

Chapter 4

The Laws of Motion

1. When an object is observed to be at rest relative to an observer in an inertial reference frame,
 - a. the sum of any forces acting on the object is zero.
 - b. there are no forces acting on the object.
 - c. any forces acting on the object are paired, with one force equal in magnitude, but opposite in direction to the other.
 - d. any forces acting on the object are paired, with one perpendicular to the other.
 - e. there is only one force acting on the object, and that force is a frictional force.

ANS: a



2. An object is placed at different locations, varying in distance from the center of the Earth. At which distance from the center will its weight be the greatest? The mean radius of the earth is 6.4×10^6 m.
 - a. 7000 km
 - b. 8000 km
 - c. 9000 km
 - d. 10,000 km
 - e. The weight is the same at all four locations listed above.

ANS: a



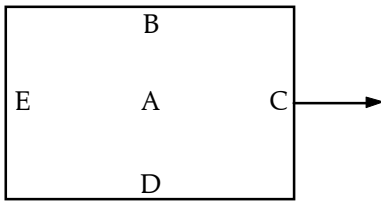
3. An object is placed at different locations, varying in distance from the center of the Earth. At which distance from the center will its weight be the greatest? The mean radius of the earth is 6.4×10^6 m.
 - a. 7000 km
 - b. 8000 km
 - c. 9000 km
 - d. 10,000 km
 - e. The mass is the same at all four locations listed above.

ANS: e



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4. A refrigerator is being moved by truck while the truck is moving to the right at highway speeds. Then the driver has to brake suddenly for a deer running across the road. If the refrigerator is located at A before braking and is not tied down, what is the most likely position of the refrigerator after braking?



- a. A
- b. B
- c. C
- d. D
- e. E

ANS: c

5. As an object moves away from a planet into space, its weight

- a. increases.
- b. decreases.
- c. stays the same.
- d. varies with the type of mass.
- e. varies with pressure.

ANS: d

6. A fish weighs 10.0 N at rest. When it is weighed on a spring scale in an elevator accelerating upwards at 2.60 m/s^2 , the scale reads ___ N.

- a. 7.35
- b. 10.7
- c. 11.7
- d. 12.7
- e. 13.7

ANS: d

7. A woman steps on a bathroom scale and finds she weighs 420 N. She then jumps off a step that is 0.2 m high. While she is in free fall toward the floor, what is her weight in N?

- a. 0
- b. 420
- c. 210
- d. 105
- e. 55

ANS: b

8. A woman whose mass at the surface of the earth is 52 kg dives off a 2 m board into a swimming pool. What is her mass in kg while she is in freefall?

- a. 0
- b. 26
- c. 52
- d. 104
- e. 510

ANS: c

9. The direction of the net force on an object is

- a. the same as the direction of the object's velocity.
- b. opposite to the direction of the object's velocity.
- c. at right angles to the direction of the object's velocity.
- d. in the same direction as the object's acceleration.
- e. opposite to the direction of the object's acceleration.

ANS: d

10. When there is no net force on an object, it may be

- a. moving in a circle.
- b. moving in a straight line at constant speed.
- c. accelerating toward the earth.
- d. moving in a circle at decreasing speed.
- e. in free fall.

ANS: b

11. A 0.20 kg rock is thrown upward with an initial speed of 15 m/s. What is the force on the rock in N when it reaches its maximum height?

- a. 0
- b. 0.20
- c. 0.10
- d. 2.0
- e. 1.0

ANS: d

12. Two persons pull on the ends of a spring scale. They each exert 300 N of force. What does the scale read in N?

- a. 200
- b. 300
- c. 400
- d. 600
- e. 800

ANS: b

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13. A person pulls on a rope attached to a wall with a force of 100 N. What is the frictional force between the person and the ground in N?

- a. 50
- b. 100
- c. 150
- d. 200
- e. 225

ANS: b ✓

14. An 1800 kg car moves straight down the highway at a constant speed of 19 m/s. What is the resultant force on the car in kN?

