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

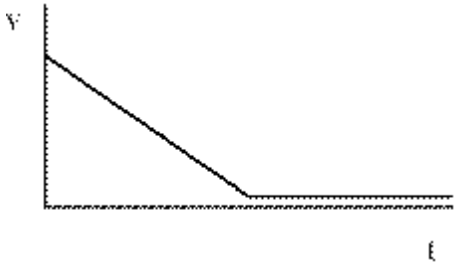
INSTRUCTIONS: Use a pencil #2 to fill your scantron. Write your code number and bubble it in under "EXAM NUMBER;" an entry in error will result in an automatic 10% deduction. Bubble in the quiz form (see letter A--D at bottom of page) in your scantron under "TEST FORM;" an error entering the "test form" 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, axis perpendicular to rod, $I = 1/12\ ML^2$
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, $I = 2/3\ MR^2$

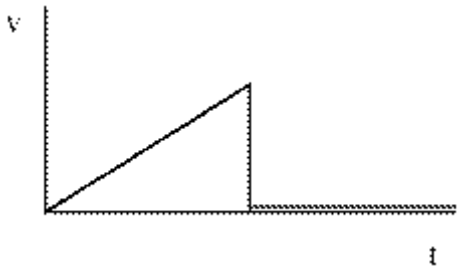
1) A trolley starts from rest and runs down a sloping track section onto a second level section as shown. Friction is negligible.

Which speed-time graph below best represents the trolley's motion on both sections?

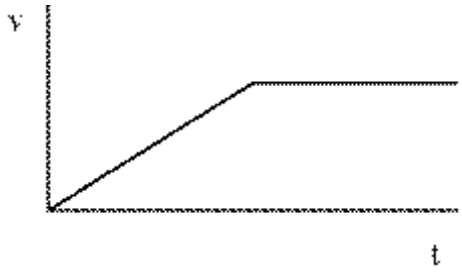
A)



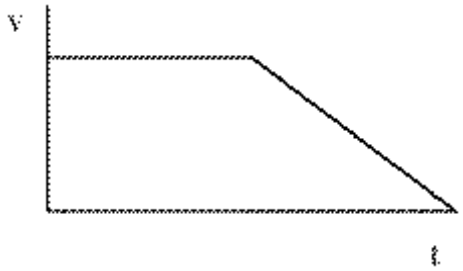
B)



C)



D)



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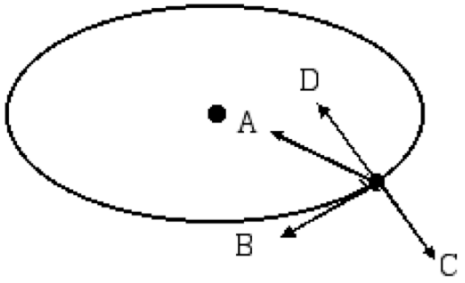
2) A stone is thrown vertically upwards, reaches a highest point, and returns to the ground. When the stone is at the **top** of its path, its acceleration

A) is directed upwards.
B) changes direction from upwards to downwards.
C) is directed downwards.
D) is zero.

3) An object has a velocity directed to the right, and an acceleration directed to the left. Which statement is true?

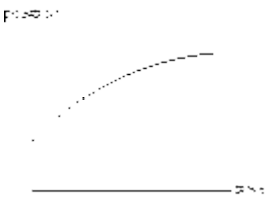
A) The position of the object is increasing to the left with time, and its speed is increasing.
B) The position of the object is increasing to the right with time, and its speed is decreasing.
C) The position of the object is increasing to the right with time, and its speed is increasing.
D) The position of the object is not changing in time.

4) A pacing bicycle rides smoothly and steadily around an elliptical (oval) track, with a <u>constant</u> speed.



At the point shown, what is the direction of the bike's instantaneous acceleration?

A) Towards the center of the ellipse.
B) Tangent to the ellipse.
C) Perpendicular to the ellipse, *outward*.
D) Perpendicular to the ellipse, *inward*
E) Something else.



