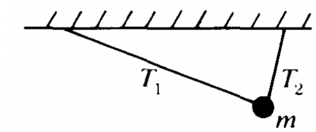
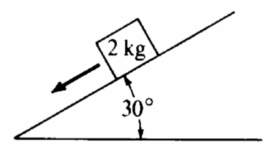
AP Physics Multiple Choice Practice – Dynamics

SECTION A – Linear Dynamics



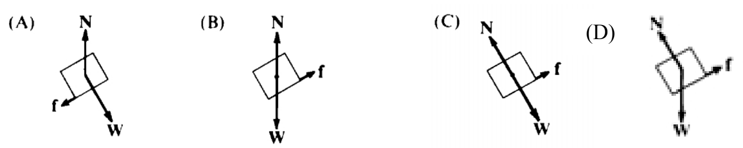
1. A ball of mass m is suspended from two strings of unequal length as shown above. The magnitudes of the tensions T_1 and T_2 in the strings must satisfy which of the following relations?
(A) $T_1 = T_2$ (B) $T_1 > T_2$ (C) $T_1 < T_2$ (D) $T_1 + T_2 = mg$

Questions 2 – 3

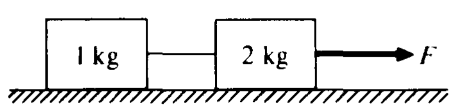


A 2-kg block slides down a 30° incline as shown above with an acceleration of 2 m/s^2.

2. Which of the following diagrams best represents the gravitational force W. the frictional force f, and the normal force N that act on the block?

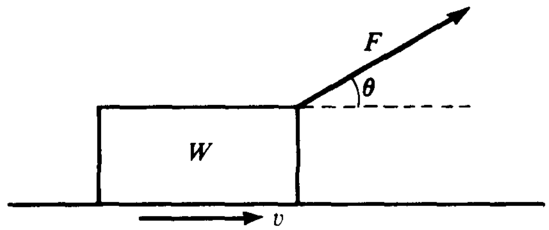


3. Which of the following correctly indicates the magnitudes of the forces acting up and down the incline?
   (A) 20 N down the plane, 16 N up the plane
   (B) 4 N down the plane, 4 N up the plane
   (C) 0 N down the plane, 4 N up the plane
   (D) 10 N down the plane, 6 N up the plane

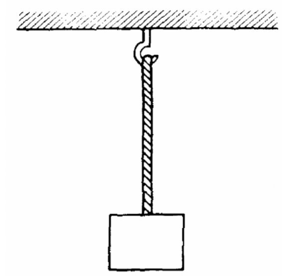


4. When the frictionless system shown above is accelerated by an applied force of magnitude the tension in the string between the blocks is (A) F (B) 2/3 F (C) ½ F (D) 1/3 F

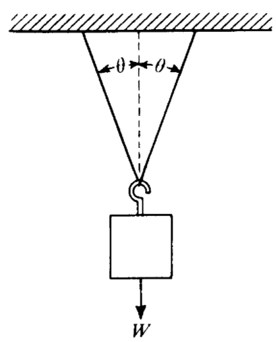
5. A ball falls straight down through the air under the influence of gravity. There is a retarding force F on the ball with magnitude given by F = *bv*, where *v* is the speed of the ball and *b* is a positive constant. The ball reaches a terminal velocity after a time *t*. The magnitude of the acceleration at time *t*/2 is
   (A) Increasing
   (B) Decreasing
   (C) 10 m/s/s
   (D) Zero



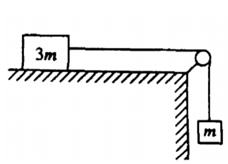
6. A block of weight W is pulled along a horizontal surface at constant speed v by a force F, which acts at an angle of θ with the horizontal, as shown above. The normal force exerted on the block by the surface has magnitude
   (A) greater than W
   (B) greater than zero but less than W
   (C) equal to W
   (D) zero



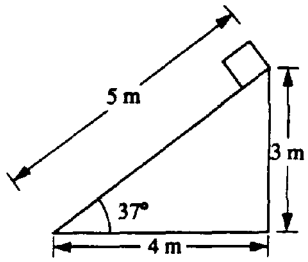
7. A uniform rope of weight 50 N hangs from a hook as shown above. A box of weight 100 N hangs from the rope. What is the tension in the rope?
   (A) 75 N throughout the rope (B) 100 N throughout the rope
   (C) 150 N throughout the rope (D) It varies from 100 N at the bottom of the rope to 150 N at the top.