- a. 0
- b. 4.9
- c. 9.8
- d. 1.9
- e. 19.6

ANS: a ✓

15. A 2 kg cart collides with an 8 kg cart. Which cart experiences the greater force during of the collision?

- a. The 2 kg cart.
- b. The 8 kg cart.
- c. The force is zero.
- d. The forces cancel each other out.
- e. The forces are equal.

ANS: e ✓

16. A 2 kg cart collides with an 8 kg cart. Which cart experiences the greater acceleration because of the collision?

- a. The 2 kg cart.
- b. The 8 kg cart.
- c. The acceleration is zero.
- d. The accelerations cancel each other out.
- e. The accelerations are equal.

ANS: a ✓

17. A force F applied to mass m_1 produces an acceleration of 2 m/s^2 . The same force F produces an acceleration of 1 m/s^2 when it is applied to m_2 . What is the ratio m_1/m_2 ?

- a. 2
- b. 1/2
- c. 3
- d. 1/3
- e. 4

ANS: b ✓

18. A force F applied to mass m_1 produces an acceleration of 4.0 m/s^2 . When the same force F is applied to mass m_2 it produces an acceleration of 8.0 m/s^2 . What acceleration, in m/s^2 , would be produced if the two masses were placed together and the same force F was applied?

- a. 0.33
- b. 0.38
- c. 0.71
- d. 2.7
- e. 3.1

ANS: d

19. A 4.0 kg mass starts from rest and is acted on by a constant force. If the mass moves 64 m in 4.0 s , what is the force in N ?

- a. 4
- b. 8
- c. 16
- d. 32
- e. 64

ANS: d

20. The acceleration due to gravity on the moon is 1.6 m/s^2 . If an object weighs 33 N on the moon, what is its weight in N on the earth?

- a. 200
- b. 190
- c. 210
- d. 180
- e. 220

ANS: a

21. Two forces, F_1 and F_2 act on a 10 kg mass. If $F_1 = 20 \text{ N}$ and $F_2 = 40 \text{ N}$ and they act in the same direction, what is the acceleration of the mass in m/s^2 ?

- a. 3
- b. 4
- c. 5
- d. 6
- e. 7

ANS: d

22. Two forces, F_1 and F_2 act in opposite directions on a 10 kg mass. If $F_1 = 20 \text{ N}$ and $F_2 = 40 \text{ N}$, what is the acceleration of the mass in m/s^2 ?

- a. 1
- b. 2
- c. 3
- d. 4
- e. 5

ANS: b

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23. A 25 kg mass is accelerated from 3.0 m/s to 9.0 m/s in 0.80 s. What is the average acceleration of the mass in m/s^2 ?

- a. 6.0
- b. 6.5
- c. 7.0
- d. 7.5
- e. 8.0

ANS: d

24. A 32 kg mass is subjected to a constant acceleration for 0.80 s while its speed changes from 3.0 m/s to 9.0 m/s. What is the force on the mass in N?

- a. 96
- b. 120
- c. 160
- d. 190
- e. 240

ANS: e

25. A stationary soccer ball is kicked by a player's foot. The foot is in contact with the ball for 0.031 s. The 0.44 kg ball reaches a speed of 32 m/s. What is the average force exerted on the ball in N?

- a. 220
- b. 320
- c. 450
- d. 640
- e. 910

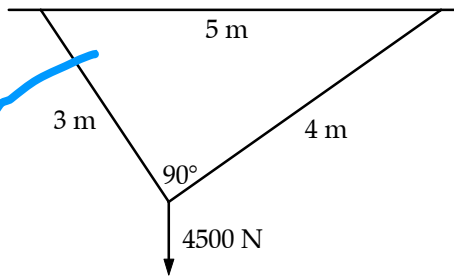
ANS: c

26. A constant force exerted on an 1100 kg mass produces an acceleration of 1.1 m/s^2 . What is the acceleration in m/s^2 when the same constant force is exerted on a 3300 kg mass?

