

HOLIDAY HOMEWORK 1: NEWTON'S LAWS AND FORCES

Complete on a separate piece of paper and submit the working and your answers first week
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Email if you have any questions with the question number and your issue

1. A body of mass m is placed on a table. The earth is pulling the body with a force mg . Taking this force to be the action what is the reaction?
2. A boy is sitting on a chair placed on the floor of a room. Write as many action-reaction pairs of forces as you can.
3. A lawyer alleges in court that the police has forced his client to issue a statement of confession. What kind of force is this?
4. When you hold a pen and write on your notebook, what kind of force is exerted by you on the pen? By the pen on the notebook? By you on the notebook?
5. List all the forces acting on the block B in figure (4-Q2).

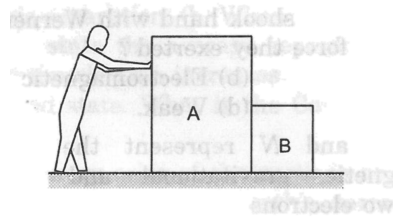


Figure 4-Q2

6. List all the forces acting on (a) the pulley A, (b) the boy and (c) the block C in figure (4-Q3).

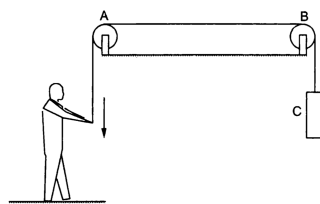


Figure 4-Q3

7. Figure (4-Q4) shows a boy pulling a wagon on a road. List as many forces as you can which are relevant with this figure. Find the pairs of forces connected by Newton's third law of motion.

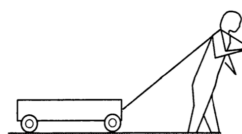


Figure 4-Q4

8. The block shown in figure (5.11) has a mass M and descends with an acceleration a . The mass of the string below the point A is m . Find the tension of the string at the point A and at the lower end.

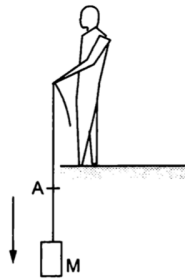


Figure 5.11

1. A bullet moving at 250 m/s penetrates 5 cm into a tree limb before coming to rest. Assuming that the force exerted by the tree limb is uniform, find its magnitude. Mass of the bullet is 10g.
2. With what acceleration 'a' should the box of figure (5-W4) descend so that the block of mass M exerts a force $Mg/4$ on the floor of the box?
3. A block 'A' of mass m is tied to a fixed point C on a horizontal table through a string passing round a massless smooth pulley B (figure 5-W5). A force F is applied by the experimenter to the pulley. Show that if the pulley is displaced by a distance x , the block will be displaced by $2x$. Find the acceleration of the block and the pulley.
4. Three blocks of masses m_1 , m_2 and m_3 are connected as shown in the figure (5-W10). All the surfaces are frictionless and the string and the pulleys are light. Find the acceleration of m_1 .
5. A car moving at 40 km/h is to be stopped by applying brakes in the next 4.0 m. If the car weighs 2000 kg, what average force must be applied on it?
6. In a TV picture tube electrons are ejected from the cathode with negligible speed and reach a velocity of 5×10^6 m/s in travelling one centimetre. Assuming straight line motion, find the constant force exerted on the electron. The mass of the electron is 9.1×10^{-31} kg.
7. A block of mass 0.2 kg is suspended from the ceiling by a light string. A second block of mass 0.3 kg is suspended from the first block through another string. Find the tensions in the two strings. Take $g = 10 \text{ m/s}^2$.
8. Two blocks of equal mass m are tied to each other through a light string. One of the blocks is pulled along the line joining them with a constant force F . Find the tension in the string joining the blocks.
9. A particle of mass 50 g moves on a straight line. The variation of speed with time is shown in figure (5-E1). Find the force acting on the particle at $t = 2, 4$ and 6 seconds.

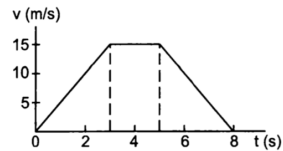


Figure 5-E1

9. Two blocks A and B of mass m , and mB respectively are kept in contact on a frictionless table. The experimenter pushes the block A from behind so that the blocks accelerate. If the block A exerts a force F on the block B, what is the force exerted by the experimenter on A?
10. Raindrops of radius 1 mm and mass 4 mg are falling with a speed of 30 m/s on the head of a bald person. The drops splash on the head and come to rest. Assuming equivalently that the drops cover a distance equal to their radii on the head, estimate the force exerted by each drop on the head.
11. A particle of mass 0.3 kg is subjected to a force $F = -kx$ with $k = 15 \text{ N/m}$. What will be its initial acceleration if it is released from a point $x = 20 \text{ cm}$?
12. A small block B is placed on another block A of mass 5 kg and length 20 cm. Initially the block B is near the right end of block A (figure 5-E3). A constant horizontal force of 10 N is applied to the block A. All the surfaces are assumed frictionless. Find the time elapsed before the block B separates from A.

