General Physics
Physics 101 –10:00 AM Section
Final – Spring 2015
Monday – 5/4/15
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:

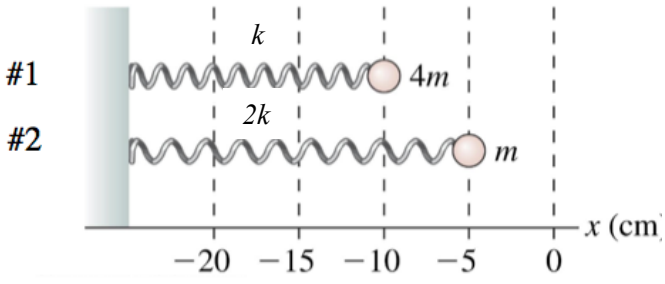
1. A mass-spring system (m=2.00 kg and k=8.00N/m) oscillates with a 0.25 m amplitude. Which of the following could be an equation of motion for the system? Units inside sine/cosine are suppressed.

(a) $v(t) = (0.25\ m) \sin (2.0\ t + \pi/2)$
(b) $a(t) = -(1.0\ m/s) \cos (2.0\ t)$
(c) $v(t) = -(0.50\ m/s) \sin (2.0\ t)$
(d) $x(t) = (0.25\ m) \cos (4.0\ t)$

2. An ice hockey puck slides across frictionless ice with an initial kinetic energy of 1.0 J. The puck slides past a ventilation duct that applies an average force of 2.0 N on the puck at angle of 30º below the horizontal slowing the puck. If this occurs over a distance of 1.0 m, what is the puck's kinetic energy after leaving the influence of the ventilation duct?

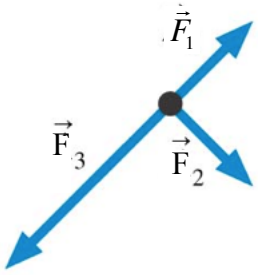
(a) 1.7 J
(b) 0.73 J
(c) 0 J
(d) The puck never makes it to 1.0 m

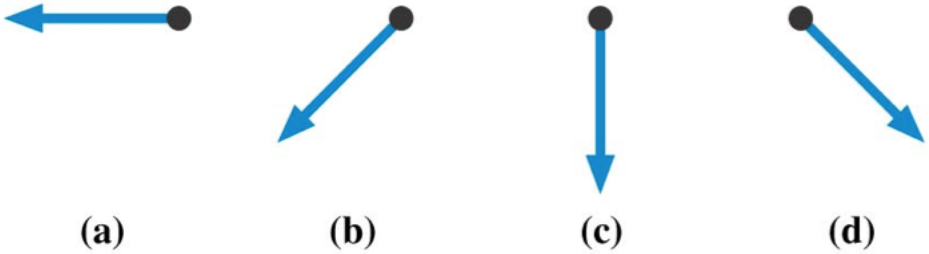
3. Two springs have been compressed from their equilibrium positions at x=0 cm. When released they will start to oscillate. Which has the larger maximum speed?



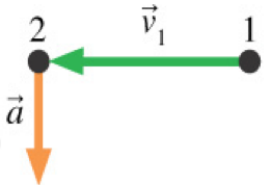
(a) They are the same.
(b) 1
(c) 2
(d) Not enough information provided.

4. For the force vectors shown, which of the following vectors represents the net force?



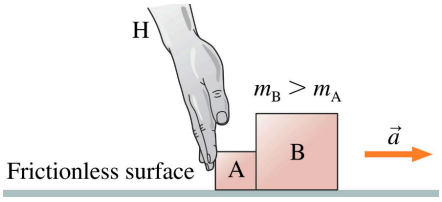


5. A particle undergoes the acceleration shown, while moving from point 1 to point 2. Which of the following statements is false about the subsequent motion of the particle.