- a. 0.27
- b. 0.37
- c. 0.42
- d. 0.49
- e. 0.53

ANS: b

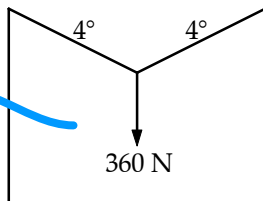
27. A person weighing 360 N hangs from a cable stretched between two buildings as shown in the diagram. What is the tension in the cable in N?



- a. 90
- b. 180
- c. 1300
- d. 2200
- e. 2600

ANS: e

28. A cable system hanging from a beam is configured as shown in the diagram below. A 360 N weight hangs from the cables. What is the tension in the 3 m cable in N?

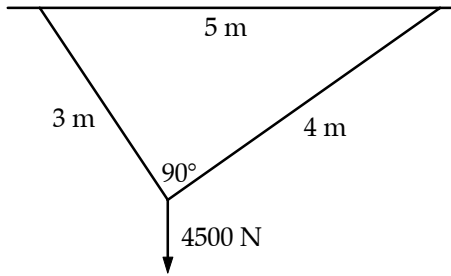


- a. 2500
- b. 2700
- c. 3600
- d. 3800
- e. 4200

ANS: c

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29. A cable system hanging from a beam is configured as shown in the diagram below. A 4500 N weight hangs from the cables. What is the tension in the 4 m cable in N?



- a. 2500
- b. 2700
- c. 3600
- d. 3800
- e. 4200

ANS: b ✓

30. Two horses are pulling on a rope in opposite directions. Each horse pulls with a force of 6000 N. What is the tension in the rope in N?

- a. 0
- b. 3000
- c. 6000
- d. 8500
- e. 12000

ANS: c ✓

31. A 2000 kg car is moving at 15 m/s. When the brakes are applied for 20 s, a 1000 N decelerating force is exerted on the car. What is the speed of the car in m/s at the end of the 20 s period?

- a. 1
- b. 2
- c. 3
- d. 4
- e. 5

ANS: e ✓

32. A 2000 kg car is moving at 15 m/s. When the brakes are applied for 20 s, a 1000 N decelerating force is exerted on the car. How far does the car move while the brakes are applied?

- a. 50
- b. 75
- c. 100
- d. 150
- e. 200

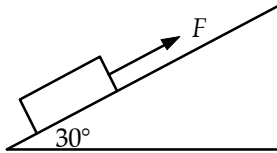
ANS: e ✓

33. A 2000 kg car is moving at 15 m/s. When the brakes are applied for 20 s, a 1000 N decelerating force is exerted on the car. What is the magnitude of the acceleration in m/s^2 ?

- a. 0.5
- b. 0.6
- c. 0.7
- d. 0.8
- e. 0.9

ANS: a ✓

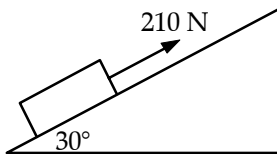
34. A 20 kg box is pulled up a 30° frictionless ramp at a constant velocity by a force F . If F is parallel to the ramp, what is its magnitude in N?



- a. 98
- b. 130
- c. 170
- d. 196
- e. 226

ANS: a ✓

35. A 30 kg box is pulled up a 30° incline by a force of 210 N. What is the acceleration of the box in m/s^2 if the 210 N force acts parallel to the incline?

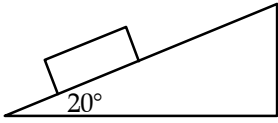


- a. 1.1
- b. 2.1
- c. 3.1
- d. 4.9
- e. 7.1

ANS: b ✓

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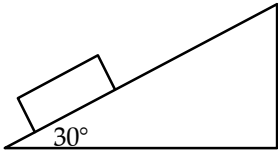
36. A 4.0 kg block slides down a frictionless incline having an angle of 20° to the horizontal. What is the acceleration of the block in m/s^2 ?



- a. 9.8
- b. 8.7
- c. 6.5
- d. 3.4
- e. 2.3

ANS: d ✓

37. After it is released from rest, a 5.0 kg mass slides down a 30° frictionless incline. How long does it take the mass to travel 3.0 m down the plane?