8. When an object of weight W is suspended from the center of a massless string as shown above, the tension at any point in the string is
   (A) $2W\cos\theta$ (B) $\frac{1}{2}W\cos\theta$ (D) $W/(2\cos\theta)$ (E) $W/(\cos\theta)$



9. A block of mass 3m can move without friction on a horizontal table. This block is attached to another block of mass m by a cord that passes over a frictionless pulley, as shown above. If the masses of the cord and the pulley are negligible, what is the magnitude of the acceleration of the descending block?
   (A) g/4 (B) g/3 (C) 2g/3 (D) g

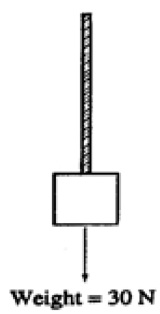


A plane 5 meters in length is inclined at an angle of 37°, as shown above. A block of weight 20 N is placed at the top of the plane and allowed to slide down.

10. The magnitude of the normal force exerted on the block by the plane is
    (A) greater than 20 N
    (B) greater than zero but less than 20 N
    (C) equal to 20 N
    (D) zero

11. **Multiple correct:** Three forces act on an object. If the object is moving to the right in translational equilibrium, which of the following must be true? Select two answers.
    (A) The vector sum of the three forces must equal zero.
    (B) All three forces must be parallel.
    (C) The magnitudes of the three forces must be equal.
    (D) The object must be moving at a constant speed.

12. For which of the following motions of an object must the acceleration always be zero?
    (A) Any motion in a straight line
    (B) Simple harmonic motion
    (C) Any motion at constant speed
    (D) Any single object in motion with constant momentum



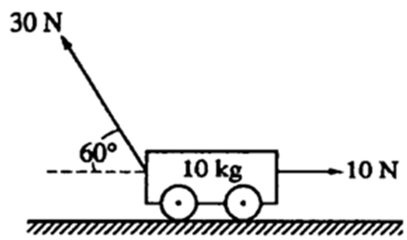
13. A rope of negligible mass supports a block that weighs 30 N, as shown above. The breaking strength of the rope is 50 N. The largest acceleration that can be given to the block by pulling up on it with the rope without breaking the rope is most nearly
    (A) 6.7 m/s^2 (B) 10 m/s^2 (C) 16.7 m/s^2 (D) 26.7 m/s^2

<u>Questions 14-15</u>

A horizontal, uniform board of weight 125 N and length 4 m is supported by vertical chains at each end. A person weighing 500 N is hanging from the board. The tension in the right chain is 250 N.

14. What is the tension in the left chain?
    (A) 125 N (B) 250 N (C) 375 N (D) 625 N

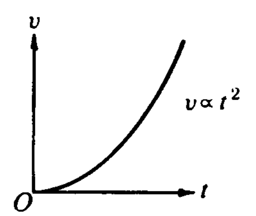
15. Which of the following describes where the person is hanging?
    (A) between the chains, but closer to the left-hand chain
    (B) between the chains, but closer to the right-hand chain
    (C) Right in the middle of the board
    (D) directly below one of the chains



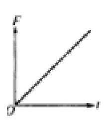
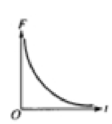
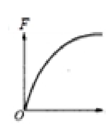
16. **Multiple correct:** The cart of mass 10 kg shown above moves without frictional loss on a level table. A 10 N force pulls on the cart horizontally to the right. At the same time, a 30 N force at an angle of 60° above the horizontal pulls on the cart to the left. Which of the following describes a manner in which this cart could be moving? Select two answers.

