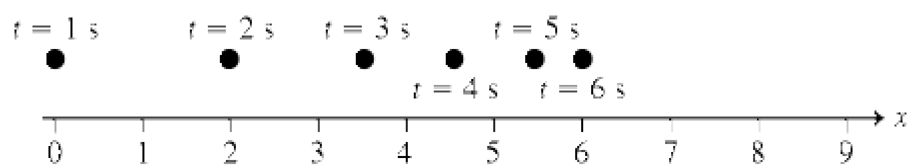
Physics 2A, Sec C00: Mechanics -- Winter 2011 Instructor: B. Grinstein
Final Exam

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.

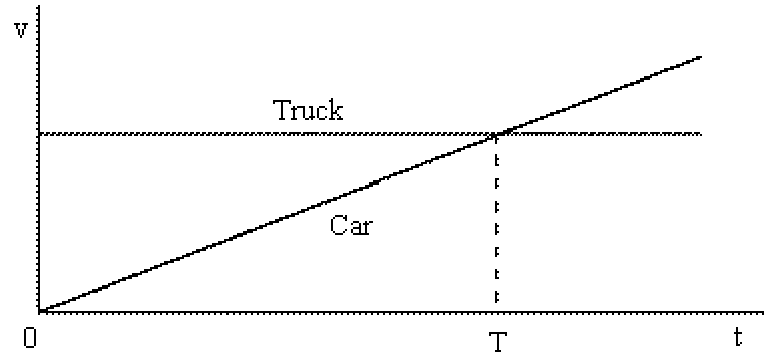
Moment of inertia about axis through center of mass:
thin rod of mass M and length L $I = 1/12\ ML^2$
solid cylinder of mass M and radius R, axis of rotation along axis of cylinder, $I = 1/2\ MR^2$
solid sphere of mass M and radius R, $I = 2/5\ MR^2$
hollow sphere of mass M and radius R, $I = 2/3\ MR^2$

1) The figure below shows the position of a particle (moving along a straight line) as a function of time. Which of the following statements is true?



A) The object is moving at a constant velocity.
B) The object is deaccelerating (slowing down).
C) The object is accelerating (speeding up).

2) The motions of a car and a truck along a straight road are represented by the velocity-time graphs below. The two vehicles are initially alongside each other at time t = 0.



At time T, what is true of the distances travelled by the vehicles since time t = 0?
A) The car will have travelled further than the truck.
B) The truck will not have moved.
C) They will have travelled the same distance.
D) The truck will have travelled further than the car.

Name________________________ Student 3-digit ID________

3) What is the minimum number of vectors, none of which have the same magnitude, for which it is theoretically possible that the sum of those vectors can be equal to zero?

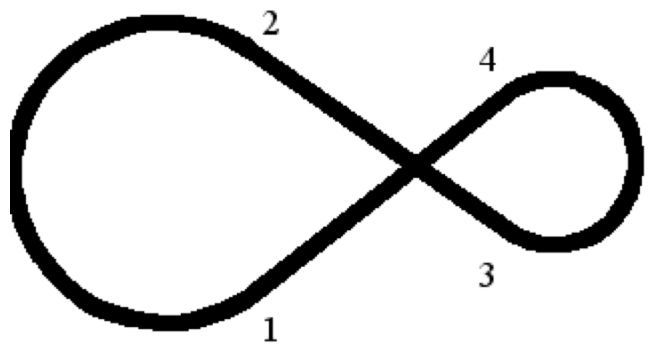
A) 3

B) 2

C) 1

D) 4

E) never possible



4)

A race car travels around the track shown at constant speed. Over which portion of the track is the magnitude of the acceleration the largest?

A) From 3 to 4

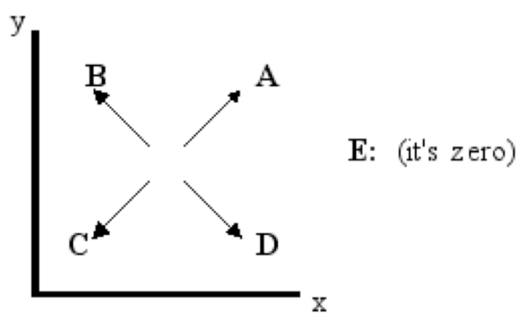
B) From 4 to 1

C) From 2 to 3

D) From 1 to 2

E) Two of the above

5) The x- and y-coordinates of a particle as a function of time are $x(t)=a+bt$, $y(t)=c-dt$, where a, b, c and d are positive constants. Which arrow best describes the velocity of the particle?