(a) The particle curves downward.
(b) The particle's velocity is constant.
(c) The particle is moving to the southwest
(d) It is possible the particle could follow a circular path

6. Two blocks are pushed by a hand, which of the following net force equations is not possible for the system.



(a) $\sum F_B = m_B a = F_{AonB}$

(b) $\sum F_A = m_A a = F_{Hand} - F_{BonA}$

(c) $\sum F_{tot} = (m_A + m_B) a = F_{Hand}$

(d) $\sum F_{tot} = m_{tot} a = F_{Hand} - F_{AonB} + F_{BonA}$

7. A 10 kg ball is thrown downwards from a cliff at a velocity of 10 m/s, it lands on the ground below the cliff 10 seconds later. What was the impact velocity of the ball?

(a) -88 m/s
(b) 108.0 m/s
(c) 1.0×10^2 m/s
(d) -0.11 km/s

8. A block pushed along the floor with velocity, *v*, slides a distance, d, after the pushing force is removed. What initial velocity is necessary, if you want the block to travel a distance of 4d before stopping?

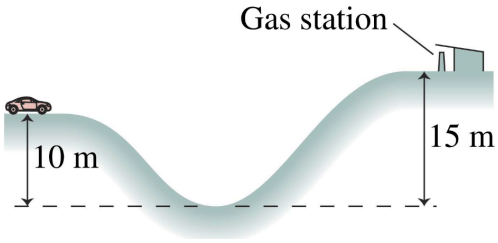
(a) $2v$
(b) $4v$
(c) $\frac{1}{4}v$
(d) $\sqrt{2}v$

9. A process occurs in which a system's potential energy increases, while the environment does work on the system. Ignoring Thermal Energy, what happens to the kinetic energy of the system?

(a) Increases
(b) Decreases
(c) Remains unchanged
(d) Not enough information to tell

10. In lab, you launched a ball a horizontal distance of 9.40 m in 1.40 seconds. The launcher was set at a launch angle of 45.0º above the horizontal and we can assume the initial and final vertical positions are 1.00 m from the floor. What is the launch velocity of the ball?

(a) 6.71 m/s^2
(b) 9.50 m/s
(c) 7.89 m/s
(d) 4.75 m/s



11. A 1500 kg car suddenly runs out of gas while approaching the valley shown. If the speed at the bottom of the hill is 18 m/s, what was the kinetic energy of the car when it ran out of gas? Ignore Friction

(a) 9.6 x 10^4 Nm
(b) 2.5 x 10^5 J
(c) 3.9 x 10^5 J
(d) 9.6 kNm

12. A rocket ship in deep space is traveling at -10 m/s and is caught in a tractor beam which causes the ship to slow. If the ship has a displacement of +10 m after 1.0 minute, what is the acceleration of the ship?

(a) 40 m/s
(b) 0.67 m/s^2
(c) -0.33 m/s^2
(d) 0.34 m/s^2

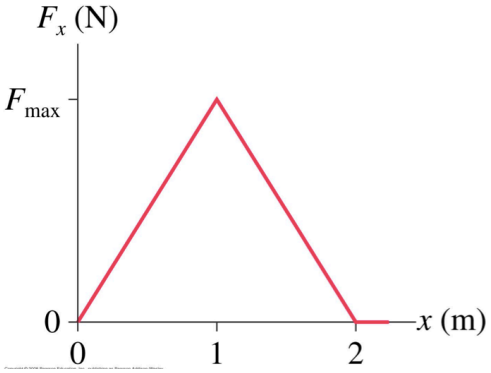
13. Calculate the moment of inertia for a 1.0 kg meter stick oscillating about its 0.30 m mark

(a) 0.12 kg m^2
(b) 0.29 kg m^2
(c) 0.33 kg m^2
(d) 0.37 kg m^2

14. A 10 kg rocket is launched upwards with an acceleration of 5.0 m/s^2. What is the work done by the thrust force once the rocket has traveled 100 m? Ignore mass loss.