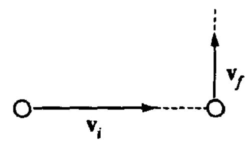
    (A) moving left and speeding up
    (B) moving left and slowing down
    (C) moving right and speeding up
    (D) moving right and slowing down

17. Two people are pulling on the ends of a rope. Each person pulls with a force of 100 N. The tension in the rope is:
    (A) 0 N (B) 50 N (C) 100 N (D) 200 N

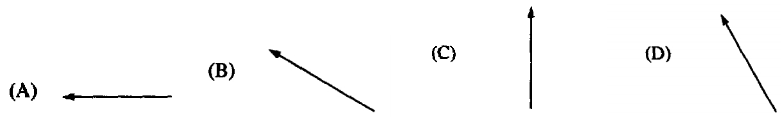


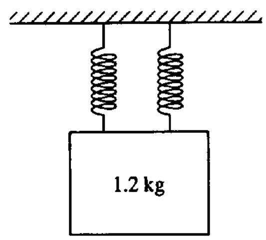
18. The parabola above is a graph of speed v as a function of time t for an object. Which of the following graphs best represents the magnitude F of the net force exerted on the object as a function of time t?

(A)  (B)  (C)  (D) 

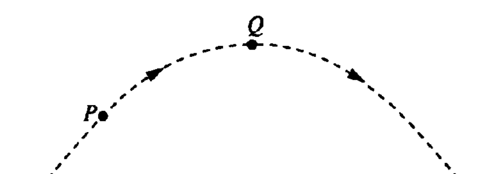


19. A ball initially moves horizontally with velocity v_i, as shown above. It is then struck by a stick. After leaving the stick, the ball moves vertically with a velocity v_f, which is smaller in magnitude than v_i. Which of the following vectors best represents the direction of the average force that the stick exerts on the ball?

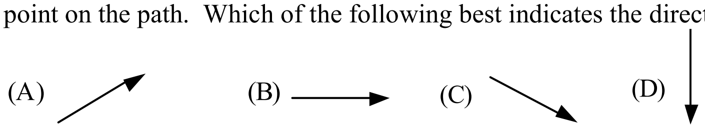


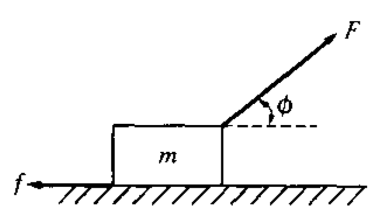


20. Two massless springs, of spring constants k_1 and k_2, are hung from a horizontal support. A block of weight 12 N is suspended from the pair of springs, as shown above. When the block is in equilibrium, each spring is stretched an additional 24 cm. Thus, the equivalent spring constant of the two-spring system is 12 N / 24 cm = 0.5 N/cm. Which of the following statements is correct about k_1 and k_2?
(A) $k_1 = k_2 = 0.25$ N/cm
(B) $1/k_1 + 1/k_2 = 1/(0.5\text{ N/cm})$
(C) $k_1 - k_2 = 0.5$ N/cm
(D) $k_1 + k_2 = 0.5$ N/cm

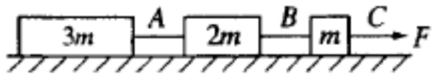


21. A ball is thrown and follows a parabolic path, as shown above. Air friction is negligible. Point Q is the highest point on the path. Which of the following best indicates the direction of the net force on the ball at point P ?

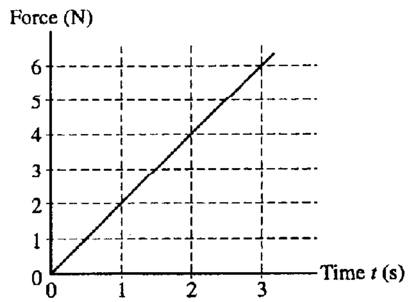




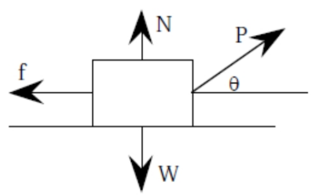
22. A block of mass m is accelerated across a rough surface by a force of magnitude F that is exerted at an angle ϕ with the horizontal, as shown above. The frictional force on the block exerted by the surface has magnitude f. What is the acceleration of the block?
(A) F/m (B) $(F\cos\phi)/m$ (C) $(F-f)/m$ (D) $(F\cos\phi - f)/m$



