Physics 2A, Sec B00: Mechanics -- Winter 2011 Instructor: B. Grinstein

Final Exam

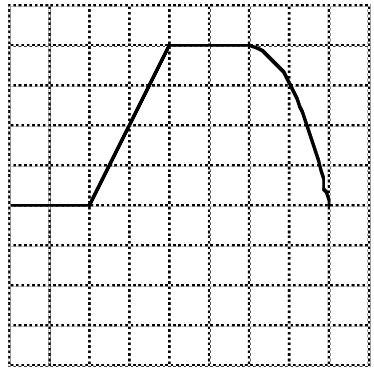
INSTRUCTIONS: Use a pencil #2 to fill your scantron. Write your code number and bubble it in under "EXAM NUMBER;" an entry in error will result in an automatic 10% deduction. Bubble in the quiz form (see letter A--D at bottom of page) in your scantron under "TEST FORM;" an error entering the "test form" will result in automatic 20% deductions, and may lead to disqualification. Write your name and 3-digit ID at the bottom of this page and turn it in with your scantron when you are finished working on the exam.

Moment of inertia about axis through center of mass:
thin rod of mass M and length L $I = 1/12\ ML^2$
solid cylinder of mass M and radius R, axis of rotation along axis of cylinder, $I = 1/2\ MR^2$
solid sphere of mass M and radius R, $I = 2/5\ MR^2$
hollow sphere of mass M and radius R, $I = 2/3\ MR^2$

1) You throw a ball straight up in the air. The acceleration of the ball
   - A) is largest just before it hits the ground, and zero when it reaches the maximum height
   - B) is largest just after it leaves your hand, and zero when it reaches the maximum height
   - C) is larger just before it hits the ground than just after it leaves your hand
   - D) is the same just before it hits the ground as when it reaches maximum height
   - E) none of the above

2) A graph of position as a function of time is shown below (The axis are not labeled, the vertical axis is for displacement and the horizontal is for time. Each square is a unit of meters in the vertical and seconds in the horizontal). During which time interval could the object be possibly moving with non-zero constant acceleration?

Name________________________________ Student 3-digit ID________



A) 6.1 s to 7.9 s
B) 4.1 s to 5.9 s
C) 0.1 s to 1.9 s
D) 2.1 s to 3.9 s
E) There is no interval that is consistent with constant non–zero acceleration.

3) Under what condition is $\left|\vec{A} + \vec{B}\right| = \left|\vec{A}\right| + \left|\vec{B}\right|$?
A) The statement is always true.
B) The statement is never true.
C) Vectors $\vec{A}$ and $\vec{B}$ are in opposite directions.
D) Vectors $\vec{A}$ and $\vec{B}$ are in perpendicular directions.
E) Vectors $\vec{A}$ and $\vec{B}$ are in the same direction.

4) The velocity of object A and object B relative to the ground are perpendicular to each other. Which statement is true regarding the magnitude of the relative velocity of object A to object B?

A) The magnitude of the relative velocity of A to B is greater than the speed of either A or B relative to the ground.

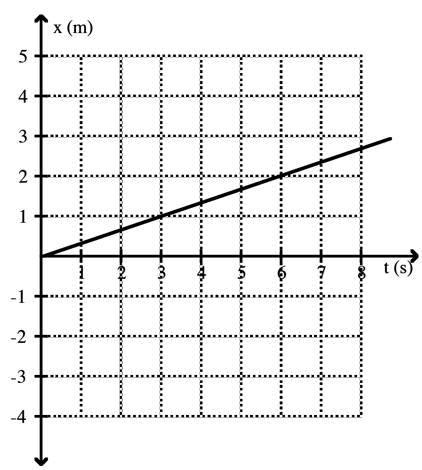
B) The magnitude of the relative velocity of A to B is equal to difference of the speeds of A and B relative to the ground.

