PHYSICS 221 – REVIEW

Name: _____ Total Points: _____
(Last) (First)

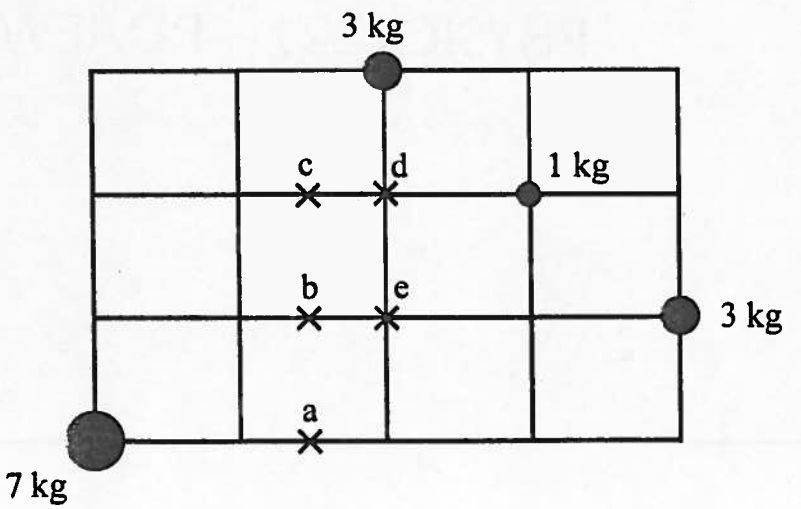
Multiple choice questions

Answer all of the following questions. Read each question carefully. **Fill the correct bubble on your scantron sheet.** Each question has exactly one correct answer. All questions are worth the same amount of points.

1. A point mass m has kinetic energy KE_1 measured in an inertial frame R_1 and kinetic energy KE_2 measured in another inertial frame R_2. The velocity of R_2 with respect to R_1 is $v \neq 0$.
   Which of the following is true for sure?

   A. $KE_2=KE_1$
   B. $KE_2=KE_1 + 1/2mv^2$
   C. $KE_2<KE_1$
   D. $KE_2>KE_1$
   E. $KE_2 \neq KE1$

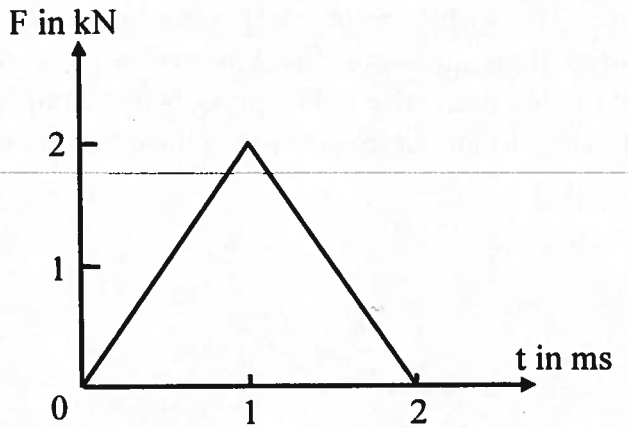
2. The center of mass of the system of particles shown in the diagram is at point



   A. a
   B. b
   C. c
   D. d
   E. e

Name: _____ Total Points: _____
(Last) (First)

3. Using a mallet, you strike a ball of mass 0.50 kg that is initially at rest. The force F on the ball as a function of time is plotted in the figure. At t=2.0ms, the speed of the ball is

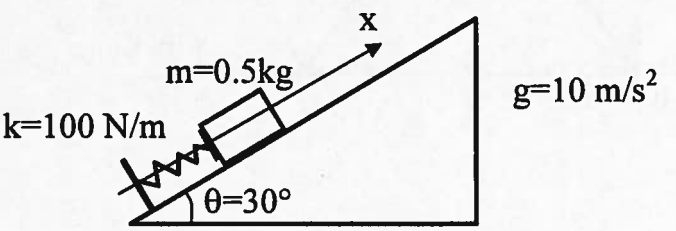


A. 10 m/s
B. 8.0 m/s
C. 6.0 m/s
D. 4.0 m/s
E. 2.0 m/s

Name: _____ Total Points: _____
(Last) (First)

Questions 4 through 10 all refer to the same problem.