5) A train car moves along a long straight track. The graph shows the position as a function of time for this train. The graph shows that the train:

A) speeds up all the time
B) moves at a constant velocity
C) speeds up part of the time and slows down part of the time
D) slows down all the time

6) Suppose the force of wind resistance is proportional to the speed of the object and in the direction opposite the object's velocity. If you throw an object upward, when is the magnitude of the acceleration the highest?

A) The acceleration of the object is the same throughout the entire trajectory.

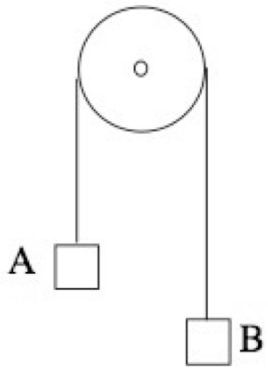
B) It is highest at the top of its trajectory.

C) It is highest right after the object is released.

D) It is highest just before it hits the ground.

E) It is highest when the wind resistance equals the force of gravity.

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



How does the force exerted on the mass B by the string (T) compare with the weight of body B? (Assume a frictionless, massless pulley).

A) $T < m_B g$

B) $T = m_B g$

C) $T > m_B g$

D) not enough information given

8) A man pushes against a rigid, immovable wall. Which of the following is the most accurate statement concerning this situation?

A) The friction force on the man's feet is equal to the force the wall exerts on the man.

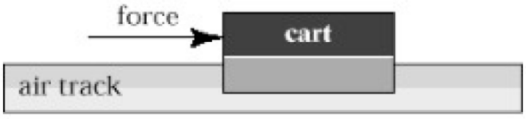
B) If the man pushes on the wall with a force of 200 N, we can be sure that the wall is pushing back with a force of exactly 200 N on him.

C) The man can never exert a force on the wall which exceeds his weight.

D) Since the wall cannot move, it cannot exert any force on the man.

E) The man cannot be in equilibrium since he is exerting a net force on the wall.

9) A constant force is exerted on a cart (initially at rest) on an air track. Neglect friction.
The force acts for a short time and gives the cart a certain final speed. To reach the same final speed with a force that is only half as big, the force must be exerted on the cart for a time interval _____that for the stronger force.



A) twice as long as

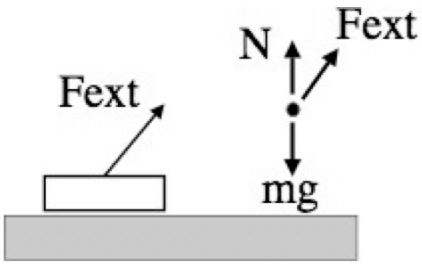
B) four times as long as

C) equal to

D) half as long as

E) (Not enough information given)

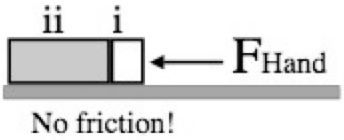
10) A mass m is pulled along a frictionless table by <u>constant</u> force external force F_{ext} at some angle above the horizontal. (The magnitudes of the forces on the free-body diagram have not been drawn carefully, but the directions are correct.)



Which statement below must be true?

A) N > mg B) mg > N C) N=mg D) F_{ext} = mg E) F_{ext} > mg

11) Two gliders with unequal mass ($M_i < M_{ii}$) are on a frictionless air track.
You push horizontally, so the gliders move faster and faster.



How does the magnitude of the *net force* on glider i compare with the magnitude of the *net force* on glider ii?

A) $F_{net(i)} = F_{net(ii)}$ B) $F_{net(i)} < F_{net(ii)}$

C) $F_{net(i)} > F_{net(ii)}$ D) Not enough information to decide.

12) Two cyclists, who weigh the same and have identical bicycles, ride up the same mountain, both starting at the same time. Joe rides straight up the mountain, and Bob rides up the longer road that has a lower grade. Joe gets to the top before Bob. Which statement is true?

