

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 $I = 1/12 ML^2$

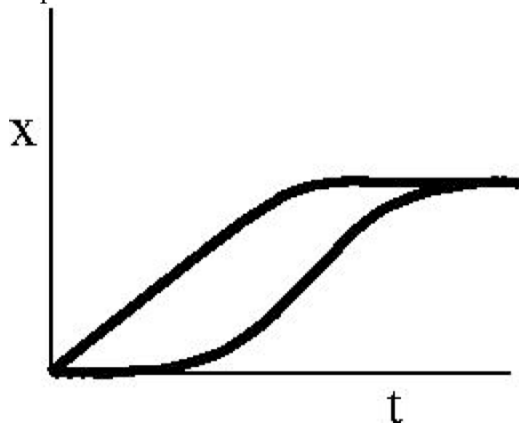
solid cylinder of mass M and radius R , axis of rotation along axis of cylinder, $I = 1/2 MR^2$

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) In which of the following situations is the acceleration of the object in a direction opposite to the direction of the velocity of the object?
- A) A car is traveling around a circular curve at constant speed.
 - B) A car is at rest and is beginning to move.
 - C) A ball is falling vertically downward and its speed is increasing.
 - D) A car is traveling along a straight line and is slowing down.
 - E) both answers A and C above

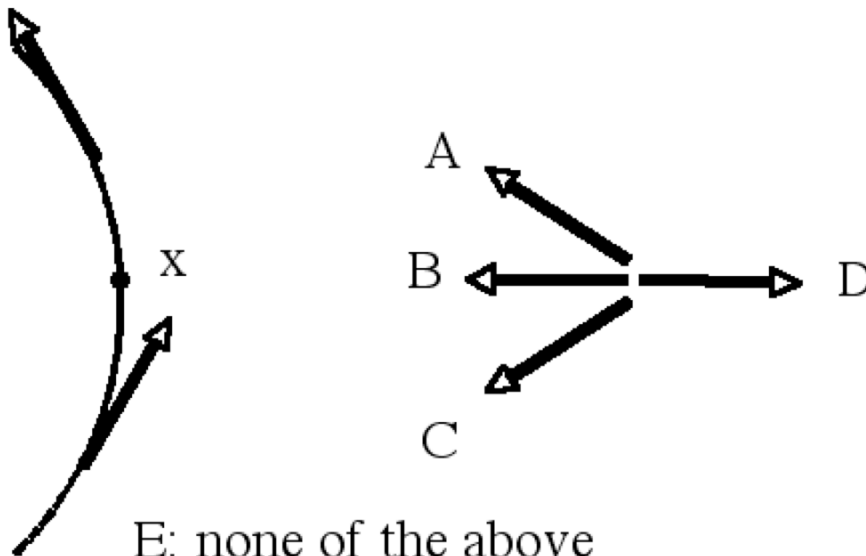
- 2) Shown in the figure is a schematic graph of position versus time for two moving objects. Which of the following best describes what is depicted here?



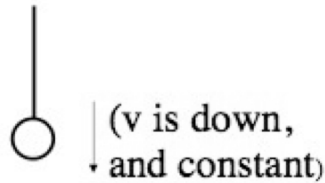
- A) A rock and a crumpled piece of paper are dropped from rest at $t = 0$ in the presence of air (i.e. friction is present).
- B) Leading the Indianapolis 500, with two laps to go, Bobby Rahal throws a wheel bearing and pulls in for a pit stop as Tom Sneva zooms by and goes on to win.
- C) A speeder races past a parked police car. A moment later the police car starts and takes off in pursuit with high acceleration and siren screaming. He ends up giving the violator a speeding ticket.
- D) A ball is thrown into the air and a moment later a second ball is thrown, but with a higher velocity than the first.