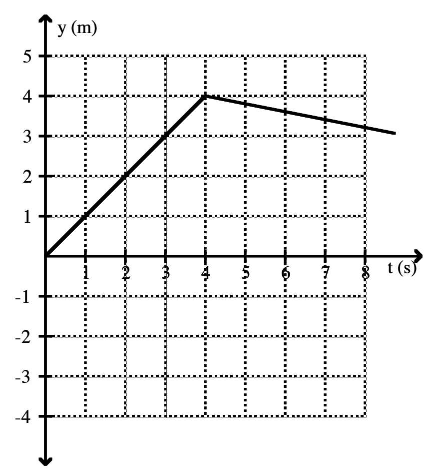
C) The magnitude of the relative velocity of A to B is equal to sum of the speeds of A and B relative to the ground.

D) The magnitude of the relative velocity of A to B is less than the speed of either A or B relative to the ground.

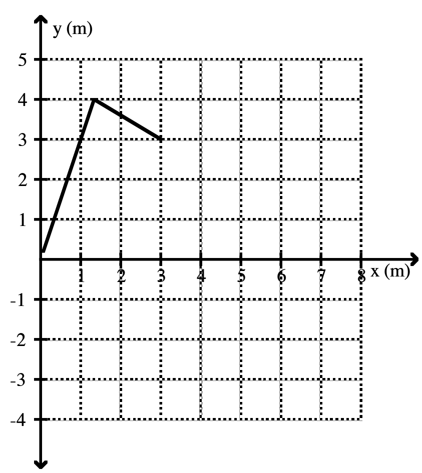
E) The magnitude of the relative velocity of A to B is equal to average of the speed of A and B relative to the ground.

5) The following graphs show the x and y coordinates of an object as a function of time. What is the shape of the path that the object follows?





A)



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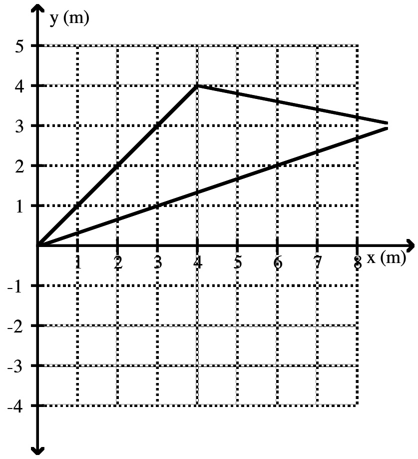

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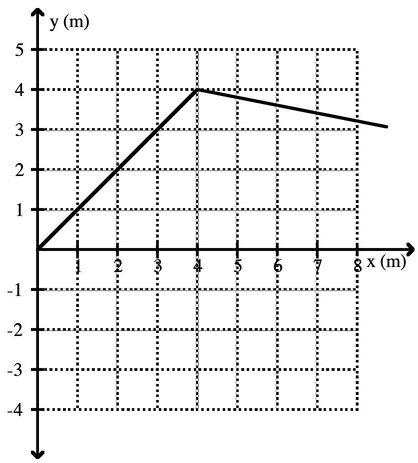

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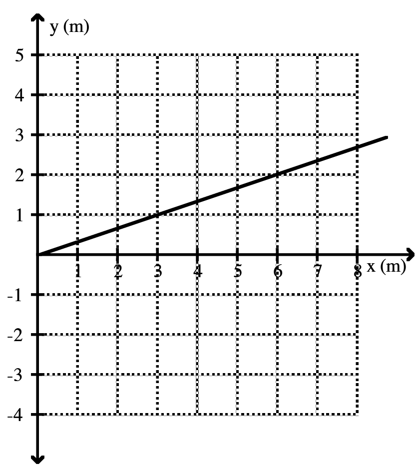


E) The motion indicated by the graphs is not possible.

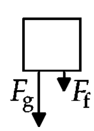
6) An object moves with constant velocity. Which statement is true about forces acting on the object?

A) The vector sum of all forces acting on the object is zero.
B) There can only be two equal magnitude, but opposite direction forces acting on the object.
C) The total force acting on the object can be non–zero and, if it is non–zero, its direction must be perpendicular to the direction of the velocity.
D) The object must be freely falling near the surface of the earth.
E) There are no forces acting on the object.