A block of mass m=0.5kg is initially at rest on a frictionless 30° incline as shown on the figure below. The block is resting against a massless spring of spring constant k=100N/m. The spring is not attached to the block.
Displacements are measured along an x-axis directed up along the incline.
Take the origin x=0 to be the location where the spring is not compressed.
Since the spring is not attached to the block, the spring loses contact with the block for x>0.
Take g=10 m/s^2.



4. What is the location x_{eq} of the block at equilibrium?

   A. -2.5 cm
   B. -4.33 cm
   C. -5 cm
   D. -7 cm
   E. -10 cm

The block is displaced by an additional 4 cm down the incline from its equilibrium position and then released (in other words, the block is released at $x=x_{eq}-4$cm with no initial velocity).
In what follows, U(x) is the potential energy of the system block block+spring+Earth at position x along the incline.

Name: _____ Total Points: _____
(Last) (First)

5. How do $U(x_{eq}-4cm)$ and $U(x_{eq})$ compare?

   A. $U(x_{eq}-4cm) > U(x_{eq})$
   B. $U(x_{eq}-4cm) < U(x_{eq})$
   C. $U(x_{eq}-4cm) = U(x_{eq})$
   D. Can't tell. There is not enough information.

6. After its release, as the block travels up the incline, what can you say about the total mechanical energy E_{mec} of the system block+spring+Earth?

   A. E_{mec} is constant.
   B. E_{mec} decreases as x increases.
   C. E_{mec} increases as x increases.
   D. From $x=x_{eq}-4$ cm to $x=0$ cm, E_{mec} increases. Then E_{mec} decreases as x increases.
   E. From $x= x_{eq} -4$ cm to $x=0$ cm, E_{mec} decreases. Then E_{mec} increases as x increases.

7. After its release, what is the position x_{max} of the block up the incline when it comes momentarily to rest for the first time?

   A. -1.5 cm
   B. 1.5 cm
   C. 1.95 cm
   D. 4 cm
   E. 10 cm

8. How do $U(x_{eq}-4cm)$ and $U(x_{max})$ compare?

   A. $U(x_{eq}-4cm) > U(x_{max})$
   B. $U(x_{eq}-4cm) < U(x_{max})$
   C. $U(x_{eq}-4cm) = U(x_{max})$
   D. Can't tell. There is not enough information.

Name: _____ Total Points: _____
(Last) (First)

9. As the block travels up the incline, where is its kinetic energy maximum?

   A. at x_{max}
   B. at x_{eq}
   C. at the origin x=0
   D. at some location between x=0 and x_{max}
   E. at some location between x_{eq}-4cm and x_{eq}

10. As the block travels up the incline, where is the magnitude of its acceleration maximum?

   A. at x_{max}
   B. at x_{eq}
   C. at the origin x=0
   D. at x_{eq}-4cm
   E. at some location between x_{eq}-4cm and x_{eq}

Additional questions:

* Find x_{max} if there is friction between the block and the incline
  → $\mu_k = 0.3$

* If $\mu_s = 0.5$, does the block slide back down?

Name: _____ Total Points: _____
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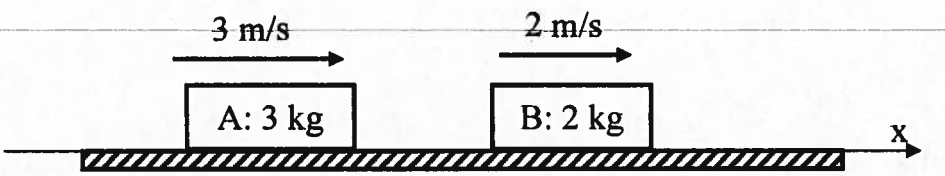
Questions 11 through 17 all refer to the same problem.