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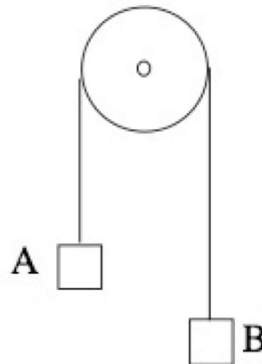
- E) While accelerating in an attempt to pass, Mario Andretti plows into the back of a speeding A.J. Foyt on the back straightaway at the Indy 500.
- 3) Two identical baseballs labeled A and B are thrown from the same spot over a flat, horizontal field. Ball A is thrown at an angle of 30° to the horizontal and ball B is thrown at an angle of 60° to the horizontal. Both A and B hit the ground at the same spot. Which of the following is true:
- A) The time of travel for A is larger than for B.
 - B) The time of travel is the same for A and B.
 - C) A and B reach the same maximum height.
 - D) A gets higher than B in the trajectory of the balls.
 - E) The time of travel for B is larger than for A.
- 4) The dot product of the two vectors \vec{A} and \vec{B} is equal to zero. You conclude that
- A) If they have non-zero magnitude, then they have the same magnitude and same direction
 - B) If they have non-zero magnitude they are perpendicular to each other
 - C) They both vanish
 - D) If they have non-zero magnitude, then they have the same magnitude but opposite direction
 - E) None of the above
- 5) An object is moving along a circular path and is slowing down, as shown. When at point x, the object's acceleration vector is best represented by which arrow?



- 6) A constant force is exerted for a short time on a cart that is initially at rest on an air track. This force gives the cart a certain final speed. We repeat the experiment but, instead of starting from rest, the cart is already moving with constant speed in the direction of the force at the moment we applied the force. After we exert the same constant force for the same short time interval, the *increase* in the cart's speed is
- the square of its initial speed.
 - four times its initial speed.
 - cannot be determined from the info provided.
 - the same as when it started from rest.
 - two times its initial speed.
- 7) A constant rightward force (F) is exerted for a short time interval (t) on a cart that is initially at rest on an air track. This gives the cart a certain velocity, v . Suppose we begin with the cart moving with the velocity v above, and then we apply a leftward force ($-F$) for the same short time interval (t). What will the cart be doing after time t ?
- Moves forward with velocity $2v$.
 - Moves forward with velocity v .
 - Moves backward with velocity $-v$.
 - Final speed is 0.
 - Cannot be determined from the info provided.



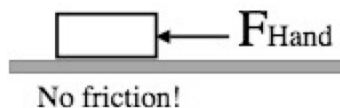
- 8) An object is lowered by a rope at a constant speed. How does the tension T in the string compare with the weight " mg " of the object?
- $T = mg$
 - $T < mg$
 - $T > mg$
 - not enough information given
- 9) An Atwood's machine is a pulley with two masses connected by a string as shown. The mass of A is twice the mass of B.



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)

- $T > m_B g$
- $T < m_B g$
- $T = m_B g$
- not enough information given

10) You push a heavy cart to the left on an air track with a force of 100 N for a while, to get it up to speed...

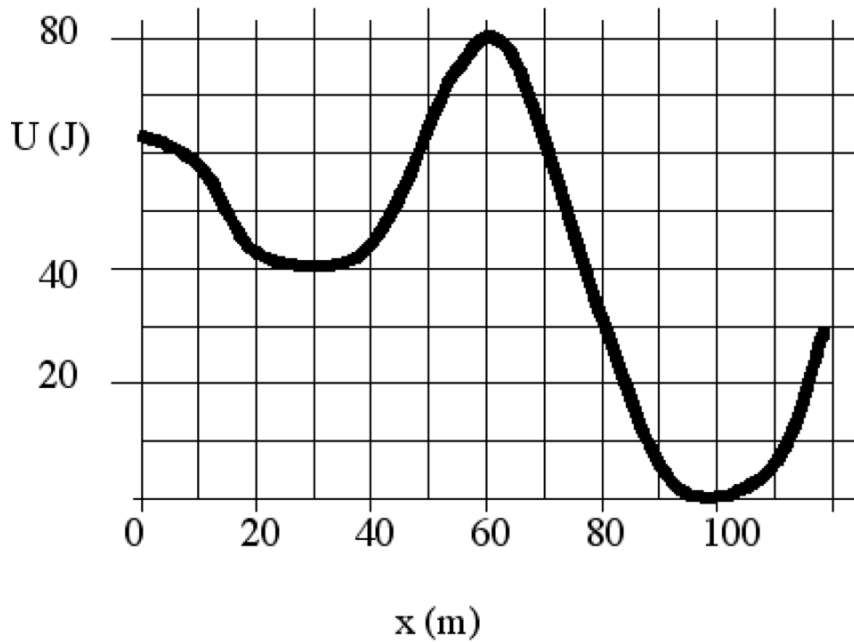


Then, at $t=0$, you begin to steadily "ease up", *continuously* decreasing the size of the force you apply from 100 N ($t=0$) down to 1 N ($t = 5$ sec).