7) Which of the following statements is true about the motion of an object during a period of time in which the total force acting on the object is constant?

A) The direction of the velocity changes if the force is not parallel to the velocity.
B) The speed of the object is proportional to the time the force has acted.
C) The acceleration of the object increases proportional to the time the force has acted.
D) The direction of the velocity of the object remains constant.
E) The speed of the object remains constant.

8) Which of the following free–body diagrams best represent the free–body diagram, with correct relative force magnitudes, of a person in an elevator that is traveling upward with a downward acceleration less than g? F_f is the force of the floor on the person and F_g is the force of gravity on the person.

A)


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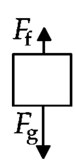

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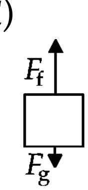

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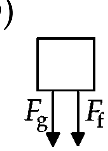
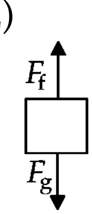


E)


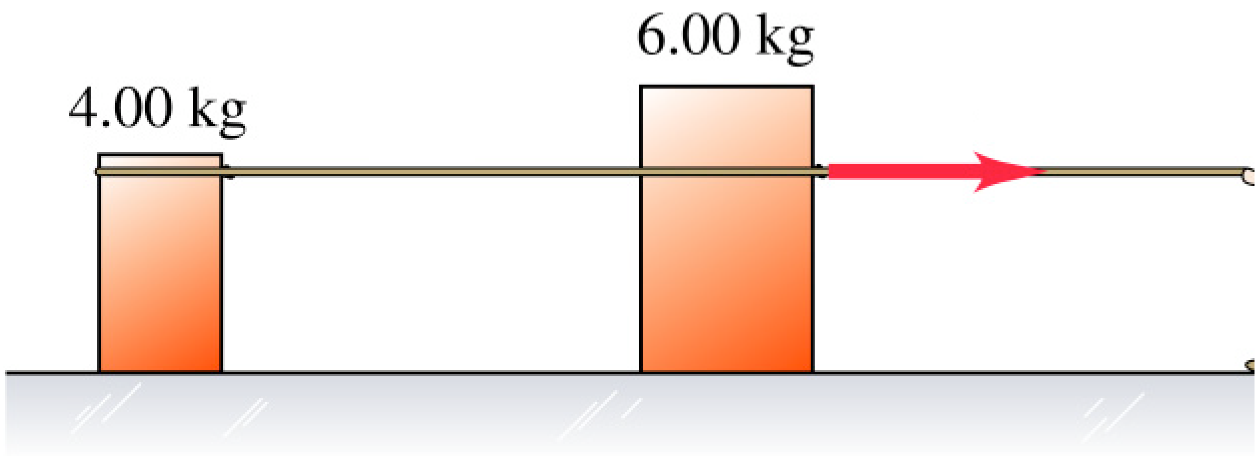
9) A tennis ball hangs on a string from the ceiling of an automobile. As the car turns to the left while speeding up, the string makes an angle θ with vertical. Where is the ball located relative to the attachment point on the ceiling?

A) The ball remains directly beneath the attachment point on the ceiling
B) The ball is to the left and behind the attachment point on the ceiling.
C) The ball is to the right and behind the attachment point on the ceiling.
D) The ball is to the right and in front of the attachment point on the ceiling.
E) The ball is to the left and in front of the attachment point on the ceiling.

10) Two identical boxes are sliding across the same floor at the same speed. The first box contains a 20.0-kg mass and the second box contains a 10.0-kg mass. Which box will the kinetic friction force stop first?