On a frictionless horizontal track, block A of mass 3kg collides with block B of mass 2 kg. Before the collision, the velocity of A is $\vec{v}_A = 3\hat{x}\,m/s$ and the velocity of B is $\vec{v}_B = 2\hat{x}\,m/s$ as indicated on the figure below.
After the collision, it is observed that A and B have the same velocity $\vec{v}$.



11. During the collision, what is the direction of the net force on A?

A. $\hat{x}$
B. $-\hat{x}$
C. Undefined, since the net force is 0

12. During the collision, what can you say about the magnitude $|\vec{p}_A|$ of the momentum of A?

A. $|\vec{p}_A|$ increases
B. $|\vec{p}_A|$ decreases
C. $|\vec{p}_A|$ stays the same
D. Can't say anything. There is not enough information.

Name: _____ Total Points: _____
(Last) (First)

13. What is the velocity of the center of mass of the system A+B before the collision (in m/s)?

A. 0
B. $2\hat{x}$
C. $2.5\hat{x}$
D. $2.6\hat{x}$
E. $5\hat{x}$

14. What is the velocity $\vec{v}$ of A and B after the collision (in m/s)?

A. 0
B. $2\hat{x}$
C. $2.5\hat{x}$
D. $2.6\hat{x}$
E. $5\hat{x}$

15. In the center of mass frame, what is the kinetic energy of the system before the collision (in Joules)?

A. 0
B. 0.6
C. 1.2
D. 17.5
E. 35

16. In the center of mass frame, what is the kinetic energy of the system after the collision (in Joules)?

A. 0
B. 0.6
C. 1.2
D. 17.5
E. 35

Name: _____ Total Points: _____
(Last) (First)

17. Is the collision an elastic collision?

A. No in all inertial frames.
B. Yes in all inertial frames.
C. Yes in the center of mass frame. No in an inertial frame fixed with respect to the horizontal track.
D. No in the center of mass frame. Yes in an inertial frame fixed with respect to the horizontal track.
E. Can't tell. There is not enough information. N

Name: _____ Total Points: _____

(Last) (First)

1

Physics 201

Exam 3

Write also your name in the appropriate box of the scantron

Name: _____ Total Points: _____
2

(Last) (First)

Multiple choice questions [60 points]

Answer all of the following questions. Read each question carefully. **Fill the correct bubble on your scantron sheet**. Each question has exactly one correct answer. All questions are worth the same amount of points.

1. Susana ascends a mountain via a short, steep trail. Sean ascends the same mountain via a long, gentle trail. Which of the following statements is true?

   A. Susana gains more gravitational potential energy than Sean.
   B. Susana gains less gravitational potential energy than Sean.
   C. Susana gains the same gravitational potential energy as Sean.
   D. To compare gravitational potential energies, we must know the height of the mountain.
   E. To compare gravitational potential energies, we must know the lengths of the two trails.

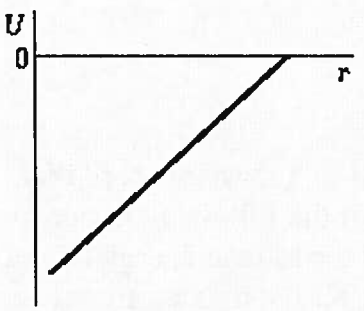
2. 

Figure A

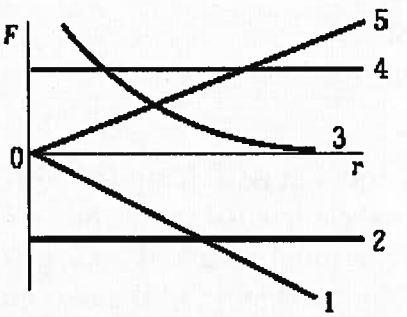


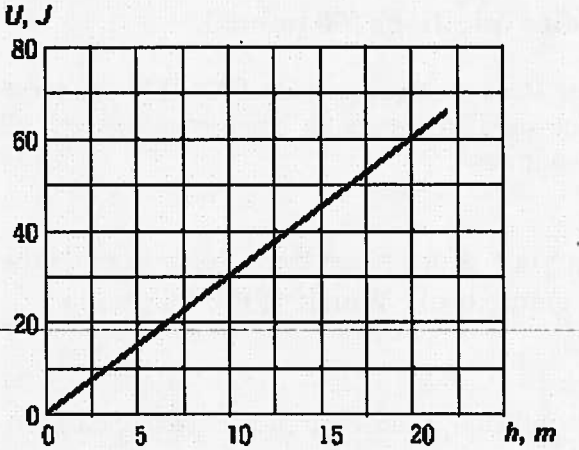
Figure B

When the potential energy *U(r)* is given as in Figure A, then the force is given in Figure B by curve