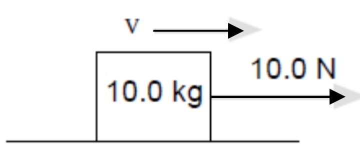
23. Three blocks of masses 3*m*, 2*m*, and*s* are connected to strings *A, B*, and *C* as shown above. The blocks are pulled along a rough surface by a force of magnitude *F* exerted by string *C*. The coefficient of friction between each block and the surface is the same. Which string must be the strongest in order not to break?
(A) *A* (B) *B* (C) *C* (D) They must all be the same strength.



24. A block of mass 3 kg, initially at rest, is pulled along a frictionless, horizontal surface with a force shown as a function of time t by the graph above. The acceleration of the block at t = 2 s is
(A) 4/3 m/s^2 (B) 2 m/s^2 (C) 8 m/s^2 (D) 12 m/s^2

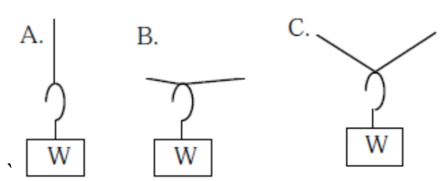


25. A student pulls a wooden box along a rough horizontal floor at constant speed by means of a force *P* as shown to the right. Which of the following must be true?
(A) P > f and N < W.
(B) P > f and N = W.
(C) P = f and N > W.
(D) P = f and N = W.

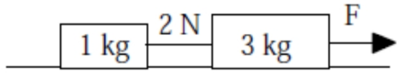


26. The 10.0 kg box shown in the figure to the right is sliding to the right along the floor. A horizontal force of 10.0 N is being applied to the right. The coefficient of kinetic friction between the box and the floor is 0.20. The box is moving with:
(A) acceleration to the left. (B) acceleration to the right.
(C) constant speed and constant velocity. (D) constant speed but not constant velocity.

27. Assume the objects in the following diagrams have equal mass and the strings holding them in place are identical. In which case would the string be most likely to break?

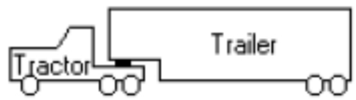


D. All would be equally likely to break



28. Two blocks of mass 1.0 kg and 3.0 kg are connected by a string which has a tension of 2.0 N. A force F acts in the direction shown to the right. Assuming friction is negligible, what is the value of F?
(A) 2.0 N (B) 4.0 N (C) 6.0 N (D) 8.0 N

29. A 50-kg student stands on a scale in an elevator. At the instant the elevator has a downward acceleration of 1.0 m/s^2 and an upward velocity of 3.0 m/s, the scale reads approximately
(A) 350 N (B) 450 N (C) 500 N (D) 550 N



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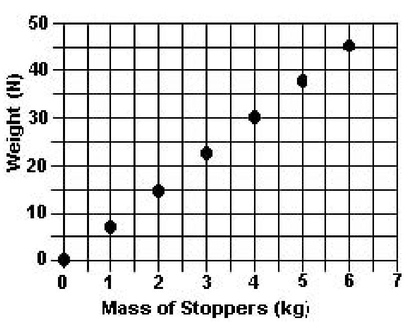
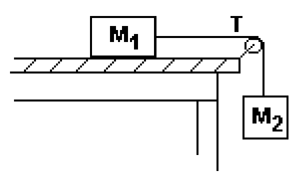
30. A tractor-trailer truck is traveling down the road. The mass of the trailer is 4 times the mass of the tractor. If the tractor accelerates forward, the force that the trailer applies on the tractor is
(A) 4 times greater than the force of the tractor on the trailer.
(B) 2 times greater than the force of the tractor on the trailer.
(C) equal to the force of the tractor on the trailer.
(D) ¼ the force of the tractor on the trailer.