- a. 0.91
- b. 1.1
- c. 1.2
- d. 1.9
- e. 2.1

ANS: b ✓

38. A constant 6.0 N net horizontal force acts on a 4.0 kg mass originally at rest. What horizontal velocity in m/s does the mass have after the force has acted on it for 2.0 s?

- a. 0.50
- b. 0.75
- c. 1.0
- d. 1.5
- e. 3

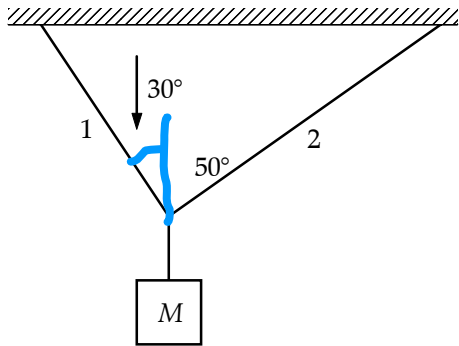
ANS: e ✓

39. How far in m has a 5.0 kg mass originally at rest moved after a 9.0 N net horizontal force has acted on it for 3.0 s?

- a. 8.1
- b. 6.7
- c. 5.1
- d. 3.2
- e. 2.7

ANS: a ✓

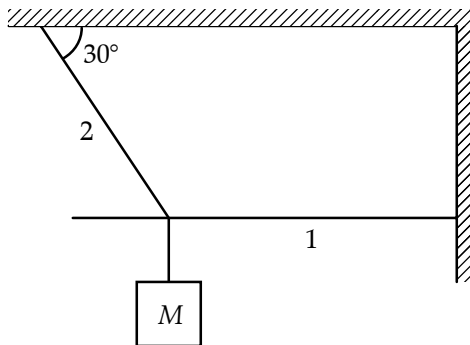
40. If the tension in string 1 is 23 N, what is the mass in kg of the object shown?



- a. 3.8
- b. 3.4
- c. 3.0
- d. 4.2
- e. 5.0

ANS: c

41. If $M = 2.0$ kg, what is the tension in N in string 1?



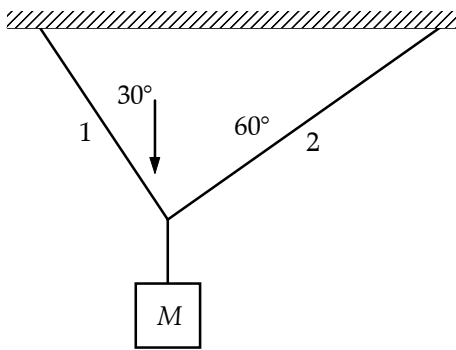
- a. 1.2
- b. 11
- c. 34
- d. 3.5
- e. 40

ANS: c



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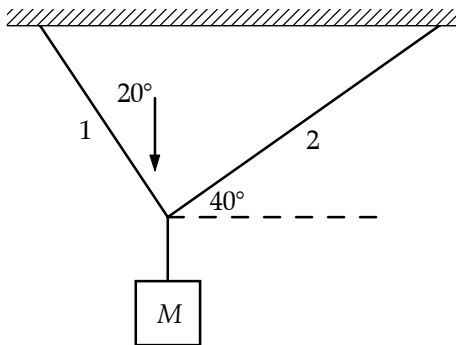
42. If $M = 6.0 \text{ kg}$, what is the tension in N in string 1?



- a. 39
- b. 34
- c. 29
- d. 44
- e. 51

ANS: e ✓

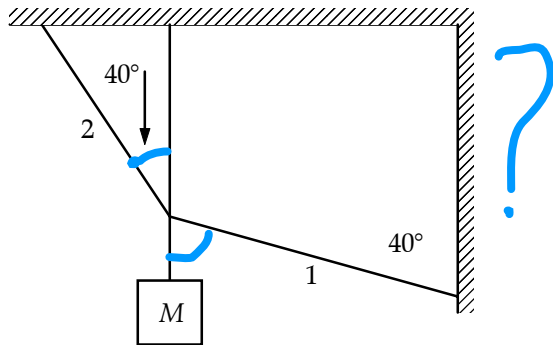
43. If $M = 2.0 \text{ kg}$, what is the tension in N in string 1?