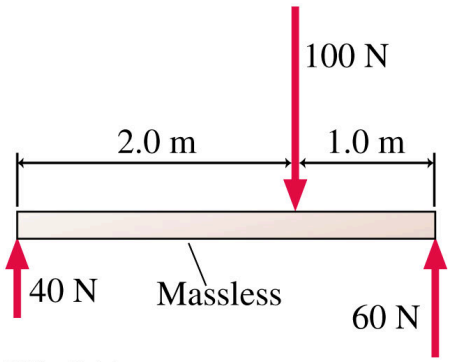
(a) 5.0 x 10^2 Nm
(b) 15 kJ
(c) 4.8 x 10^2 W
(d) 5.0 x 10^3 J

15. 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?



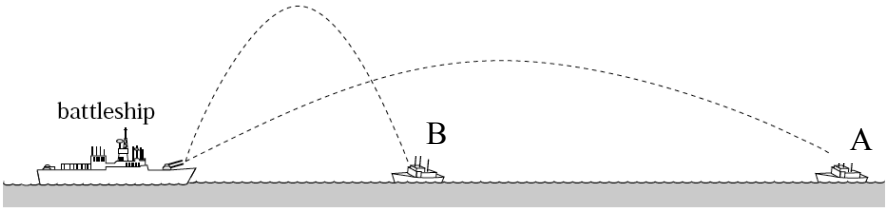
(a) 8.0 N
(b) 4.0 J/m
(c) 9.0 kg m/s^2
(d) 16.0 N

16. The massless beam shown can rotate freely about its right end. What is the net outcome of the applied forces?

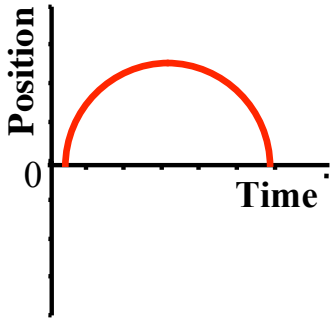


(a) Rotates CCW
(b) Rotates CW
(c) Does not rotate but translates.
(d) Is in equilibrium.

17. A battleship fires two shells simultaneously at enemy ships. If the shells follow the trajectories shown, which ship gets hit first?



(a) A
(b) both at the same time
(c) B
(d) need more information



18. Which of the following statements about this position versus time graph is true? Assume the moving object is a rigid body and only moving in one-dimension.

(a) The object has a non-zero velocity at its maximum height.

(b) The object has a moment of zero acceleration during the motion

(c) The rise and fall time for the motion are the same.

(d) The velocity changes from positive decreasing to positive increasing.

19. 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 1, speeds up at first and then has a constant speed

20. In Avengers: Age of Ultron, Iron Man in the in his "HulkBuster" armor punches a stationary Hulk, and the Hulk travels off at a velocity of 41 m/s (he flies about 100 m). In the trailer for the movie, the punch lasts for three frames (67 ms), and we can estimate the Hulk has a mass of about 4.0×10^2 kg. What is the average force experienced by the Hulk from the hit? http://www.wired.com/2015/04/iron-man-hits-hulk-pretty-damn-hard-age-ultron/

(a) 2.4×10^2 N
(b) 1.6×10^4 N
(c) 2.4×10^5 kg m/s^2
(d) Need more information

21. A 2.0 kg mass on the end of a 1.5 m long string is spun in a vertical circle. If at the bottom of the motion tension in the string is 3.0 times the gravitational force, what is the magnitude of the centripetal force acting on the mass at this point in the motion?

(a) 20 N
(b) 39 N
(c) 59 N
(d) 78 N

22. You spin a 1.0 kg ball on the end of a 1.0 m long string from rest with an angular acceleration of 1.0 rad/s^2. What arc length has the ball traveled after the ball has traveled for 1.0 second?