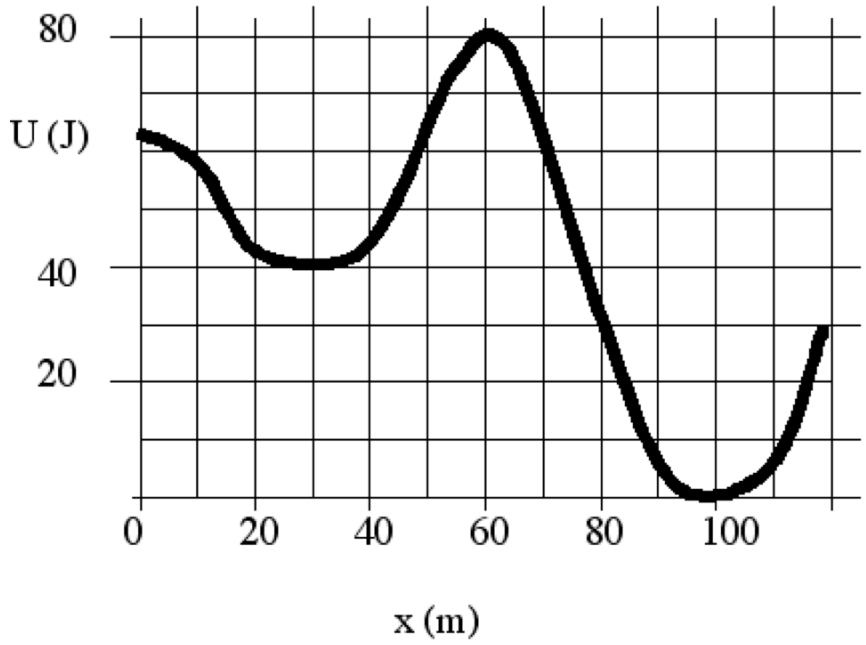
A) Ignoring friction and wind resistance, the amount of work done by Joe is equal to the amount of work done by Bob, but the average power exerted by Joe is greater than that of Bob.

B) Ignoring friction and wind resistance, the average power exerted by Bob and Joe was the same, but Joe exerted more work in getting there.

C) Ignoring friction and wind resistance, Bob and Joe exerted the same amount of work, and the average power of each cyclist was also the same.

D) Ignoring friction and wind resistance, the amount of work done by Joe is greater than the amount of work done by Bob, and the average power exerted by Joe is greater than that of Bob.

13) A body moves in the presence of an external force field. The graph below shows the potential energy associated with this force field as a function of position. The body starts from rest at x = 10 m. Describe its motion



A) The body moves to decreasing x, bounces back at x = 0, and comes to a stop at the original position of x=10 m

B) The body moves to increasing x, attains an maximum speed at x = 30 m, comes to a stop close to x = 50m, tracks back it motion all the way to its initial position and starts anew.

C) The body moves to increasing x, attains an minimum speed at x = 60 m, and accelerates to finally escape to the region beyond x =120 m (whence we cannot describe the motion further).

D) The body moves to decreasing x, bounces back at x = 0, overshoots the original position of x=10 m and bounces backat x = 50 m, henceforth performing oscillatory motion between turning points at x=0 m and 50 m.

E) The body moves to increasing x, attains an minimum speed at x = 60 m, and accelerates to finally come to rest at its minimum energy at x = 90 m.

14) In order to do work on an object,

A) the object must move.

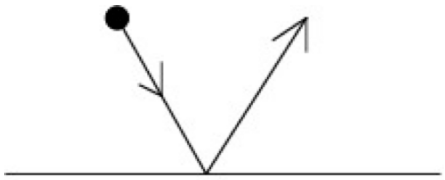
B) the applied force must be greater than the reaction force of the object.

C) the force doing the work must be directed perpendicular to the motion of the object.

D) it is necessary that friction not be present.

E) it is necessary that friction be present.

15) A ball bounces off the floor as shown. The angle the trajectory makes with the floor before the bounce is the same as after the bounce.