A. 1
B. 2
C. 3
D. 4
E. 5

Name: _____ Total Points: _____
3

(Last) (First)

3. 

The graph shows a plot of the gravitational potential energy U of a 1-kg body as a function of its height h above the surface of a planet. The acceleration due to gravity at the surface of the planet is

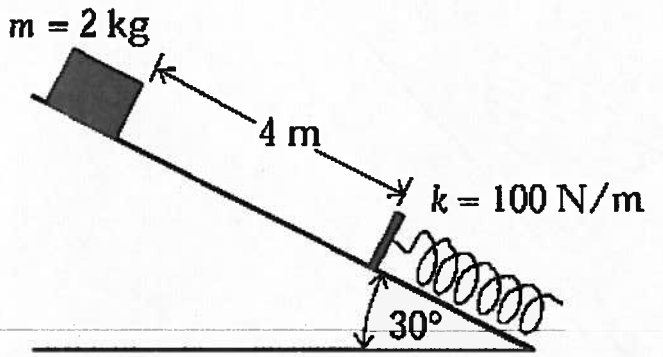
A. $0\ m/s^2$
B. $9.8\ m/s^2$
C. $6\ m/s^2$
D. $3\ m/s^2$
E. None of these is correct.

4. Two unequal masses hang from either end of a massless cord that passes over a frictionless pulley. Which of the following is true about the gravitational potential energy (U) and the kinetic energy (K) of the system consisting of the two masses after the masses are released from rest?

A. $\Delta U < 0$ and $\Delta K > 0$
B. $\Delta U = 0$ and $\Delta K > 0$
C. $\Delta U < 0$ and $\Delta K = 0$
D. $\Delta U = 0$ and $\Delta K = 0$
E. $\Delta U > 0$ and $\Delta K < 0$

Name: _____ Total Points: _____
4

(Last) (First)

5. 

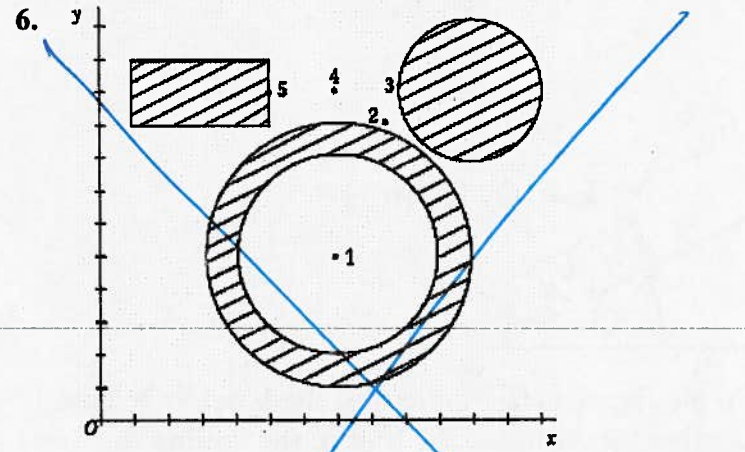
The surface shown in the figure is frictionless. If the block is released from rest, it will compress the spring at the foot of the incline

Hint: use the conservation of mechanical energy. You will need to solve a quadratic equation.

A. 4.0 m
B. 3.24 m
C. 1.57 m
D. 0.989 m
E. 0.5 m

Name: _____ Total Points: _____
5

(Last) (First)

6. 