(a) 50 cm
(b) 0.78 rev
(c) 0.50 rad
(d) 1.0 m

23. 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) 34 kN
(d) 1.0×10^4 N

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

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

25. A 200 g block hangs from a spring with a spring constant of 10 N/m. At t = 0s the block is 20 cm below the equilibrium point and is moving with a speed of 100 cm/s. What is the amplitude of oscillation?

(a) 24.49 cm
(b) 20 cm
(c) 2.4 x 10^2 mm
(d) 6.4 x 10^{-2} m

26. The equation for the Ultimate Question of Life, the Universe, and Everything provides the answer of 42 and has the form shown. What are the combined SI base units for this equation?

$$\frac{1}{v}\left(\frac{a}{t^2}\right) = 42 \ [units?]$$

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

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

(c) s^{-3}

(d) $m^2 s^{-3}$

27. 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) greater.
(b) the same.
(c) smaller.
(d) not possible to determine without more information.

28. Which of the following statements is true.

(a) Linear momentum is not always conserved.
(b) Amplitude does not affect the period of a pendulum.
(c) An object in uniform circular motion is not in equilibrium.
(d) The normal & gravitational force on a motionless object are NIII law pairs.

29. A 2.0 kg car collides with a 1.0 kg stationary car and they travel together after the collision at 2.0 m/s. What is the velocity of the 2.0 kg car initially?

(a) 6.0 m/s
(b) 1.0 m/s
(c) 2.0 m/s
(d) 3.0 m/s

30. A 2.0 m diameter, 2.0 kg solid disc accelerates from rest to its operational speed of 50 rad/s and turns through 200 radians during the startup. What is the net torque applied to the disc?

(a) 12.5 J
(b) 6.3 Nm
(c) 25 Nm
(d) 13 Nm

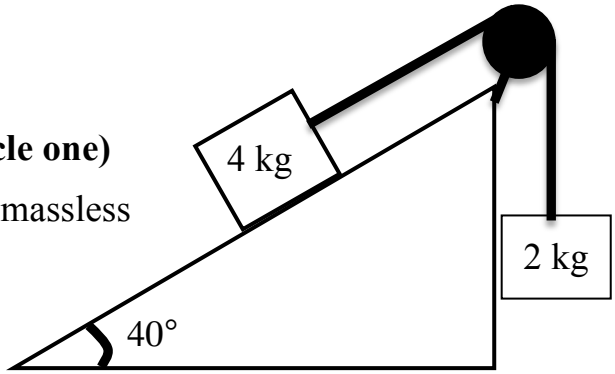
Part II. Short answer problems (12 pts each)

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 4.0 kg block and 2.0 kg block are connected via a massless string. In the first experiment, the blocks are placed as shown on an incline. Ignore friection.
(a) What is the net force on the system?
Please specify direction in terms of up/down ramp.

(b) Draw a motion diagram for the 4.0 kg block including the velocity and acceleration vectors.

You now remove the system from the ramp and start to spin it in a horizontal circle about its center of mass.
(c) Where is the center of mass between the two masses if the string is 1.0 m long?

(d) What is magnitude and direction of the centripetal force on the 2.0 kg block if it is rotating at 3.0 rad/s?

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

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. Ignore bearing friction.

(a) How long did it take the fly wheel to spin-up to its maximum counter-clockwise angular velocity of 125 rad/s?

(b) If the flywheel is disconnected from the motor that "spun it up" and freely rotates, is the net torque on the wheel +, - or 0? Explain using words and equations.

(c) If the spinning wheel is then connected to a machine, which expends half of its energy in 2.0 seconds, what is the average power used during the 2.0 seconds?

(d) The spinning part of the machine was initially at rest. It begins to rotate, and after a certain time is rotating at 40 rad/s (same as the flywheel). What is the inertia of the machine the flywheel connected to?

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

Susan's 10 kg baby brother Paul sits on a matt of negligible mass. Susan pulls the matt across the floor using a rope that is angled 60º above the floor. The tension in the rope is a constant 30 N and the coefficient of friction is 0.10.

(a) What is the normal force acting on the system (Paul + matt) as its pulled across the floor?