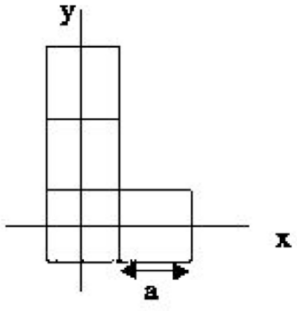
The direction of the impulse on the ball, $\triangle \vec{p}$, is ...

A) straight down
B) to the right
C) to the left
D) straight up
E) None of the above

16) Consider two carts, of masses m and 2m, at rest on an air track. If you push each car for 3 s, exerting equal force on each, the momentum of the light cart after the push is _____ the momentum of the heavy cart.

A) one-quarter
B) four times
C) equal to
D) one-half
E) twice

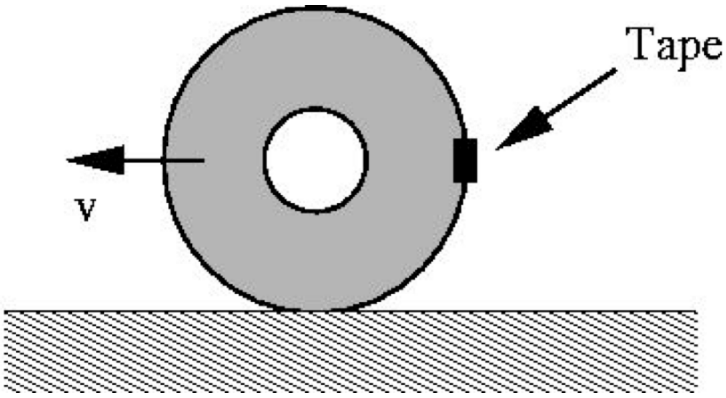
17) Four equal mass floor tiles are laid out in an L-pattern as shown. The origin of the x-y axes is at the center of the lower left tile.



What is the y-coordinate of the center of mass?

A) $\frac{3}{2}$ a B) $\frac{3}{4}$ a C) $\frac{5}{4}$ a D) $\frac{1}{2}$ a E) a

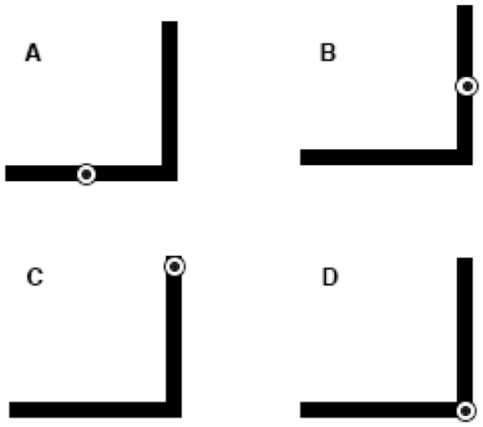
18)



A tire is rolling along a road, without slipping, with velocity v. A small piece of tape is attached to the tire as shown in the figure. When the tape is directly below the axis, instantaneously in contact with the ground, its velocity with respect the center of mass of the tire is

A) –v
B) v
C) 1.5 v
D) 2 v
E) None of the above

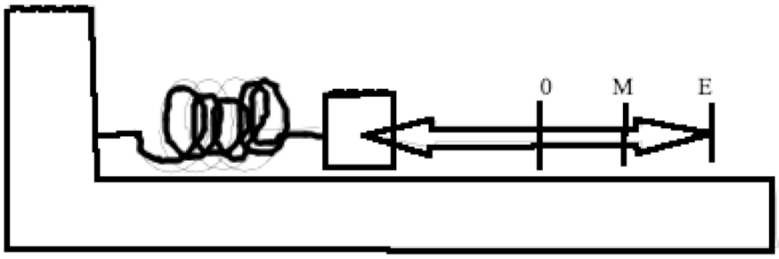
19) Below are four identical figure L's, which are constructed from two rods of equal lengths and masses. For each figure, a different axis of rotation is indicated by the small circle with the dot inside, which indicates an axis that is perpendicular to the plane of the L's. The axis of rotation is located either at the center or at one end of a rod for each figure.