During the period $0 < t < 5$ sec, the cart is ...

- A) Moving with a constant v the whole time
 - B) Something else (e.g speeds up then slows)
 - C) Slowing down the whole time.
 - D) Speeding up the whole time
 - E) Not enough information to decide.
- 11) In outer space, a large star and a small planet attract each other due to gravitational forces. How do the magnitudes of these attractive forces compare?
- A) The large star exerts a greater force on the small planet
 - B) The forces are equal
 - C) There are actually no forces at all
 - D) The small planet exerts a greater force on the large star
 - E) The forces are zero because they cancel out
- 12) A car starts from rest with constant acceleration and uses some energy E , converted from chemical to mechanical form, in making it to a speed of v . After using up another quantity of energy E , the car speed is
- A) v
 - B) $v/\sqrt{2}$
 - C) $\sqrt{3} v$
 - D) $2 v$
 - E) $\sqrt{2} v$

- 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 moves from the region $x > 120$ m towards the region shown in the graph. What is the minimum kinetic energy the body must have when it enters the graph (at $x = 120$ m) so that the body will reach the region of $x < 0$?



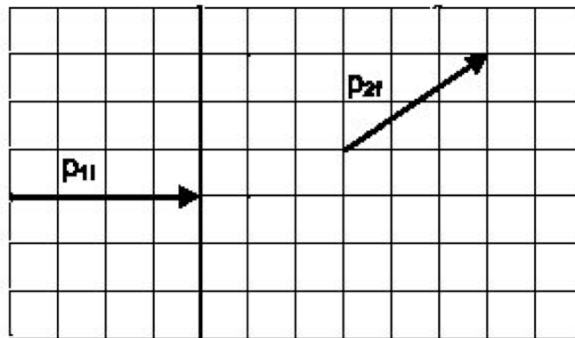
- A) 30 J B) 63 J C) 10 J D) 50 J E) 80 J
- 14) A hockey puck slides without friction along a frozen lake toward an icy but rough ramp followed by an ice plateau as shown.



- Under what conditions will the puck make it up the ramp?
- A) The initial kinetic energy must be positive
 B) The energy loss in friction must be less than the gravitational potential energy gain mgh .
 C) The collision of the puck with the ramp must be elastic
 D) The initial kinetic energy of the puck has to be larger than the gravitational potential energy gain mgh plus the energy loss to friction on the ramp.
 E) All of the above

- 15) A car is placed atop an aircraft carrier. Initially they are both at rest (with respect to you, an observer on land). The car then accelerates from rest. Find the most reasonable completion of the following sentence, neglecting the effects of drag or friction on the motion of the aircraft carrier on water: "The car gains a certain amount of kinetic energy and the aircraft carrier _____ "
- A) loses kinetic energy as the car gains it.
 - B) gains more kinetic energy.
 - C) gains the same amount of kinetic energy.
 - D) gains less kinetic energy.
 - E) may gain more or less kinetic energy, depending on the nature of the force between the two.

- 16) Ball 1 strikes stationary Ball 2 in 2D elastic collision. The initial momentum of Ball 1, \vec{p}_{1i} , (4,0) and the final momentum of Ball 2, \vec{p}_{2f} (3,2) are shown on the graph.



What is the magnitude of \vec{p}_{1f} (in units of the grid on the graph)?

A) 2

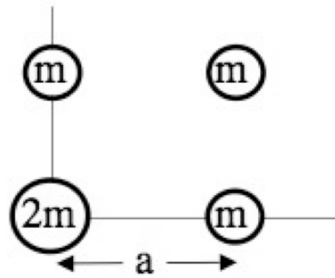
B) $\sqrt{3}$

C) $\sqrt{5}$

D) 0

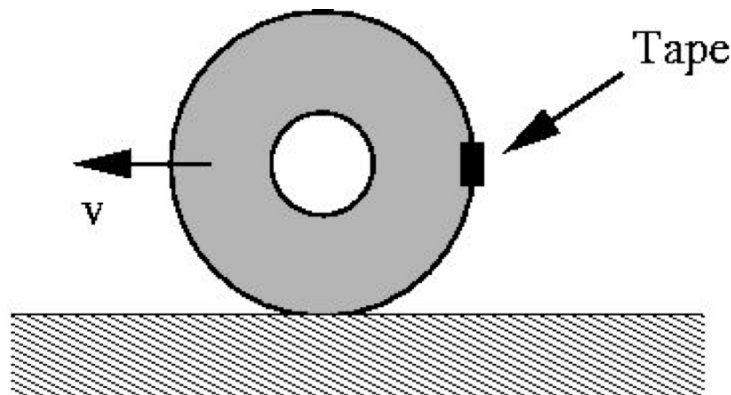
E) 1

- 17) Four masses are laid out in a square pattern as shown.
The origin of the x-y axes is at the center of the lower left mass.
Three of the masses are "m", the one in the lower left is "2m"