6) If you jumped out of a plane, you would begin speeding up as you fall downward. Eventually, due to wind resistance, your velocity would become constant with time. After this occurs, the magnitude of the force of wind resistance

A) is much smaller than the magnitude of the force of gravity acting on you.

B) is greater than the magnitude of force of the gravity acting on you.

C) is slightly smaller than the magnitude of the force of gravity acting on you.

D) is equal to the magnitude of the force of gravity acting on you.

E) bares no relation to the magnitude of the force of gravity acting on you.

7) A stalled car is being pushed up a hill by three people, and it is moving at a constant speed. The net force on the car is

A) zero.

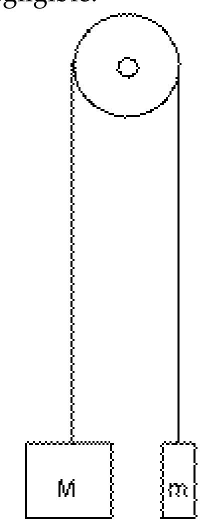
B) in the opposite direction of the car's motion.

C) in the same direction of the car's motion.

D) the vector sum of the forces applied by each man.

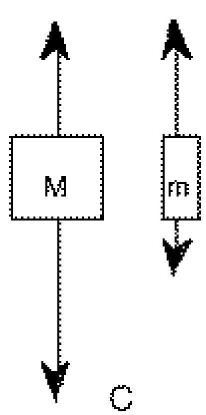
E) none of the above

8) Two unequal masses $M > m$ are connected by a light cord passing over a pulley of negligible mass. When released, the system accelerates. Friction is negligible.

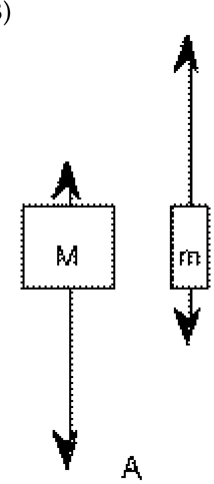


Which figure below gives the correct free–body force diagrams for the two masses in the moving system?

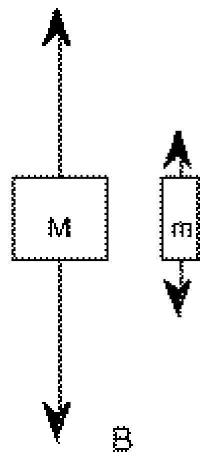
A)



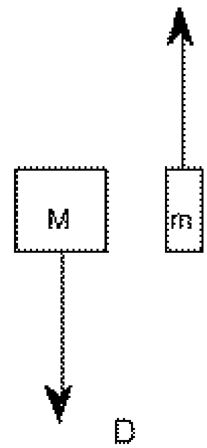
B)



C)



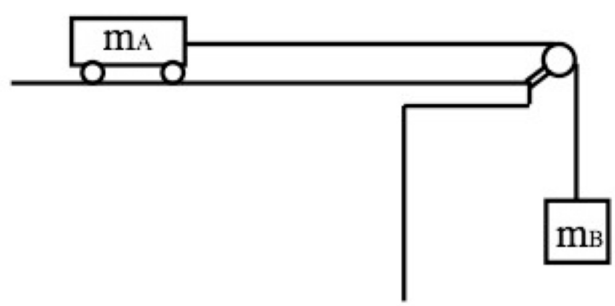
D)



9) A person who normally weighs 200 pounds is standing on a scale inside an elevator. The elevator is moving upwards with a speed of 7 m/s, and then begins to decelerate at a rate of 5 m/s^2. Before the elevator begins to decelerate, the reading of the scale is _________, and while the elevator is slowing down, the reading of the scale is ________.