- a. 16
- b. 24
- c. 32
- d. 40
- e. 20

ANS: a ✓

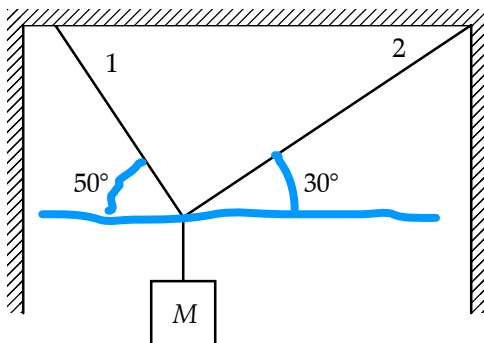
44. If $M = 1.1 \text{ kg}$, what is the tension in N in string 1?



- a. 54
- b. 47
- c. 40
- d. 62
- e. 57

ANS: c

45. If $M = 4.5 \text{ kg}$, what is the tension in N in string 1?



- a. 56
- b. 47
- c. 39
- d. 65
- e. 22

ANS: c

46. When forces act across empty space they are called

- a. spring forces.
- b. frictional forces.
- c. contact forces.
- d. vacuum forces.
- e. field forces.

ANS: e

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47. A frame of reference in which Newton's 1st law is valid is called a/an

- a. non-inertial reference frame.
- b. inertial reference frame.
- c. constant velocity reference frame.
- d. earth-centered reference frame.
- e. scientific reference frame.

ANS: b

48. The gravitational acceleration on the moon is $1/6$ the gravitational acceleration on the Earth. What mass in kg does a body with a 24 kg mass on Earth have on the moon?

- a. 24
- b. 6
- c. 0.25
- d. 30
- e. 18

ANS: a

49. Sue holds a block in place on the frictionless surface of an inclined plane by exerting a horizontal force \vec{P} on the block. She then releases the block and lets it slide down the plane. Compare the total force \vec{F}_R that the plane exerts on the block at rest with the total force \vec{F}_V that the plane exerts on the sliding block.

- a. $\vec{F}_R = 0$; \vec{F}_V is the normal force of the plane on the block.
- b. $|\vec{F}_R| = |\vec{F}_V|$, but their directions are different.
- c. $|\vec{F}_V| > |\vec{F}_R|$, but their directions are the same.
- d. $|\vec{F}_V| < |\vec{F}_R|$, but their directions are the same.
- e. $\vec{F}_V = \vec{F}_R$

ANS: d

50. A 100 kg mass is sitting on a frictionless surface. First Robert makes it move across the surface with constant velocity. Then Larry makes it move across the surface with constant acceleration. Compare the force \vec{F}_R that Robert exerts on the mass while it is moving at constant velocity with the force \vec{F}_L that Larry exerts on the mass while it is moving with constant acceleration.

- a. $\vec{F}_R = 0$; $\vec{F}_L > 0$ is a constant vector.
- b. $\vec{F}_R = 0$; $\vec{F}_L > 0$ has constant direction but increases in magnitude at a constant rate.
- c. $\vec{F}_R > 0$ is a constant vector; \vec{F}_L is a constant vector; and $|\vec{F}_L| > |\vec{F}_R|$.
- d. $\vec{F}_R > 0$ is a constant vector; \vec{F}_L has constant direction but increases in magnitude at a constant rate.
- e. $\vec{F}_R = \vec{F}_L$.

ANS: a

51. Mike crushes a destructive gypsy moth caterpillar by stepping on it. Compare the force, \vec{F}_M , that Mike exerts on the caterpillar to the force \vec{F}_C that the caterpillar exerts on Mike.

- a. $|\vec{F}_C| = 0; |\vec{F}_M| > 0$.
- b. $|\vec{F}_C| < |\vec{F}_M|$.
- c. $|\vec{F}_C| > |\vec{F}_M|$.
- d. $|\vec{F}_C| = |\vec{F}_M|$, but their directions are different.
- e. $\vec{F}_C = \vec{F}_M$.