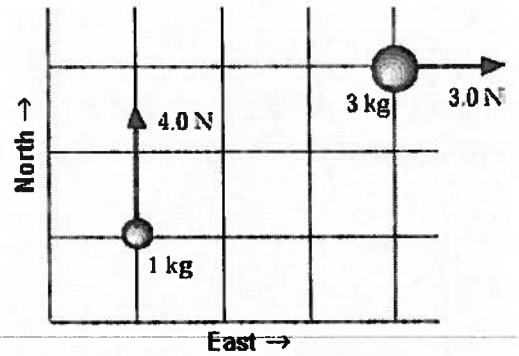
The mass of the rectangle in the figure is M, the mass of the ring is M, and the mass of the circle is $3M$. The center of mass of the system (consisting of the rectangle, the circle and the ring) with respect to the origin O is located at point

A. 1
B. 2
C. 3
D. 4
E. 5

Name: _____ Total Points: _____
6

(Last) (First)

7.



A 1.0-kg mass is acted on by a net force of 4.0 N and a 3.0-kg mass is acted on by a net force of 3.0 N, in the directions shown. The acceleration of the center of mass of this system is approximately

A. 1.25 m/s^2, 53° N of E
B. 1.85 m/s^2, 45° N of E
C. 4.00 m/s^2, due north
D. 5.30 m/s^2, N of E
E. 7.25 m/s^2, 53° N of E

8. A boy and girl initially at rest on ice skates face each other. The girl has a mass of 20 kg and the boy has a mass of 30 kg. The boy pushes the girl backward at a speed of 3.0 m/s. As a result of the push, the speed of the boy is

A. 0 m/s
B. 2.0 m/s
C. 3.0 m/s
D. 4.5 m/s
E. 9.0 m/s

9. If a body moves in such a way that its linear momentum is constant, then

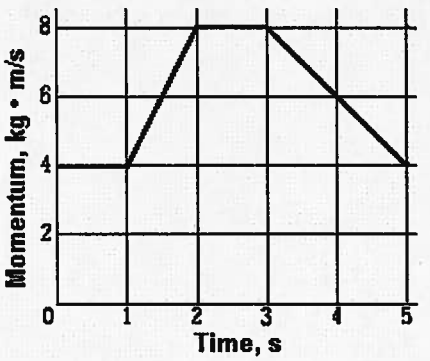
A. its kinetic energy is zero.
B. the sum of all the forces acting on the body is constant and nonzero.
C. its acceleration is greater than zero and is constant.
D. its center of mass remains at rest.
E. the sum of all the forces acting on it must be zero.

Name: _____ Total Points: _____
7

(Last) (First)

10. While in horizontal flight at a speed of 20 m/s, a baseball of mass 0.11 kg is struck by a bat. After leaving the bat, the baseball has a speed of 29 m/s in a direction opposite to its original direction. The magnitude of the impulse given the ball is

A. 0.99 kg · m/s
B. 3.2 kg · m/s
C. 2.2 kg · m/s
D. 5.4 kg · m/s
E. 0.55 kg · m/s

11. 

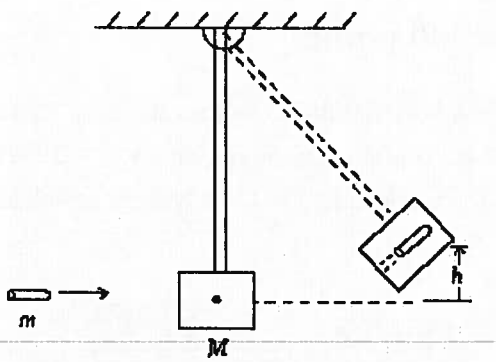
The graph shows the momentum of a body as a function of time. The time at which the force acting on the body is greatest is

A. 0.5 s
B. 2.5 s
C. 4.0 s
D. 1.5 s
E. 5.0 s

Name: _____ Total Points: _____
8

(Last) (First)

12.