A) less than 200 pounds, 100 pounds
B) greater than 200 pounds, 0 pounds
C) greater than 200 pounds, 100 pounds
D) 200 pounds, 100 pounds
E) none of the above

10) How does the force exerted on the cart by the string (T) compare with the weight of body B? (Assume all surfaces are frictionless)



A) $T > m_B g$
B) $T < m_B g$
C) $T = m_B g$
D) Need to know which object, A or B, is heavier
E) Need to know whether the mass and friction of the pulley are negligible

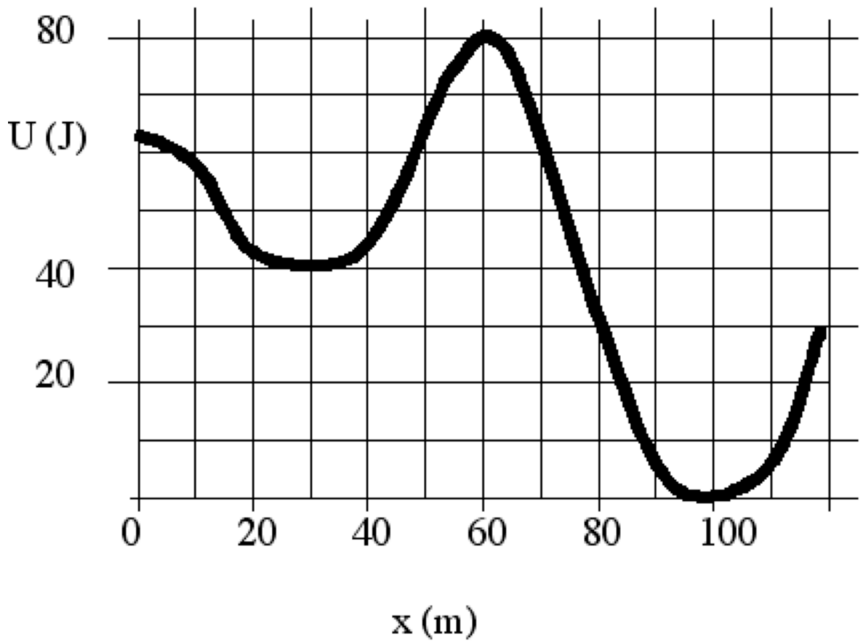
11) The instructor's box of chalk slides across a horizontal rough desk, moving with constant deceleration and coming to a stop in two seconds. The ratio of the work done by friction during the first second to the work done by friction during the last second is

A) 2 B) 1 C) 1/2 D) 3 E) 1/3

12) A spring-loaded dart gun is used to shoot a dart straight up into the air, and the dart reaches a maximum height of 24 meters. The same dart is shot up a second time from the same gun, but this time the spring is compressed only half as far (compared to the first shot). How far up does the dart go this time (neglect friction and assume the spring obeys Hooke's law)?

A) 48 meters B) 12 meters C) 6 meters D) 3 meters

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. If the total mechanical energy of the body is 50 J when it is moving at x = 20 m, what is the maximum kinetic ebergy the body will attain?



A) 50 J B) 30 J C) 20 J D) 10 J E) 40 J

14) A mass slides down a frictionless ramp of height h and hits a carpet with kinetic friction coefficient $\mu_K = 0.9$

Its initial speed is zero.
How far does the mass slide along the carpet?

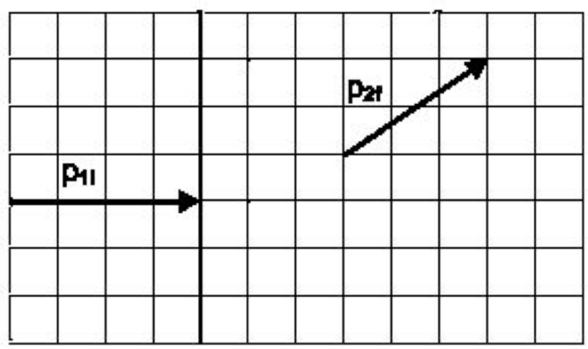
A) Less than h

B) Not enough information to decide.

C) h

D) More than h

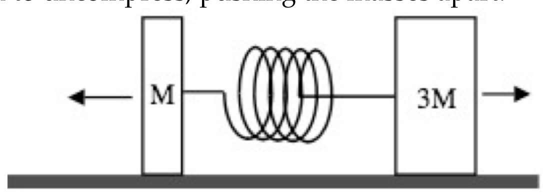
15) Ball 1 strikes stationary Ball 2 in 2D elastic collision. The initial momentum of Ball 1, $\overrightarrow{p1i}$, (4,0) and the final momentum of Ball 2, $\overrightarrow{p2f}$ (3,2) are shown on the graph.



What is the absolute value of the y-component of $\overrightarrow{p1f}$ (in units of the grid on the graph)?