ANS: d

52. Two hockey players scratch perpendicular x and y axes into the ice. Player 1 shoves a puck so that it travels in the x -axis direction with constant velocity of magnitude v . Player 2 strikes the puck with his stick so that it travels in the positive y -axis direction with constant velocity of magnitude v . The force that player 2's stick exerted on the puck was directed along:

- a. the negative x -axis.
- b. the positive y -axis.
- c. a line 45 degrees from the negative x -axis and 45 degrees from the positive y -axis.
- d. a line 45 degrees from the positive x -axis and 45 degrees from the positive y -axis.
- e. the puck's instantaneous velocity at each instant.



ANS: c

53. You are told that an object in an inertial reference frame is not accelerating. Which of the following statements is correct?

- a. The object may be at rest.
- b. The object may be moving at constant velocity.
- c. Two forces may be acting on the object.
- d. All of the statements above are correct.
- e. None of the statements above are correct.

ANS: d

54. When Susan holds a baseball in her hand, the reaction force to the force of the earth on the ball is:

- a. the force of the hand on the ball.
- b. the force of the ball on the hand.
- c. the force of the earth on the hand.
- d. the force of the hand on the earth.
- e. the force of the ball on the earth.

ANS: e

55. When a force of magnitude F is applied to a block of mass m sitting on a frictionless surface, the block has acceleration a . Then $n - 1$ additional blocks are placed in front of the first block. When the force of magnitude F is now applied to the original block, it has acceleration:

- a. $\frac{a}{n}$.
- b. $\frac{a}{n-1}$.
- c. a .
- d. $(n-1)a$.
- e. na .

ANS: a

56. When a force of magnitude F is applied to a block of mass m sitting on a frictionless surface, the block has acceleration a . A second block of mass m is placed on top of the first block. All surfaces of contact between the blocks are also frictionless. When the force of magnitude F is again applied to the first block, it now has acceleration:

- a. 0.
- b. $\frac{a}{2}$.
- c. a .
- d. $2a$.
- e. that is not determined unless we know the acceleration of the second block.

ANS: c

57. A book is sitting on a table. A lipstick is sitting on the book. The forces acting on the book are:

- a. the weight of the book and the weight of the lipstick.
- b. the weight of the book, the weight of the lipstick, and the normal force of the table on the book.
- c. the weight of the book, the normal force of the lipstick on the book, and the normal force of the table on the book.
- d. the weight of the book, the weight of the lipstick, the normal force of the lipstick on the book and the normal force of the table on the book.
- e. the weight of the book, the weight of the lipstick, the normal force of the lipstick on the book, the normal force of the table on the book, and the weight of the table.

ANS: c

58. A 5.0 kg mass and a 10.0 kg mass are connected by a rope that passes over a massless pulley. What is the acceleration of the 5.0 kg mass in m/s^2 ?

- a. 3.3, upwards
- b. 3.3, downwards
- c. 4.9, upwards
- d. 4.9, downwards
- e. 9.8, upwards

ANS: a

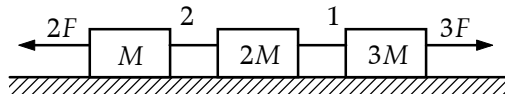
59. A small weight of mass 2.0 kg is tied to the ceiling of a plane by a short rope. When the plane accelerates down the runway at 4.0 m/s^2 , the angle θ between the string and the ceiling is:

- a. 0°
- b. 22°
- c. 45°
- d. 68°
- e. 90°



ANS: d

60. The horizontal surface on which the objects slide is frictionless. If $M = 2.0 \text{ kg}$, the tension in string 1 is 12 N . Determine F in N.

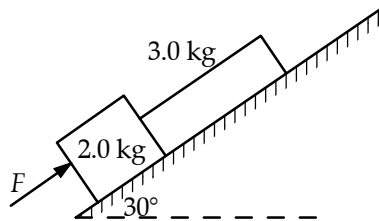


- a. 25
- b. 20
- c. 30
- d. 35
- e. 40



ANS: b

61. The horizontal surface on which the objects slide is frictionless. If $F = 18 \text{ N}$, what is the magnitude of the force in N exerted on the 2.0 kg block by the 3.0 kg block?