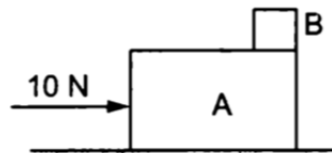


Figure 5-E3

13. The elevator shown in figure (5-E5) is descending with an acceleration of 2 m/s^2 . The mass of the block A is 0.5 kg. What force is exerted by the block A on the block B?

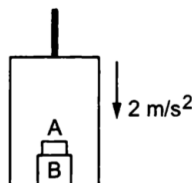


Figure 5-E5

14. A pendulum bob of mass 50 g is suspended from the ceiling of an elevator. Find the tension in the string if the elevator (a) goes up with acceleration 1.2 m/s^2 , (b) goes up with deceleration 1.2 m/s^2 , (c) goes up with uniform velocity, (d) goes down with acceleration 1.2 m/s^2 , (e) goes down with deceleration 1.2 m/s^2 and (f) goes down with uniform velocity

15. A person is standing on a weighing machine placed on the floor of an elevator. The elevator starts going up with some acceleration, moves with uniform velocity for a while and finally decelerates to stop. The maximum and the minimum weights recorded are 72 kg and 60 kg. Assuming that the magnitudes of the acceleration and the deceleration are the same, find (a) the true weight of the person and (b) the magnitude of the acceleration. Take $g = 10 \text{ m/s}^2$
16. The force of buoyancy exerted by the atmosphere on a balloon is B in the upward direction and remains constant. The force of air resistance on the balloon acts opposite to the direction of velocity and is proportional to it. The balloon carries a mass M and is found to fall down near the earth's surface with a constant velocity v . How much mass should be removed from the balloon so that it may rise with a constant velocity v ?
17. An empty plastic box of mass m is found to accelerate up at the rate of $g/6$ when placed deep inside water. How much sand should be put inside the box so that it may accelerate down at the rate of $g/6$?
18. In a simple Atwood machine, two unequal masses m_1 and m_2 are connected by a string going over a clamped light smooth pulley. In a typical arrangement (figure 5-E7) $m_1 = 300 \text{ g}$ and $m_2 = 600 \text{ g}$. The system is released from rest. (a) Find the distance travelled by the first block in the first two seconds. (b) Find the tension in the string. (c) Find the force exerted by the clamp on the pulley.

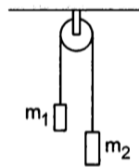


Figure 5-E7

19. Consider the Atwood machine of the previous problem. The larger mass is stopped for a moment 2.0 s after the system is set into motion. Find the time elapsed before the string is tight again.
20. A constant force $F = m_2 g / 2$ is applied on the block of mass m_1 , as shown in figure (5-E10). The string and the pulley are light and the surface of the table is smooth. Find the acceleration of m_1 .

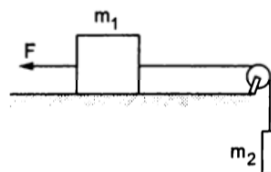


Figure 5-E10

21. In figure (5-E11) $m_1 = 5 \text{ kg}$, $m_2 = 2 \text{ kg}$ and $F = 1 \text{ N}$. Find the acceleration of either block. Describe the motion of m_1 if the string breaks but F continues to act.

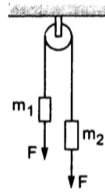


Figure 5-E11

22. Let $m_1 = 1 \text{ kg}$, $m_2 = 2 \text{ kg}$ and $m_3 = 3 \text{ kg}$ in figure (5-E12). Find the accelerations of m_1 , m_2 and m_3 . The string from the upper pulley to m_1 is 20 cm when the system is released from rest. How long will it take before m_1 strikes the pulley?