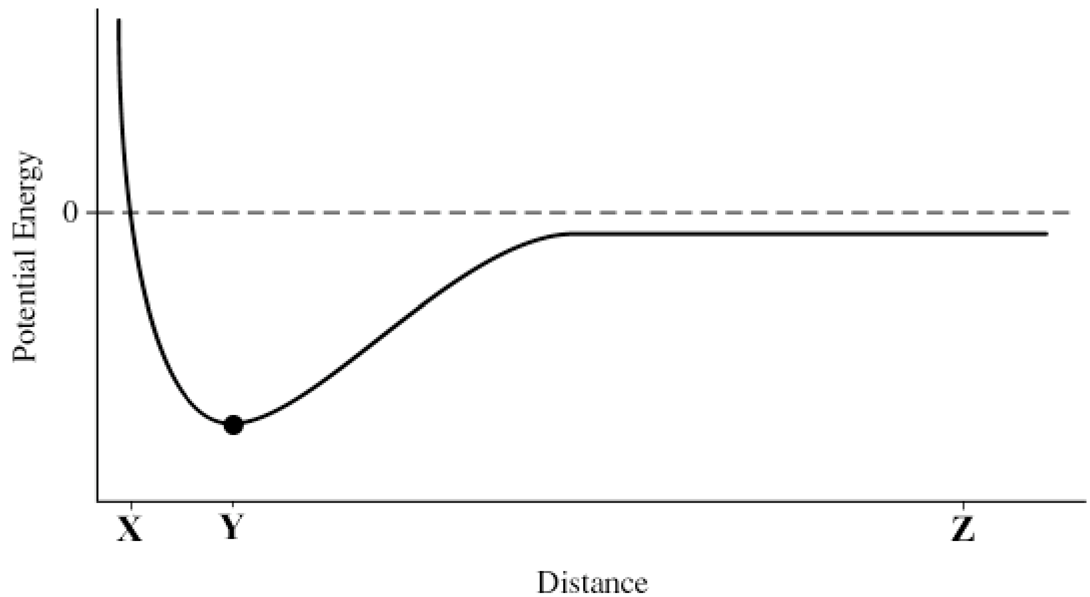
A) Both boxes will stop at the same time.
B) The box containing 10.0 kg will stop first.
C) The box containing 20.0 kg will stop first.
D) More information is needed to answer this question.
E) The answer depends on the magnitude of the coefficient of kinetic friction.

11) A woman pulls on a 6.00–kg crate, which in turn is connected to a 4.00–kg crate by a light rope. The light rope remains taut.Compared to the 6.00–kg crate, the lighter 4.00–kg crate



A) is subjected to a smaller net force and has a smaller acceleration
B) is subjected to the same net force and has a smaller acceleration
C) is subjected to the same net force and has the same acceleration
D) is subjected to a smaller net force and has the same acceleration
E) none of the above

12) Three cars (car L, car M, and car N) are moving with the same velocity, and slam on the breaks. The most massive car is car L, and the least massive is car N. Assuming all three cars have identical tires, for which car is the amount of work done by friction in stopping it the highest?
A) The amount of work done by friction is the same for all cars.
B) car M
C) car N
D) car L



13) The plot above shows the potential energy of a particle, due to the force exerted on it by another particle, as a function of distance. For which region(s) is the force exerted on the particle zero?

A) region X
B) region Y
C) region Z
D) regions Y and Z

14) Three blocks (block P, block Q, and block R) are all initially at rest. Block P is the most massive, and block R is the least massive. Identical horizontal forces push each block (causing them to accelerate) for five seconds. Assuming the coefficient of friction between the block and the ground is the same for all blocks, which block will have the highest amount of kinetic energy?

A) block P
B) block Q
C) block R
D) They all have the same kinetic energy, although they have different speeds.

15) You are given two carts, A and B. They look identical, and you've been told they are made of the same material. You place A at rest on an air track and give B a constant velocity to the right so that it collides elastically with A. After the collision, both carts move to the right, the velocity of B being smaller than what it was before the collision. What do you conclude?