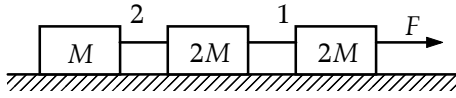


- a. 10
- b. 12
- c. 14
- d. 16
- e. 18

ANS: a

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62. The horizontal surface on which the objects slide is frictionless. If $F = 12 \text{ N}$, what is the tension in N in string 1?

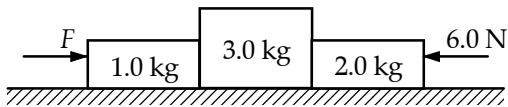


- a. 35
- b. 30
- c. 40
- d. 45
- e. 25



ANS: b

63. The surface of the inclined plane is frictionless. If $F = 30 \text{ N}$, what is the magnitude of the force in N exerted on the 3.0 kg block by the 2.0 kg block?

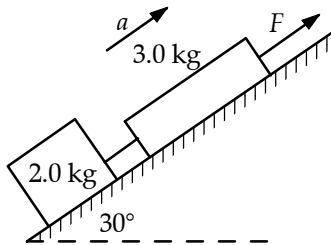


- a. 19
- b. 27
- c. 24
- d. 21
- e. 15



ANS: a

64. The surface of the inclined plane is frictionless. If $a = 1.3 \text{ m/s}^2$, what is F in N?



- a. 37
- b. 31
- c. 35
- d. 33
- e. 39

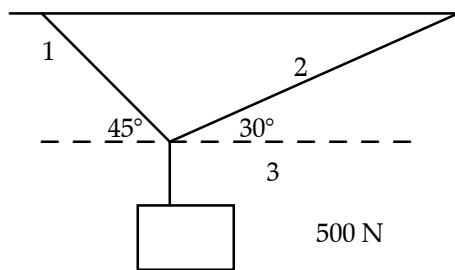
ANS: b

65. A train of 2.50×10^7 kg mass is descending a 5.00° degree grade—the slope makes an angle of 5.00° with the horizontal—when the brakes fail. If friction with the track is negligible, what is the acceleration of the train in m/s^2 ?

- a. 0.854
- b. 0.98
- c. 9.76
- d. 9.80
- e. 112

ANS: a

66. A system of cables supports a 500 N weight, as shown below. Which of the equations below states correctly Newton's second law as applied to the horizontal forces cables 1 and 2 exert on the knot where the three cables are joined?

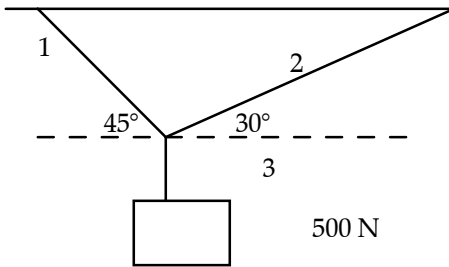


- a. $0 = T_1 \sin 45^\circ - T_2 \sin 30^\circ$
- b. $0 = T_1 \sin 45^\circ - T_2 \cos 30^\circ$
- c. $0 = T_1 \cos 45^\circ - T_2 \sin 30^\circ$
- d. $0 = T_1 \cos 45^\circ - T_2 \cos 30^\circ$
- e. $0 = T_1 \cos 45^\circ + T_2 \cos 30^\circ$

ANS: d

84 The Laws of Motion

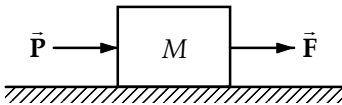
67. A system of cables supports a 500 N weight, as shown below. Which of the equations below states correctly Newton's second law as applied to the vertical forces cables 1, 2 and 3 exert on the knot where the three cables are joined?