31. A wooden box is first pulled across a horizontal steel plate as shown in the diagram A. The box is then pulled across the same steel plate while the plate is inclined as shown in diagram B. How does the force required to overcome friction in the inclined case (B) compare to the horizontal case (A)?
(A) the frictional force is the same in both cases
(B) the inclined case has a greater frictional force
(C) the inclined case has less frictional force
(D) the frictional force increases with angle until the angle is 90º, then drops to zero



32. The graph at left shows the relationship between the mass of a number of rubber stoppers and their resulting weight on some far-off planet. The slope of the graph is a representation of the:
(A) mass of a stopper
(B) density of a stopper
(C) acceleration due to gravity
(D) number of stoppers for each unit of weight

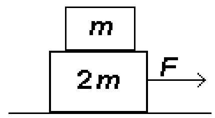


33. Two masses, m_1 and m_2, are connected by a cord and arranged as shown in the diagram with m_1 sliding along on a frictionless surface and m_2 hanging from a light frictionless pulley. What would be the mass of the falling mass, m_2, if both the sliding mass, m_1, and the tension, T, in the cord were known?
(A) $\frac{m_1 g - T}{g}$ (B) $\frac{1}{2}Tg$ (C) $\frac{m_1(T-g)}{(gm_1 - T)}$ (D) $\frac{Tm_1}{(gm_1 - T)}$

34. A mass is suspended from the roof of a lift (elevator) by means of a spring balance. The lift (elevator) is moving upwards and the readings of the spring balance are noted as follows:

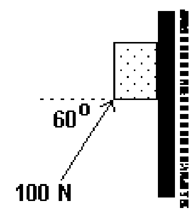
Speeding up: R_U Constant speed: R_C Slowing down: R_D

Which of the following is a correct relationship between the readings?
(A) $R_U > R_C$ (B) $R_U = R_D$ (C) $R_C < R_D$ (D) $R_C < R_D$



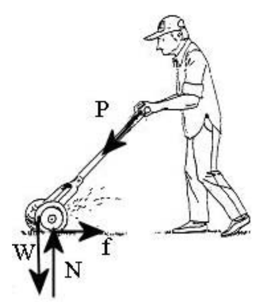
35. A small box of mass *m* is placed on top of a larger box of mass *2m* as shown in the diagram at right. When a force *F* is applied to the large box, both boxes accelerate to the right with the same acceleration. If the coefficient of friction between all surfaces is μ, what would be the force accelerating the smaller mass?
(A) $\dfrac{F}{3} - mg\mu$ (B) $F - 3mg\mu$ (C) $F - mg\mu$ (D) $\dfrac{F - mg\mu}{3}$

36. A 6.0 kg block initially at rest is pushed against a wall by a 100 N force as shown. The coefficient of kinetic friction is 0.30 while the coefficient of static friction is 0.50. What is true of the friction acting on the block after a time of 1 second?
(A) Static friction acts upward on the block.
(B) Kinetic friction acts upward on the block
(C) Kinetic friction acts downward on the block.
(D) Static friction acts downward on the block.



37. A homeowner pushes a lawn mower across a horizontal patch of grass with a constant speed by applying a force P. The arrows in the diagram correctly indicate the directions but not necessarily the magnitudes of the various forces on the lawn mower. Which of the following relations among the various force magnitudes, *W, f, N, P* is correct?

(A) $P > f$ and $N > W$
(B) $P < f$ and $N = W$
(C) $P > f$ and $N < W$
(D) $P = f$ and $N > W$

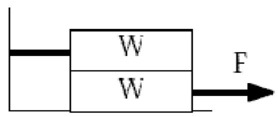


38. A mass, M, is at rest on a frictionless surface, connected to an ideal horizontal spring that is unstretched. A person extends the spring 30 cm from equilibrium and holds it at this location by applying a 10 N force. The spring is brought back to equilibrium and the mass connected to it is now doubled to 2M. If the spring is extended back 30 cm from equilibrium, what is the necessary force applied by the person to hold the mass stationary there?
(A) 20.0 N (B) 14.1 N (C) 10.0 N (D) 7.07 N