Rank these L figures according to their moments of inertia about the indicated axes, from largest to smallest. Ignore the width of each rod but not the length.

A) ID > IA = IB > IC
B) IC > IA = IB > ID
C) IC > ID > IA = IB
D) IC > IA = IB = ID
E) None ofthe above

20) A mass is oscillating back and forth on a spring without friction, as shown. At which position is the magnitude of the acceleration of the mass a maximum? Position 0 is the relaxed (unstretched) position of the mass.



A) E
B) M
C) 0
D) None of the above

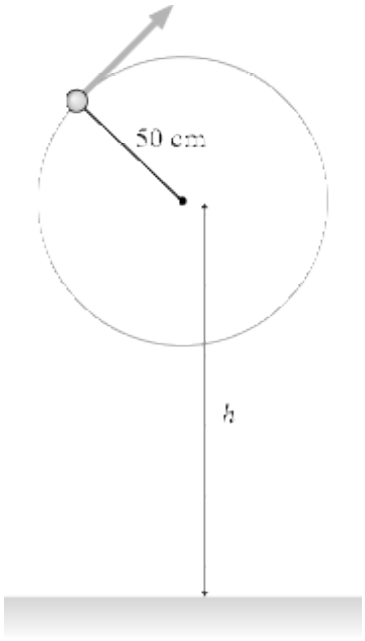
21) The x– and y–coordinates of a particle in motion, as functions of time t, are given by:

$$x = 5t^2 - 3t + 6 \qquad y = 3t^3 - 3t^2 - 12t - 3$$

The smallest magnitude of the acceleration is closest to:

A) 15 m/s^2 B) 5 m/s^2 C) 13 m/s^2 D) 12 m/s^2 E) 10 m/s^2

22) The figure shows a 3.0 kg ball tied to the end of a 50 cm long string being swung in a circle in a vertical plane at constant speed. The center of the circle is h = 230 cm above the floor. The ball is swung at the minimum speed necessary to make it over the top without the string going slack. If the string is released at the instant the ball is at the top of the loop, how far to the right of the center of the circle does the ball hit the ground?

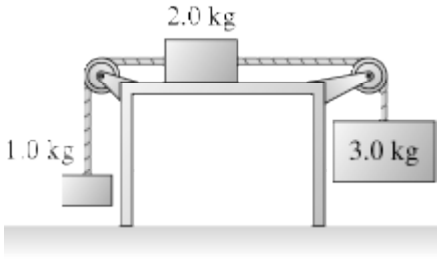


A) 170 cm B) 0.0 cm C) 150 cm D) 130 cm

23) Two particles, A and B, are in uniform circular motion about a common center with the same radial acceleration. Particle A moves in a circle of 2.6 m radius with a periods of 6.7 s. Particle B moves with a speed of 7.5 m/s. The period of the motion of particle B is closest to:

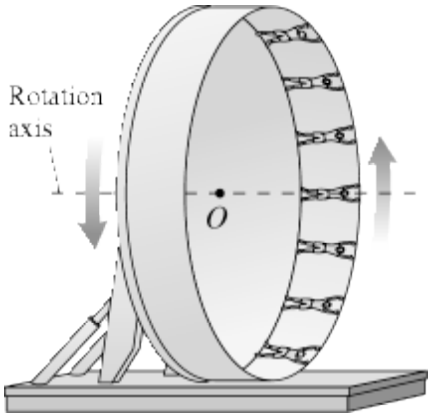
A) 19 s B) 18 s C) 22 s D) 21 s E) 23 s

24) Consider the following figure. Assume the strings and pulleys have negligible masses and the coefficient of kinetic friction between the 2.0 kg block and the table is 0.16. What is the acceleration of the 2.0 kg block?



A) 2.7 m/s2 B) 1.9 m/s2 C) 4.4 m/s2 D) 3.6 m/s2

25) In an amusement park ride passengers stand inside an 8 m radius cylinder. Initially the cylinder rotates with its axis oriented along the vertical. After the cylinder has acquired sufficient speed, it tilts into a vertical plane, that is, the axis tilts into the horizontal, as shown in the figure. Suppose that, once the axis has tilted into the horizontal, the ring rotates once every 4.5 s. If a rider's mass is 44 kg, with how much force does the ring push on her at the top of the ride?