- a. $0 = T_1 \sin 45^\circ + T_2 \sin 30^\circ + T_3$
- b. $0 = T_1 \sin 45^\circ - T_2 \sin 30^\circ - T_3$
- c. $0 = -T_1 \sin 45^\circ - T_2 \sin 30^\circ - T_3$
- d. $0 = -T_1 \sin 45^\circ + T_2 \sin 30^\circ + T_3$
- e. $0 = T_1 \sin 45^\circ + T_2 \sin 30^\circ - T_3$

ANS: e

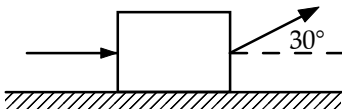
68. A heavy packing case of mass M is pulled by a force \vec{F} and pushed by a force \vec{P} , both acting horizontally. The equation of motion of the packing case is



- a. $Ma = F - P$.
- b. $Ma = F - P - Mg$.
- c. $Ma = F - P + N - Mg$.
- d. $Ma = F + P$.
- e. $Ma = F + P - Mg$.

ANS: d

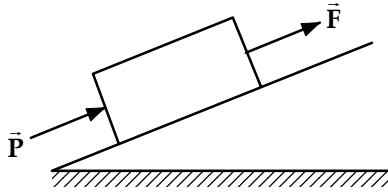
69. A heavy packing case is pulled by a force \vec{F} exerted at a 30° angle, and pushed by a force \vec{P} exerted horizontally. The equation of motion of the packing case is



- a. $Ma = F - P$.
- b. $Ma = F \sin 30^\circ - P$.
- c. $Ma = F \cos 30^\circ - P$.
- d. $Ma = F \sin 30^\circ - P - Mg \cos 30^\circ$.
- e. $Ma = F \cos 30^\circ - P - Mg \cos 30^\circ$.

ANS: c

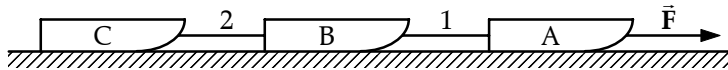
70. A heavy packing case of mass M is pulled up a frictionless 15° incline by a force \vec{F} and is pushed by a force \vec{P} , both parallel to the incline. The equation of motion of the packing case is



- $Ma = F + P.$
- $Ma = (F + P) \cos 15^\circ.$
- $Ma = F + P - Mg \sin 15^\circ.$
- $Ma = F + P - Mg \cos 15^\circ.$
- $Ma = (F + P) \cos 15^\circ - Mg \sin 15^\circ.$

ANS: c ✓

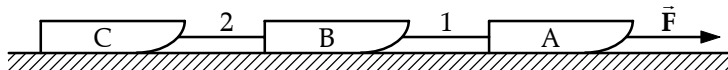
71. Three sleds are pulled across a frictionless surface by a force \vec{F} . The tensions in the lines are \vec{T}_1 and \vec{T}_2 . The sleds have masses $M_A = M$, $M_B = 3M$ and $M_C = 2M$. When we apply Newton's second law to sled B, we find that



- $3Ma = T_1 - T_2.$
- $3Ma = T_1 + T_2.$
- $3Ma = F - T_1 - T_2.$
- $3Ma = F + T_1 - T_2.$
- $3Ma = F + T_1 + T_2.$

ANS: a ✓

72. Three sleds are pulled across a frictionless surface by a force \vec{F} . The tensions in the lines are \vec{T}_1 and \vec{T}_2 . The sleds have masses $M_A = M$, $M_B = 3M$ and $M_C = 2M$. When we apply Newton's second law to sled C, we find that



- $2Ma = F.$
- $2Ma = T_2.$
- $2Ma = F - T_2.$
- $2Ma = F + T_2.$
- $2Ma = F + T_1 + T_2.$

ANS: b ✓

73. Aline and Charlie are arguing as to whether or not it is possible in principle for an elevator to have an acceleration of magnitude greater than g . In the course of their discussion they come up with the statements below. Which one is correct?

- a. No, because once $|\vec{a}|$ reaches g , the elevator is in free fall.
- b. No, because an acceleration greater than g is not possible.
- c. Yes, because it can reach an acceleration greater than g when the cable breaks.
- d. Yes, because it can reach an acceleration greater than g if the motor is strong enough.
- e. No, because it cannot exceed its terminal acceleration.

ANS: d