A) Cart B is made of lighter (less dense) material than cart A

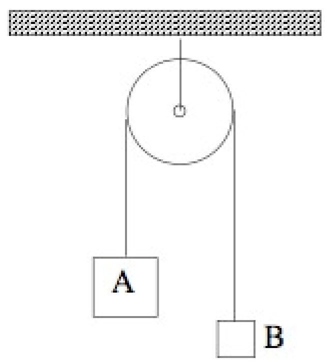
B) The force of cart A on cart B is smaller than that of cart B on cart A

C) Cart A is made of lighter (less dense) material than cart B

D) The force of cart A on cart B is larger than that of cart B on cart A

E) The two carts are identical.

16) An Atwood's machine is a pulley with two masses connected by a string as shown.



Here, the mass of A is twice the mass of B. The system is released. There is no friction. What happens to the vertical component of the CM of the system?

A) Moves down with constant velocity.

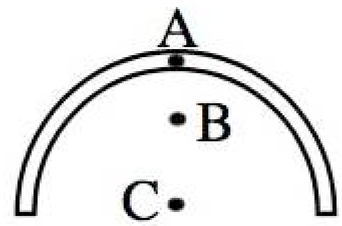
B) Accelerates up

C) Moves up with constant velocity.

D) Stays fixed

E) Accelerates down

17) Where is the CM (center of mass) of a half–hoop?



D: none of the above

18) A wheel of radius R is rolling on a horizontal surface. Its center is moving forward with speed v. A point on the wheel a distance r/3 below the center is moving forward at a speed $2v/3$. The wheel is

A) not rotating at all.

B) made of rubber.

C) slipping because its angular speed is too high to be rolling without slipping.

D) slipping because its angular speed is too low to be rolling without slipping.

E) rolling without slipping.

19) The space station stabilizer rockets are malfunctioning, but the space station rotation rate must be slowed down before a supply ship can dock with it. Which of the following actions of the astronauts would slow the rotation rate of the space station?

A) Start a massive flywheel spinning in a direction opposite to the direction of rotation of the space station.

B) Move as much mass as far as possible away from the axis of rotation of the space station.

C) Move as much mass as close as possible toward the axis of rotation of the space station.

D) Run around the inside of the space station in a direction opposite to the rotation of the space station.

E) answers A, C, and D

20) What is impossible about the following situation? An object in simple harmonic motion has an equilibrium position $x = 0.00$ m. At some instant in time, the position of the object is +3.00 m, the velocity is –2.00 m/s, and the acceleration is +9.00 m/s^2.

A) The displacement from equilibrium and the acceleration are in the same direction.
B) The acceleration is greater than the speed.
C) The speed is less than the displacement.
D) The velocity is opposite in direction to the displacement.
E) The numerical value of the velocity is smaller than the distance from the equilibrium position, but the numerical value of the magnitude of the acceleration is larger than the distance from equilibrium.

21) An airplane flies between two points on the ground that are 500 km apart. The destination is directly north of the origination of the flight. The plane flies with an air speed of 120 m/s. If a constant wind blows at 10.0 m/s due west during the flight, what direction must the plane fly relative to the air to arrive at the destination?

A) 4.78° east of north
B) 4.78° west of north
C) 4.76° east of north
D) 4.76° west of north
E) 85.2° west of north

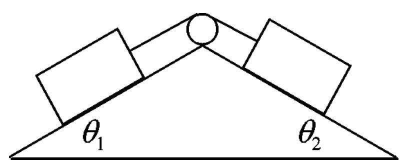
22) A rock is thrown at a window that is located 18.0 m above the ground. The rock is thrown at an angle of 40.0° above horizontal. The rock is released from a height of 2.00 m above the ground with a speed of 30.0 m/s. If the rock strikes the window on its downward trajectory, from what horizontal distance from the window was it released?

A) 63.0 m B) 53.2 m C) 48.7 m D) 71.6 m E) 29.8 m

23) A satellite orbits a planet with a centripetal acceleration 2.00 m/s^2 at a radius of 5.00 × 10^8 m from the center of the planet. How much time does it take the satellite to complete one orbit?