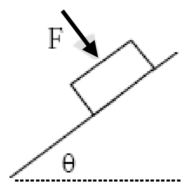
39. A crate of toys remains at rest on a sleigh as the sleigh is pulled up a hill with an increasing speed. The crate is not fastened down to the sleigh. What force is responsible for the crate's increase in speed up the hill?
(A) the contact force (normal force) of the ground on the sleigh
(B) the force of static friction of the sleigh on the crate
(C) the gravitational force acting on the sleigh
(D) no force is needed

40. A box slides to the right across a horizontal floor. A person called Ted exerts a force T to the right on the box. A person called Mario exerts a force M to the left, which is half as large as the force T. Given that there is friction f and the box accelerates to the right, rank the sizes of these three forces exerted on the box.
(A) $f < M < T$ (B) $M < f < T$ (C) $M < T < f$ (D) $f = M < T$

41. A spaceman of mass 80 kg is sitting in a spacecraft near the surface of the Earth. The spacecraft is accelerating upward at five times the acceleration due to gravity. What is the force of the spaceman on the spacecraft?
(A) 4800 N (B) 4000 N (C) 3200 N (D) 800 N

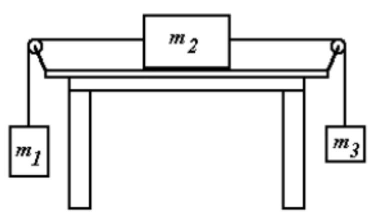


42. Two identical blocks of weight W are placed one on top of the other as shown in the diagram above. The upper block is tied to the wall. The lower block is pulled to the right with a force F. The coefficient of static friction between all surfaces in contact is μ. What is the largest force F that can be exerted before the lower block starts to slip?
(A) μW (B) $2\mu W$ (C) $3\mu W$ (D) $3\mu W/2$



43. A force F is used to hold a block of mass m on an incline as shown in the diagram (see above). The plane makes an angle of θ with the horizontal and F is perpendicular to the plane. The coefficient of friction between the plane and the block is μ. What is the minimum force, F, necessary to keep the block at rest?
(A) $mg\cos\theta$ (B) $mg\sin\theta$ (C) $mg\sin\theta/\mu$ (D) $mg(\sin\theta - \mu\cos\theta)/\mu$

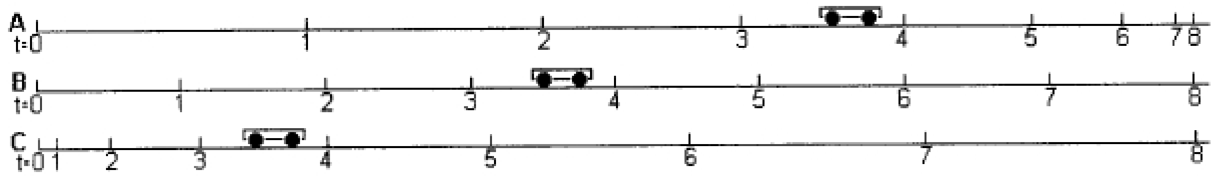
44. When the speed of a rear-drive car is increasing on a horizontal road, what is the direction of the frictional force on the tires?
(A) backward on the front tires and forward on the rear tires
(B) forward on the front tires and backward on the rear tires
(C) forward on all tires
(D) backward on all tires



45. Given the three masses as shown in the diagram above, if the coefficient of kinetic friction between the large mass (m_2) and the table is μ, what would be the upward acceleration of the small mass (m_3)? The mass and friction of the cords and pulleys are small enough to produce a negligible effect on the system.
(A) $g(m_1 + m_2\mu)/(m_1 + m_2 + m_3)$ (B) $g\mu(m_1 + m_2 + m_3)/(m_1 - m_2 - m_3)$
(C) $g\mu(m_1 - m_2 - m_3)/(m_1 + m_2 + m_3)$ (D) $g(m_1 - \mu m_2 - m_3)/(m_1 + m_2 + m_3)$

Questions 47-48

Three identical laboratory carts A, B, and C are each subject to a constant force F_A, F_B, and F_C, respectively. One or more of these forces may be zero. The diagram below shows the position of each cart at each second of an 8.0 second interval.