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

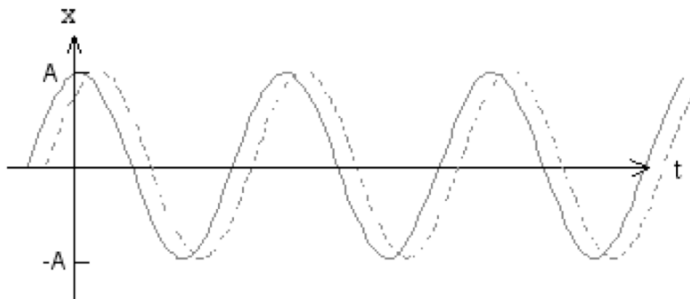
- A) $\frac{1}{2} a$
- B) $\frac{2}{5} a$
- C) $\frac{1}{3} a$
- D) $\frac{1}{5} a$
- E) None of the above



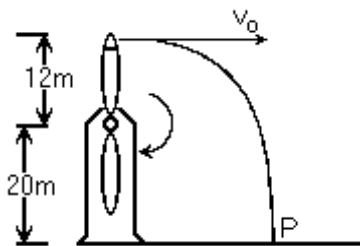
- 18) A tire is rolling along a road, without slipping, with velocity v . A small piece of tape is attached to the tire as shown in the figure. When the tape is halfway up (moving up and at the same height as the tire's axis), the magnitude of its velocity with respect to the road is
- A) v
 - B) $2 v$
 - C) $1.5 v$
 - D) The velocity depends on the radius of the tire.
 - E) None of the above

- 19) When a torque acts on an object
- A) the rotational kinetic energy may or may not be changing.
 - B) the rotational kinetic energy of the object is increasing.
 - C) the rotational kinetic energy of the object is changing.
 - D) the rotational kinetic energy of the object is decreasing.
 - E) the rotational kinetic energy of the object is constant.

- 20) The solid curve is a graph of $x(t) = \cos(\omega t)$. The dotted curve is a graph of $x(t) = \cos(\omega t + \phi)$ where ϕ is a phase constant whose magnitude is less than $\pi/2$. From the graph we can determine that ...



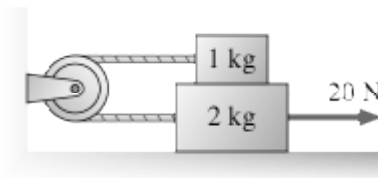
- A) ϕ is negative
 - B) ϕ is zero
 - C) ϕ is positive
 - D) ϕ equals A
 - E) none of these statements can be unequivocally determined from the graph
- 21) A long distance swimmer is able to swim through still water at 4 km/h. She wishes to try to swim from Port Angeles, WA due north to Victoria, B.C., a distance of 50 km. An ocean current flows through the Strait of Juan de Fuca from west to east at 3 km/h. In what direction should she swim to make the crossing along a straight line between the two cities?
- A) 49° west of north
 - B) 41° east of north
 - C) 37° east of north
 - D) 41° west of north
 - E) 37° west of north



- 22) A wind farm generator uses a two-bladed propeller mounted on a pylon at a height of 20 m. The length of each propeller blade is 12 m. A tip of the propeller breaks off when the propeller is vertical. At that instant, the period of the motion of the propeller is 1.2 s. The fragment flies off horizontally, falls, and strikes the ground at P. The angle with respect to the vertical at which the fragment strikes the ground is closest to:
- A) 73°
 - B) 63°
 - C) 58°
 - D) 78°
 - E) 68°