A bullet, $m = 0.500$ kg, traveling with a velocity v strikes and embeds itself in the bob of a ballistic pendulum, $M = 9.50$ kg. The combined masses rise to a height $h = 1.28$ m. The velocity v of the bullet is

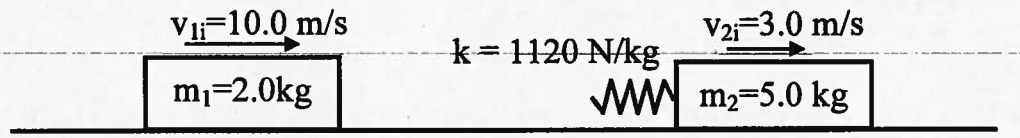
A. 5.00 m/s
B. 50 m/s
C. 100 m/s
D. 250 m/s
E. 275 m/s

Name: _____ Total Points: _____
9

(Last) (First)

PROBLEM [40 points]

Two masses m_1=2.0 kg and m_2=5.0 kg are on a horizontal frictionless surface. Mass m_1 is moving to the right with velocity $v_{1i} = 10\ m/s$ and m_2 with velocity $v_{2i} = 3.0\ m/s$. As shown in the figure a massless spring of force constant k = 1120 N/kg is attached to m_2.



1). [15 pts] After the masses collide and separate completely from one another, what are the final velocities of the two masses? (Hint: the collision is elastic).

2). [10 pts] What are the final kinetic energies of each of the two masses (K_{1f} and K_{2f})?

3). [15 pts] What is the maximum potential energy stored in the spring during the collision? (Hint: at maximum compression, both masses have the same velocity equal to the center of mass velocity. Use also that the mechanical energy of m_1+spring +m_2 is constant).

Name: _____ Total Points: _____
(Last) (First)

Physics 201

Exam 3

Write also your name in the appropriate box of the scantron

Name: _____ Total Points: _____
(Last) (First)

Multiple choice questions [60 points]

Answer all of the following questions. Read each question carefully. **Fill the correct bubble on your scantron sheet.** Each correct answer is worth 4 points. Each question has exactly one correct answer.

1. A woman runs up a flight of stairs. The gain in her gravitational potential energy is U. If she runs up the same stairs with twice the speed, what is her gain in potential energy?

   A. U
   B. 2U
   C. U/2
   D. 4U
   E. U/4

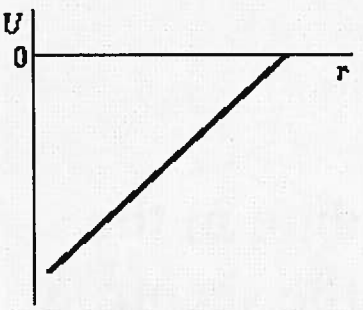
2. 

Figure A

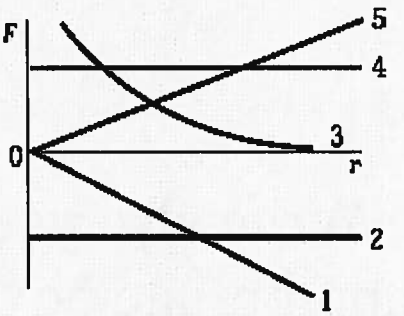


Figure B

When the potential energy *U(r)* is given as in Figure A, then the force is given in Figure B by curve

   A. 1
   B. 2
   C. 3
   D. 4
   E. 5

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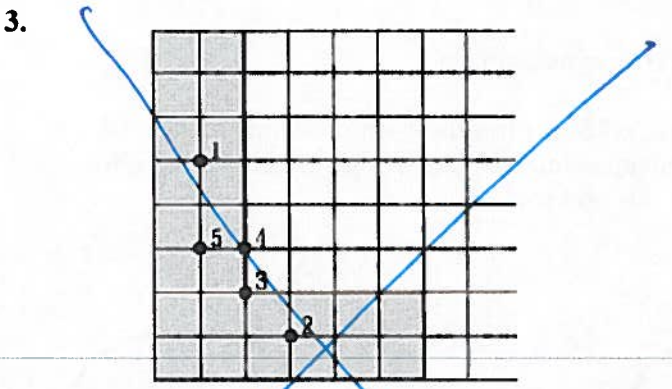
(Last) (First)

3.