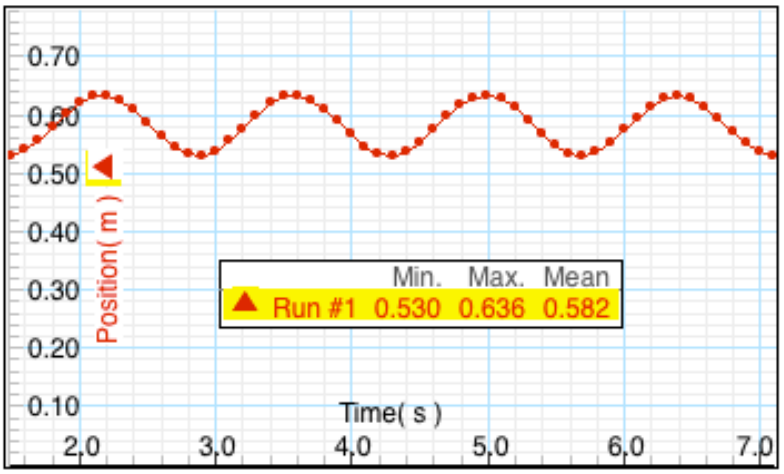
(b) What is the net force in the horizontal direction acting on the system?

(c) What is system's velocity after being pulled 3.0 m?

(d) What are the signs (+, 0 or -) of the work done by all forces acting on the system? This includes the normal force, friction, gravity and the tension force.

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

In the last lab, you took the following data for the position vs time of a mass oscillating on a spring.



(a) What is the angular frequency for this oscillation?

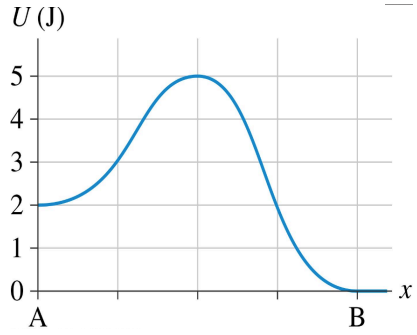
(b) Calculate the magnitude of the maximum acceleration of the mass, and indicate one position on the above graph where it can occur (actually label the graph at this point).

(c) If the spring constant is 10 N/m, what is the value of the mass?

(d) What is the speed of the mass when it is at its half amplitude position?

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

A 200 g mass glides over a friction free track and experiences the potential energy versus position graph shown.

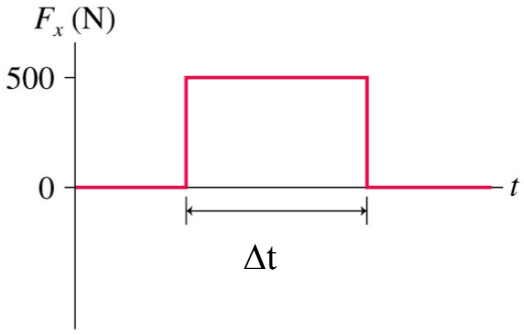


(a) If the total energy at point B is 6.0 J, what is the kinetic energy at point A?

(b) What is the momentum of the particle at point B?

At point B the 200g particle collides elastically with a 400 g particle traveling in the opposite direction as the 200 g particle with a speed of 1.0 m/s. Assume all 1D.
(c) What is the velocity of the 400 g particle after the collision?

(d) If the 400 g particle experiences the force shown, what is the impact time of the collision?



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

A ball is thrown toward a cliff of height h with a speed of 30.0 m/s and an angle of 60.0º above the horizontal $(15.0\ \hat{i} + 26.0\ \hat{j})\,m/s$. It lands on the cliff 5.0 s later.

(a) What was the maximum height of the ball?

(b) How high is the cliff?

(c) What is the ball's impact speed?

(d) As the ball impacts the ground, which experiences a larger impulse, the earth or the ball? Explain your answer in words and possibly equations.