A) 24 days 17 hours
B) 27 hours and 36 minutes
C) 240 days
D) 131 days
E) 1.32 years

24) Two masses rest on opposite sides of a frictionless pulley on frictionless inclines as shown in the diagram. The mass of the object to the left of the pulley is 40.0 kg. If θ_1 = 35.0° and θ_2 = 55.0°, what is the mass of the object to the right of the pulley if the system remains at rest?



A) 25.5 kg B) 28.0 kg C) 57.1 kg D) 62.9 kg E) 25.0 kg

25) A 0.800-kg ball is tied to the end of a cable of negligible mass. The ball is spun in a horizontal circle with a radius 2.00 m making 0.700 revolutions per second. What is the tension in the cable?

A) 31.0 N B) 33.2 N C) 34.8 N D) 30.7 N E) 35.9 N

26) A mass of 2.0 kg traveling at 3.0 m/s along a smooth, horizontal plane hits a relaxed spring. The mass is slowed to zero velocity when the spring has been compressed by 0.15 m. What is the spring constant of the spring?

A) 400 N/m
B) 9.0 N/m
C) 18 N/m
D) 800 N/m
E) 20 N/m

27) The potential energy for a certain mass moving in one dimension is given by $U(x) = (2.0\ J/m^3)x^3 - (15\ J/m^2)x^2 + (36\ J/m)x - 23\ J$. Find the location(s) where the force on the mass is zero.

A) 1.0 m

B) 4.0 m, 5.0 m

C) 3.0 m, 5.0 m

D) 2.0 m, 3.0 m

E) (3.25 – 0.968i) m, (3.25 + 0.968i) m

28) A billiard ball traveling at 3.00 m/s collides perfectly elastically with an identical billiard ball initially at rest on the table. The initially moving billiard ball deflects 30 degrees. What is the speed of the initially stationary billiard ball after the collision?

A) 0.750 m/s

B) 2.00 m/s

C) 1.50 m/s

D) 2.59 m/s

E) 0.866 m/s

29) A 3.00–m long uniform thin rod that starts at rest takes 30.0 J of work to make the rod rotate with an angular speed 20.0 revolutions per minute about an axis perpendicular to the rod that passes through one end of the rod. What is the mass of the rod?

A) 0.245 kg

B) 0.115 kg

C) 3.22 kg

D) 4.56 kg

E) 0.344 kg

30) A thin cylindrical shell is released from rest and rolls without slipping down an inclined plane that makes an angle of 30° with the horizontal. How long does it take it to travel 3.1 m?

A) 1.1 s B) 2.1 s C) 1.6 s D) 1.8 s E) 1.4 s

31) A person pushes on a doorknob with a force of 5.00 N perpendicular to the surface of the door. The doorknob is located 0.800 m from axis of the hinges of the door. The door begins to rotate with an angular acceleration of 2.00 rad/s^2. What is the moment of inertia of the door about the hinges?

A) 8.00 kg•m^2
B) 6.40 kg•m^2
C) 1.00 kg•m^2
D) 12.5 kg•m^2
E) 2.00 kg•m^2

32) Treat a planet as a uniform density sphere of mass M, radius R, and rotation period T. A large asteroid of mass αM is moving at speed $\beta R/\mathrm{T}$. The asteroid collides perfectly inelastically with the planet at its equator while traveling tangentially to the surface of the planet in the same direction as the velocity of the contact point on the equator. What is the rotation period of the planet after the asteroid collides with the planet?

A) $(1 + 10\alpha/4)T$
B) $(4\pi + 10\pi\alpha)T/(4\pi + 5\alpha\beta)$
C) $(1 + 10\pi\alpha)T/(1 + 5\alpha\beta)$
D) $(1 + \alpha\beta)T$
E) $(1 + 10\alpha\beta/4)T$

1) D
2) A
3) E
4) A
5) A
6) A
7) A
8) B
9) C
10) A
11) D
12) D
13) D
14) C
15) C
16) E
17) In the air, below the center/middle.
18) E
19) B
20) A
21) A
22) A
23) B
24) B
25) A
26) D
27) D
28) C
29) D
30) C
31) E
32) B