An L-shaped piece, represented by the shaded area on the figure, is cut from a metal plate of uniform thickness. The point that corresponds to the center of mass of the L-shaped piece is

A. 1
B. 2
C. 3
D. 4
E. 5

4. The condition necessary for the conservation of momentum in a given system is that
   A. energy is conserved.
   B. one body is at rest.
   C. the net external force is zero.
   D. internal forces equal external forces.

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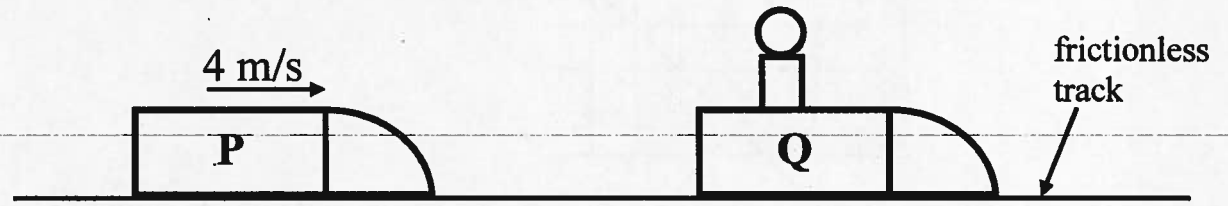
(Last) (First)

Questions 5 through 11 all refer to the same problem.

An empty bobsled (labeled P) of mass 150 kg travels at 4m/s toward an identical stationary bobsled (labeled Q) containing an athlete of unknown mass. Ignore friction between the sleds and the track in this problem.



5 In a one-second interval, the center of mass of the system composed of P and Q moves a distance

A. greater than 4 m
B. equal to 4 m
C. less than 4 m

6 When the centers of mass of P and Q are 20 m apart, the center of mass of the system composed of P and Q is 8 m from the center of mass of sled Q. The mass of the athlete is therefore:

A. 100 kg
B. 150 kg
C. 120 kg
D. 75 kg
E. 60 kg

When the two sleds collide, they stick together and then move along the track.

7 During the collision, the force exerted on bobsled P by bobsled Q is:

A. greater than the force exerted on bobsled Q by bobsled P
B. less than the force exerted on bobsled Q by bobsled P
C. equal to the force exerted on bobsled Q by bobsled P
D. there is not enough information to say

8 The change in momentum of bobsled P as a result of the collision is:

A. directed to the right
B. directed to the left
C. zero

Name: _____ Total Points: _____
(Last) (First)

9 the final speed of the system composed of P and Q is

A. 4 m/s
B. 1.6 m/s
C. 2.7 m/s
D. 0 m/s
E. Other

10 When the sleds are moving together along the track after the collision, the force exerted on bobsled P by bobsled Q is

A. directed to the right
B. directed to the left
C. zero
D. there is not enough information to answer

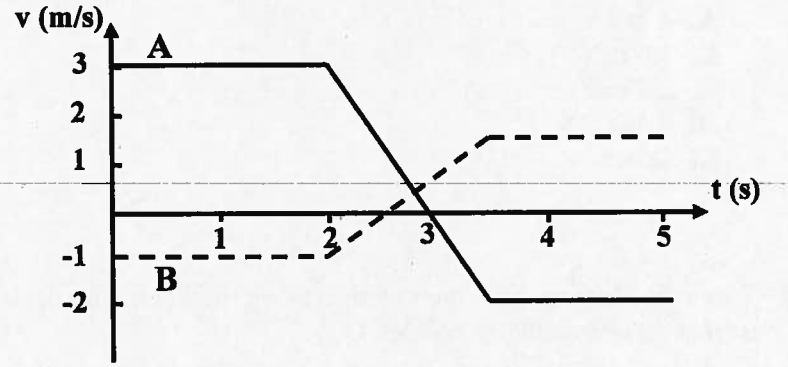
11 For the system composed of P and Q, how does the total kinetic energy after the collision (KE_f) compare with the total kinetic energy before the collision (KE_i)?

A. $KE_f > KE_i$
B. $KE_f = KE_i$
C. $KE_f < KE_i$
D. $KE_f = -KE_i$

Name: _____ Total Points: _____
(Last) (First)

Questions 12 through 15 all refer to the same problem.