A) 430 N B) 690 N C) 1100 N D) 260 N

26) A block starts from rest at the top of a 13.0° inclined plane and encounters a spring, of constant 4.5 kN/m, rigidly attached to the plane. If the block's mass is 64.0 kg and it compresses the spring by 60.0 cm, find the distance the block travelled before it encountered the spring.

A) 320 m B) 129.9 cm C) 5.1 m D) 561 cm

27) A potential is described by

$U(x) = 8.000\, x\, e^{-(x^2/11.000)}$

where the potential is in Joules and the displacement x is in meters. There is a point on the x–axis where the force on the mass vanishes and such that if the mass is moved slightly to one side or the other the force will accelerate it back towards this point. This point is at

A) $x = -3.000$ m

B) $x = 3.000$ m

C) $x = -2.345$ m

D) $x = 2.345$ m

E) $x = 0$ m

28) Two vehicles approach a right angle intersection and then collide. After the collision, they become entangled. If their mass ratios were 1:2 and their respective speeds as they approached were 13 m/s and 13 m/s, find the final speed of the wreck.

A) 11.3 m/s B) 14.5 m/s C) 7.5 m/s D) 9.7 m/s

29) It takes 200 J of work to increase the magnitude of the angular velocity of a wheel from 100 rev/s to 200 rev/s. What is the moment of inertia of the wheel?

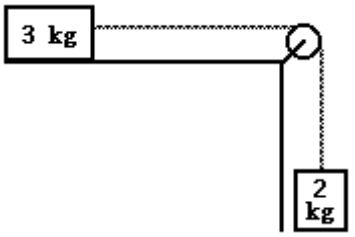
A) 2.00 $kg \cdot m^2$

B) 3.38×10^{-4} $kg \cdot m^2$

C) 1.69×10^{-4} $kg \cdot m^2$

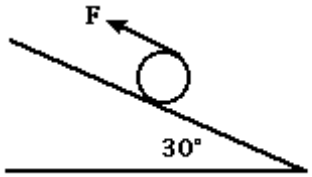
D) 4.00 $kg \cdot m^2$

E) 1.33×10^{-2} $kg \cdot m^2$



30) In the figure, two blocks, of masses 2 kg and 3 kg, are connected by a light string which passes over a pulley of moment of inertia 0.004 $kg \cdot m^2$ and radius 5 cms. The coefficient of friction for the table top is 0.30. The blocks are released from rest. Using energy methods, one can deduce that after the upper block has moved 0.6 m, its speed is:

A) 1.95 m/s B) 3.19 m/s C) 5.44 m/s D) 1.22 m/s E) 1.40 m/s



31) A solid cylinder of 5 cms radius is positioned on a frictionless plane inclined at 30° above horizontal, as shown in the figure. A force F is exerted by a string wrapped around the spool. When F has a certain critical value the center of mass of the spool does not move. When this is the case, what is the angular acceleration of the spool?

A) 340 rad/s^2 B) 98 rad/s^2 C) 392 rad/s^2 D) 196 rad/s^2 E) 260 rad/s^2

32) In a classroom demonstration, a professor steps onto a stationary turntable while holding a rotating bicycle wheel that is rotating with an angular velocity of 15 rad/s pointing upward. The wheel's axis of rotation goes through the axis of the turntable. The rotational inertia of the wheel is 1.5 kg m^2 and the combined rotational inertia of the professor and the turntable about the turntable's axis is 9.0 kg m^2. The professor flips the bicycle wheel so that it is still rotating with the same angular velocity, but pointing downward. How fast will this cause the professor and the turntable to rotate?

A) 2.5 rad/s B) 6.0 rad/s C) 5.0 rad/s D) 5.5 rad/s E) 3.0 rad/s

Answer Key
Testname: FINAL–B

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

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