A) 2
B) 3
C) 1
D) 0
E) None of the above

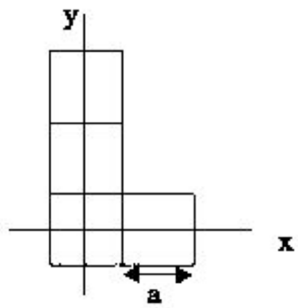
16) Two masses, of size M and 3M, are at rest on a frictionless surface. A compressed, massless spring between the masses is suddenly allowed to uncompress, pushing the masses apart.



After the spring losses contact with both masses, the speed of M is ____ the speed of 3M.

A) the same as
B) a third
C) half
D) twice
E) three times

17) Four 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 x–coordinate of the center of mass?

A) $\frac{1}{2}$ a

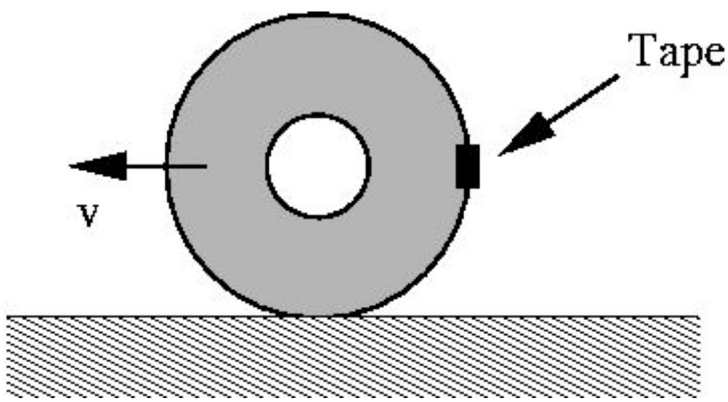
B) $\frac{1}{3}$ a

C) $\frac{1}{4}$ a

D) a

E) None of the above

18)



A tire is rolling along a road, without slipping, with speed v. A small piece of tape is attached to the tire as shwon in the figure. When the tape is at its highest spot in its trajectory (directly above the tire's axis), the magnitude of it's velocity with respect to the road is

A) 1.5 v

B) 2 v

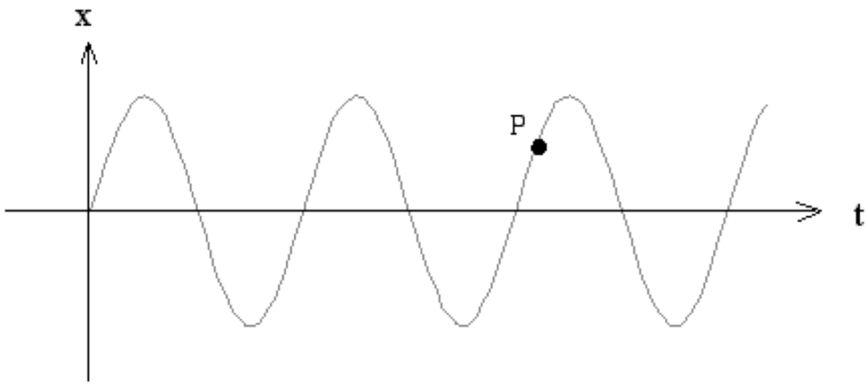
C) v

D) The velocity depends on the radius of the tire.

E) None of the above

19) The total force on an object is zero. The angular momentum of the object
A) may be changing.
B) can only be changing direction.
C) is constant.
D) can only be changing magnitude.
E) is zero.

20) The position of a mass on a spring as a function of time is shown below. At the time corresponding to point P,



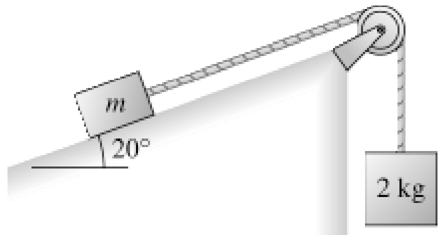
A) The velocity $v < 0$ and acceleration $a > 0$
B) The velocity $v > 0$ and acceleration $a > 0$
C) The velocity $v > 0$ and acceleration $a < 0$
D) The velocity $v < 0$ and acceleration $a < 0$
E) The velocity $v > 0$ and acceleration $a = 0$

