the floor (obviously awakened by the pain of impact), does the floor or the student experience a larger force? Explain using words and possibly equations. No calculations are necessary.

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



A 50.0 kg Martian lander is approaching the surface. It is slowing its descent by firing its rocket motor, which exerts an upward thrust force of 238 N in magnitude on the lander. Ignore air resistance and fuel loss.

(a) As the lander descends, it slows due to the thrust. What are signs of the work done by gravity, work done by the thrust force and the net work? Be sure to explain and/or justify your answer with words and possibly equations.

(b) If the lander's initial velocity is 65.0 m/s downward, and it travels 2100 m until the lander slows to 5.0 m/s, what is the net work done on the Lander while it slows?

(c) Using the concept of net work, determine the work done by the gravity during the descent.

(d) Determine the acceleration due to gravity on Mars.

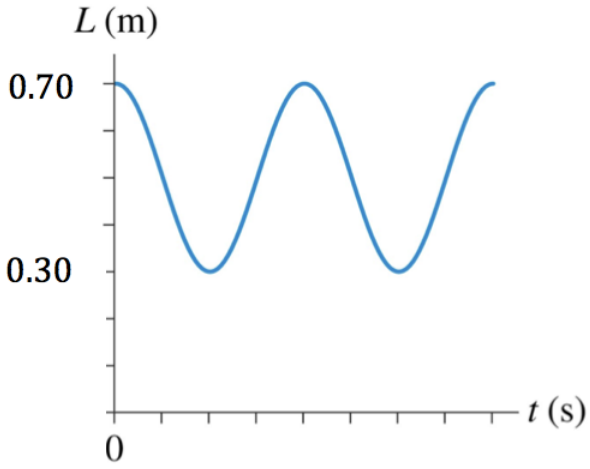
Question 5. **Grade this problem? Yes or No (circle one)**

An air-track glider attached to a spring oscillates between the 30 cm mark and the 70 cm mark on the track. The glider completes 10 oscillations in 40 seconds.

(a) If the mass of the glider is 500 g, what is the spring constant of the spring?

(b) What is the speed of the mass, when it is located at the 40 cm mark?

(c) A graph of the length of the spring versus time is shown. Mark on the graph a possible location of the maximum velocity. Also mark a place where the acceleration is a maximum. Justify your choices with words and possibly equations.



(d) If you double the amplitude by what factor does the total energy change? Equations are necessary, but you are not required to calculate the total energy, just determine the "factor" by which it changes.

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

A 6.0 kg block sits at rest on an icy-frictionless surface, and explodes into 3 pieces. A 1.0 kg piece travels to the south at 2.0 m/s. A 2.0 kg piece travels to the north-west with velocity components of 1.0 m/s to the north and 1.0 m/s to the west. The 3.0 kg piece travels off to the east.

(a) What is the velocity of the 3.0 kg block after the explosion?

(b) The 3.0 kg piece travels over a rough patch of ice and experiences an acceleration of 0.20 m/s^2 to the west. What is the coefficient of friction between the block and the ice?

(c) The 1.0 kg piece traveling at 1.0 m/s collides with a stationary 0.50 kg block. If the 1.0 kg piece moves away with a velocity 0.50 m/s post collision, what is the velocity of the 0.50 kg block post-collision?

(d) The 0.50 kg block begins to feel a draft from the wind, which slows the block to half of its velocity found in (c). If the wind lasts for 4.0 seconds, what impulse does the block experience?