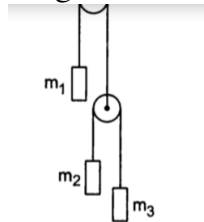


Figure 5-E12

23. In the previous problem, suppose $m_2 = 2.0 \text{ kg}$ and $m_1 = 3.0 \text{ kg}$. What should be the mass m so that it remains at rest?
24. Calculate the tension in the string shown in figure (5-E13). The pulley and the string are light and all surfaces are frictionless. Take $g = 10 \text{ m/s}^2$.

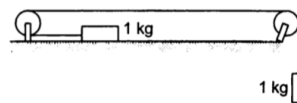


Figure 5-E13

25. A constant force $F = m_2 g / 2$ is applied on the block of mass m , as shown in figure (5-E10). The string and the pulley are light and the surface of the table is smooth. Find the acceleration of m_1 .

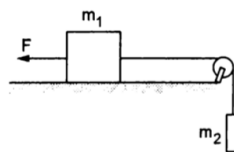


Figure 5-E10

26. In figure (5-E11) $m_1 = 5 \text{ kg}$, $m_2 = 2 \text{ kg}$ and $F = 1 \text{ N}$. Find the acceleration of either block. Describe the motion of m_1 , if the string breaks but F continues to act.

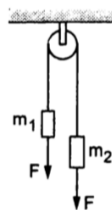


Figure 5-E11

27. Calculate the tension in the string shown in figure (5-E13). The pulley and the string are light and all surfaces are frictionless. Take $g = 10 \text{ m/s}^2$.

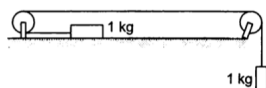


Figure 5-E13

28. Consider the situation shown in figure (5-E14). Both the pulleys and the string are light and all the surfaces are frictionless. (a) Find the acceleration of the mass M . (b) Find the tension in the string. (c) Calculate the force exerted by the clamp on the pulley A in the figure.

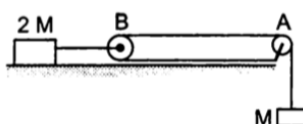


Figure 5-E14

29. Find the acceleration of the blocks A and B in the three situations shown in figure (5-E17).

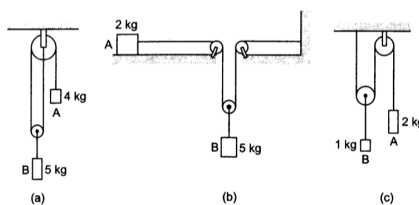


Figure 5-E17

30. A monkey of mass 15 kg is climbing on a rope with one end fixed to the ceiling. If it wishes to go up with an acceleration of 1 m/s^2 , how much force should it apply to the rope? If the rope is 5 m long and the monkey starts from rest, how much time will it take to reach the ceiling?
31. Why do you fall forward when a moving bus decelerates to a stop and fall backward when it accelerates from rest? Sub way standees often find it convenient to face the side of the car when the train is starting or stopping and to face the front or rear when it is running at constant speed. Why?
32. What's the relation — if any — between the force acting on an object and the direction in which the object is moving?
33. Suppose that a body that is acted on by exactly two forces is accelerated. Does it then follow that:
- the body cannot move with constant speed
 - the velocity can never be zero
34. A horse is urged to pull a wagon. The horse refuses to try, citing Newton's third law as a defence: the pull of the horse on the wagon is equal but opposite to the pull of the wagon on the horse. "If I can never exert a greater force on the wagon

than it exerts on me, how can I ever start the wagon moving?” asks the horse. How would you reply?

35. The following statement is true; explain it. Two teams are having a tug of war; the team that pushes harder (horizontally) against the ground wins.
36. A bird alights on a stretched telegraph wire. Does this change the tension in the wire? If so, by an amount less than, equal to, or greater than the weight of the bird?
37. You are an astronaut in the lounge of an orbiting space station and you remove the cover from a long thin jar containing a single olive. Describe several ways— all taking advantage of the inertia of either the olive or the jar— to remove the olive from the jar.
38. The owner’s manual of a car suggests that your seat belt should be adjusted “to fit snugly” and that the front seat head rest should not be adjusted so that it fits comfortably at the back of your neck but so that “the top of the head rest is level with the top of your ears.” How do Newton’s laws support these good recommendations?
39. You shoot an arrow into the air and you keep your eye on it as it follows a parabolic flight path to the ground. You note that the arrow turns in flight so that it is always tangent to its flight path. What makes it do that?
40. You are on the flight deck of the orbiting space shuttle Discovery and someone hands you two wooden balls, outwardly identical. One, however, has a lead core but the other does not. Describe several ways of telling them apart.
41. Could you weigh yourself on a scale whose maximum reading is less than your weight? If so, how?