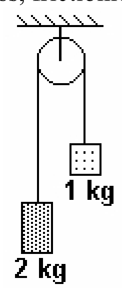


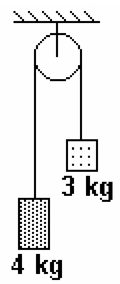
47. Which car has the greatest average velocity during the interval?
(A) A (B) B (C) C (D) all three average velocities are equal

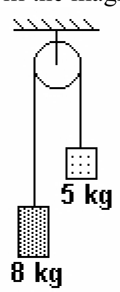
48. How does the magnitude of the force acting on each car compare?
(A) $F_A > F_B > F_C$ (B) $F_A = F_C > F_B$ (C) $F_A > F_C = F_B$ (D) $F_A = F_B > F_C$

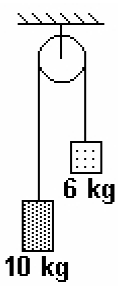
49. A skydiver is falling at terminal velocity before opening her parachute. After opening her parachute, she falls at a much smaller terminal velocity. How does the total upward force before she opens her parachute compare to the total upward force after she opens her parachute?
(A) The ratio of the forces is equal to the ratio of the velocities.
(B) The upward force with the parachute will depend on the size of the parachute.
(C) The upward force before the parachute will be greater because of the greater velocity.
(D) The upward force in both cases must be the same.

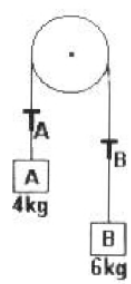
50. Each of the diagrams below represents two weights connected by a massless string which passes over a massless, frictionless pulley. In which diagram will the magnitude of the acceleration be the largest?

(A) 

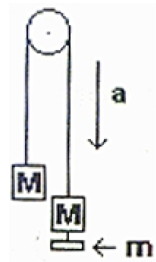
(B) 

(C) 

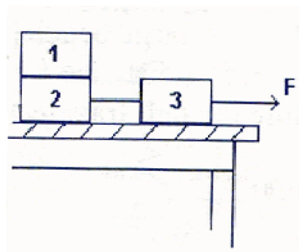
(D) 



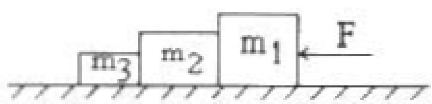
51. A simple Atwood's machine is shown in the diagram above. It is composed of a frictionless lightweight pulley with two cubes connected by a light string. If cube A has a mass of 4.0 kg and cube B has a mass of 6.0 kg, the system will move such that cube B accelerates downwards. What would be the tension in the two parts of the string between the pulley and the cubes?
(A) T_A = 47 N ; T_B = 71 N (B) T_A = 47 N ; T_B = 47 N (C) T_A = 47 N ; T_B = 42 N
(D) T_A = 39 N ; T_B = 39 N



52. A simple Atwood's machine remains motionless when equal masses M are placed on each end of the chord. When a small mass m is added to one side, the masses have an acceleration a. What is M? You may neglect friction and the mass of the cord and pulley.
(A) $\frac{m(g-a)}{2a}$ (B) $\frac{2m(g-a)}{a}$ (C) $\frac{2m(g+a)}{a}$ (D) $\frac{m(g+a)}{2a}$



53. Block 1 is stacked on top of block 2. Block 2 is connected by a light cord to block 3, which is pulled along a frictionless surface with a force F as shown in the diagram. Block 1 is accelerated at the same rate as block 2 because of the frictional forces between the two blocks. If all three blocks have the same mass m, what is the minimum coefficient of static friction between block 1 and block 2?
(A) 2F/mg (B) F/mg (C) 3F/2mg (D) F/3mg



54. Three blocks (m_1, m_2, and m_3) are sliding at a constant velocity across a rough surface as shown in the diagram above. The coefficient of kinetic friction between each block and the surface is μ. What would be the force of m_1 on m_2?
(A) $(m_2 + m_3)g\mu$ (B) $F - (m_2 - m_3)g\mu$ (C) F (D) $m_1 g\mu - (m_2 + m_3)g\mu$