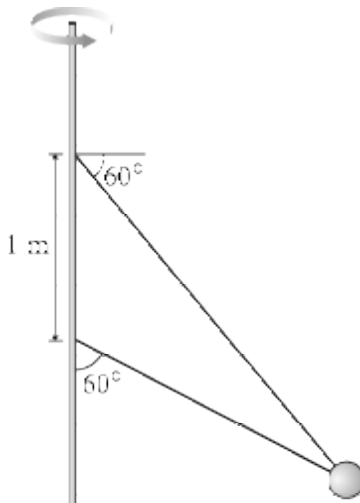
- 23) Two particles, A and B, are in uniform circular motion about a common center. The acceleration of particle A is 4.0 times that of particle B. The period of particle B is 2.3 times the period of particle A. The ratio of the radius of the motion of particle A to that of particle B is closest to:
- A) 1.7 B) 0.58 C) 3.0 D) 0.76 E) 9

- 24) A rope pulls on the lower block in the figure with a tension force of 20 N. The coefficient of kinetic friction between the lower block and the surface is 0.21. The coefficient of kinetic friction between the lower block and the upper block is also 0.21. What is the acceleration of the 2.0 kg block?



- A) 6.9 m/s² B) 4.6 m/s² C) 5.9 m/s² D) 3.2 m/s² E) 11.8 m/s²

- 25) The figure shows two wires tied to a 9.2 kg sphere which revolves in a horizontal circle at constant speed. At this particular speed the tension is the same in both wires. What is the tension?



- A) 120 N B) 66 N C) 90 N D) 62 N

- 26) 77 J of work are needed to stretch a spring from a point 1.4 m from the equilibrium position to a second point 2.9 m from equilibrium. What is the value of the spring constant?
- A) 34 N/m B) 69 N/m C) 46 N/m D) 24 N/m

- 27) A potential is described by

$$U(x) = 5.0e^{-x^2/7} + 91x^2 e^{-x^2/7}.$$

Find the equilibrium points of a particle in this field.

- A) $x = \pm 2.6, x = 0.0$ B) $x = \pm 2.7$ C) $x = \text{not real}$ D) $x = \pm 2.2$

- 28) A container initially at rest explodes and breaks into three fragments that fly off 120° apart from each other, with mass ratios 1:4:2. if the first piece flies off with a speed of 6.2 m/s, what is the speed of the other two fragments? (All fragments are in the plane.)

- A) 1.0 and 3.1 m/s B) 1.6 and 0.9 m/s C) 0.9 and 3.1 m/s D) 1.6 and 3.1 m/s

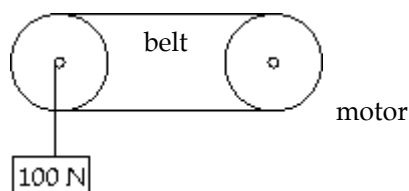
29) A record that is initially at rest (not rotating) is dropped vertically onto a freely rotating turntable. Frictional forces act to bring the record and turntable to a common angular speed. If the rotational inertia of the record is 0.45 times that of the turntable, what percentage of the initial kinetic energy is lost?

- A) 53% B) 31% C) 40% D) 16%

30) A solid, uniform sphere of mass 2.0 kg and radius 1.7 m rolls without slipping down an inclined plane of height 4.3 m. What is the angular velocity of the sphere at the bottom of the inclined plane?

- A) 8.7 rad/s B) 4.6 rad/s C) 7.8 rad/s D) 5.5 rad/s

31) The figure below shows a winch that is being used to raise a 100 N load. If the motor supplies a torque at a radius of 1.2 m and the cylinder upon which the rope is being wrapped has a radius a 0.2 m, how much force must the motor supply to keep the load suspended in place while the work crew goes to lunch? (Note: in case you forgot, a winch is a machine used for hoisting, having a drum around which is wound a rope attached to the load being moved).



- A) 100 N B) 86 N C) 17 N D) 600 N

32) A particular motor can provide a maximum of 110.0 N · m of torque. Assuming that all of this torque is used to accelerate a solid, uniform flywheel (cylinder free to rotate about its axis) of mass 10.0 kg and radius 3.00 m, how long will it take for the flywheel to accelerate from rest to 6.58 rad/s?

- A) 3.25 s B) 2.29 s C) 3.52 s D) 2.69 s

Answer Key

Testname: FINAL-A

1) D

2) C

3) E

4) B



5)

6) D

7) D

8) A

9) A

10) D

11) B

12) E

13) D

14) D

15) D

16) C

17) B

18) E

19) A

20) A

21) E

22) E

23) D

24) D

25) B

26) D

27) A

28) D

29) B

30) B

31) C

32) D

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