Two carts collide on a level frictionless track that is oriented in the x direction. A graph of the velocities versus time is shown below. The mass of cart A is 1.0 kg and the mass of cart B is 2.0 kg.



12 At what time does the collision begin?

A. 0 s
B. 1 s
C. 2 s
D. 3 s
E. 4 s

13 What is the total momentum of the system of carts before the collision (in kg m/s)?

A. 0
B. 1
C. 2
D. 3
E. 4

14 What impulse does the collision impart to cart A (in kg m/s)?

A. 0
B. 1
C. 3
D. 5
E. 8

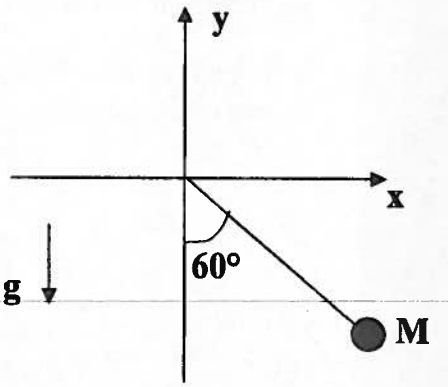
15 The collision is

A. elastic
B. inelastic
C. partially elastic
D. impossible
E. super elastic

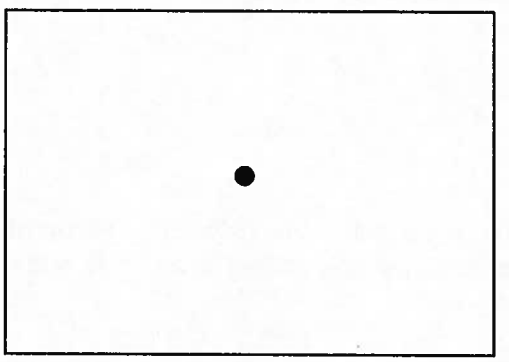
Name: _____ Total Points: _____
(Last) (First)

PROBLEM [40 points]

A pendulum consisting of a string and a ball of mass M has just been released at t=0 at rest with an initial angle of 60 degrees from the vertical. The string has length L. Ignore air resistance. The acceleration of gravity is g.



1). [5 pts] In the box below, draw a free body diagram for the ball just after the pendulum is released. Clearly label all of the forces.



2). [5 pts] What is the value of the radial acceleration ($a_\perp$) just after the pendulum has been released? Explain.

3). [10 pts] What is the magnitude of the tension in the string just after the pendulum has been released? Circle your answer and explain your reasoning (no credit given without an explanation)

A) 0 B)1/2Mg C)$\sqrt{3}$/2 Mg D) Mg E) 2Mg

Name: _____ Total Points: _____
(Last) (First)

A short time t_1 later, the pendulum is still descending and you observe that the angle of the pendulum is 30 degrees.

4). [5 pts] What is the work done by the tension on the ball by the string between t=0 and $t=t_1$? Explain

5). [5 pts]What is the sign of the work done by gravity between t=0 and $t=t_1$? (Circle your answer and explain your reasoning)
A) 0 B) positive C) negative

6). [5 pts]What is the direction of the instantaneous velocity vector of the ball at $t=t_1$? Express your answer in terms of the unit vectors $\hat{x}$ and $\hat{y}$ (circle your answer and explain your reasoning).

A) $-\frac{1}{2}\hat{x}-\frac{\sqrt{3}}{2}\hat{y}$ B) $-\frac{\sqrt{3}}{2}\hat{x}-\frac{1}{2}\hat{y}$ C) $\frac{1}{2}\hat{x}-\frac{\sqrt{3}}{2}\hat{y}$ D) $\frac{\sqrt{3}}{2}\hat{x}+\frac{1}{2}\hat{y}$

A short time t_2 later, the pendulum is at its lowest position moving to the left.

7). [5 pts]What is the direction of the acceleration vector at $t=t_2$? Express your answer in terms of the unit vectors $\hat{x}$ and $\hat{y}$.