21) You want to swim straight across a river that is 76 m wide. You find that you can do this if you swim 28° upstream at a constant rate of 1.3 m/s relative to the water. At what rate does the river flow? The angle is measured from the river bank (directly upstream is $\Theta = 0°$ while directly across the river is $\Theta = 90°$).
A) 1.3 m/s B) 1.5 m/s C) 1.1 m/s D) 0.6 m/s

22) A football kicker is attempting a field–goal from 26 m out. The ball is kicked and just clears the lower bar with a time of flight of 3.1 s. If we assume the angle of the kick was 45°, what was the initial speed of the ball?
A) 44.9 m/s B) 2.2 m/s C) 11.9 m/s D) 35.2 m/s

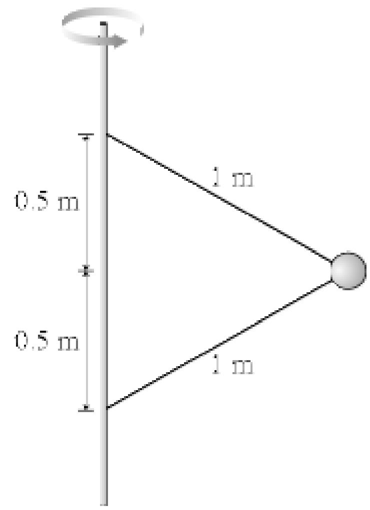
23) A rotating merry–go–round has an angular velocity of 0.184 rad/s. Find the period of rotation of the merry–go–round.
A) 34.1 s B) 3.91 s C) 13.6 s D) 5.43 s

24) The figure shows a block of mass m resting on a 20° slope. The block has coefficients of friction $\mu_s = 0.46$ and $\mu_k = 0.36$ with the surface. It is connected via a massless string over a massless, frictionless pulley to a hanging block of mass 2.0 kg. What is the minimum mass m that will stick and not slip?



A) 1.5 kg B) 4.6 kg C) 4.0 kg D) 2.6 kg

25) The figure shows two wires that are tied to a 980 g mass which revolves in a horizontal circle at a constant speed of 7.5 m/s. What is the tension in the upper wire?



A) 37 N B) 56 N C) 27 N D) 46 N

26) A spring with a spring constant of 11 N/m is stretched from equilibrium to 2.9 m. How much work is done in the process?

A) 46 J B) 60 J C) 92 J D) 23 J

27) A 10 g mass moves in a potential 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 away form this point. This point is at

A) $x = -2.345$ m
B) $x = 2.345$ m
C) $x = 3.000$ m
D) $x = -3.000$ m
E) $x = 0$

28) A steel ball is thrown in the air with a speed of 1.7 m/s at an angle of 62° from the horizontal. It drops on another steel ball of 2.6 times its mass resting on a sandy surface. If the original ball comes to a rest after the collision and the resting ball bounces, find the horizontal component of its velocity.

A) 1.1 m/s B) 0.31 m/s C) 0.58 m/s D) 2.1 m/s

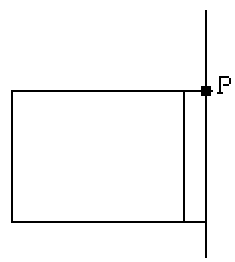
29) Calculate the average power needed to spin a uniform, solid disk of mass 2.2 kg and radius 0.70 m from rest to 5.0 rad/s in 2.3 s.

A) 2.9 W B) 4.1 W C) 3.5 W D) 2.3 W

30) A 2.00-kg solid sphere of radius 5.00 cm rolls down a 20.0° inclined plane starting from rest. What is the magnitude of the acceleration of the center of mass of the sphere?

A) 1.20 m/s^2 B) 2.40 m/s^2 C) 1.00 m/s^2 D) 1.60 m/s^2 E) 3.50 m/s^2

31) A sign is supported at P as shown. If the sign is a square 0.4 m on a side and its mass is 4.0 kg, what is the magnitude of the horizontal force that P experiences?



A) 0 N B) 98 N C) 20 N D) 7.8 N

32) A potter's wheel, with rotational inertia 46 kg•m^2, is spinning freely at 40.0 rpm. The potter drops a lump of clay onto the wheel, where it sticks a distance 1.2 m from the rotational axis. If the subsequent angular speed of the wheel and clay is 32 rpm, what is the mass of the clay?

A) 5.4 kg B) 7.0 kg C) 8.8 kg D) 8.0 kg

Answer Key
Testname: FINAL-C

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