Exam

Name_____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) Which of Newton's laws best explains why motorists should buckle-up?
A) the law of gravitation
B) the second law
C) the third law
D) the first law

Answer: D

2) When you sit on a chair, the resultant force on you is
A) depending on your weight.
B) zero.
C) down.
D) up.

Answer: B

3) In the absence of an external force, a moving object will
A) stop immediately.
B) go faster and faster.
C) slow down and eventually come to a stop.
D) move with constant velocity.

Answer: D

4) When the rocket engines on the starship NO-PAIN-NO-GAIN are suddenly turned off, while traveling in empty space, the starship will
A) slowly slow down, and then stop.
B) move with constant speed.
C) go faster and faster.
D) stop immediately.

Answer: B

5) A rocket moves through empty space in a straight line with constant speed. It is far from the gravitational effect of any star or planet. Under these conditions, the force that must be applied to the rocket in order to sustain its motion is
A) dependent on how fast it is moving.
B) zero.
C) equal to its weight.
D) equal to its mass.

Answer: B

6) You are standing in a moving bus, facing forward, and you suddenly fall forward. You can imply from this that the bus's
A) velocity increased.
B) velocity decreased.
C) speed remained the same, but it's turning to the left.
D) speed remained the same, but it's turning to the right.

Answer: B

7) You are standing in a moving bus, facing forward, and you suddenly fall forward as the bus comes to an immediate stop. What force caused you to fall forward?
A) normal force due to your contact with the floor of the bus
B) gravity
C) force due to friction between you and the floor of the bus
D) There is not a force leading to your fall.

Answer: D

8) A constant net force acts on an object. Describe the motion of the object.
A) constant acceleration
B) constant speed
C) increasing acceleration
D) constant velocity

Answer: A

9) The acceleration of an object is inversely proportional to
A) its velocity.
B) its position.
C) its mass.
D) the net force acting on it.

Answer: C

10) A net force F accelerates a mass m with an acceleration a. If the same net force is applied to mass 2m, then the acceleration will be
A) a/2.
B) a/4.
C) 2a.
D) 4a.

Answer: A

11) A net force F acts on a mass m and produces an acceleration a. What acceleration results if a net force 2F acts on mass 4m?
A) 4a
B) 2a
C) a/2
D) 8a

Answer: B

12) If you blow up a balloon, and then release it, the balloon will fly away. This is an illustration of
A) Galileo's law of inertia.
B) Newton's third law.
C) Newton's first law.
D) Newton's second law.

Answer: B

13) Two cars collide head-on. At every moment during the collision, the magnitude of the force the first car exerts on the second is exactly equal to the magnitude of the force the second car exerts on the first. This is an example of
A) Newton's first law.
B) Newton's third law.
C) Newton's second law.
D) Newton's law of gravitation.

Answer: B

14) If you exert a force F on an object, the force which the object exerts on you will
A) always be F.
B) depend on whether or not the object is moving.
C) depend on the relative masses of you and the object.
D) depend on whether or not you are moving.

Answer: A

15) Action-reaction forces
A) may be at right angles.
B) sometimes act on the same object.
C) always act on different objects.
D) always act on the same object.

Answer: C

16) Action-reaction forces are
A) equal in magnitude but point in opposite directions.
B) unequal in magnitude and point in opposite directions
C) unequal in magnitude but point in the same direction.
D) equal in magnitude and point in the same direction.

Answer: A

17) A 20-ton truck collides with a 1500-lb car and causes a lot of damage to the car. Since a lot of damage is done on the car
A) the force on the truck is greater then the force on the car.
B) the force on the truck is equal to the force on the car.
C) the truck did not slow down during the collision.
D) the force on the truck is smaller than the force on the car.

Answer: B

18) An object of mass m sits on a flat table. The Earth pulls on this object with force mg, which we will call the action force. What is the reaction force?
A) The object pushing down on the table with force mg.
B) The object pulling upward on the Earth with force mg.
C) The table pushing up on the object with force mg.
D) The table pushing down on the floor with force mg.

Answer: B

19) A child's toy is suspended from the ceiling by means of a string. The Earth pulls downward on the toy with its weight force of 8.0 N. If this is the "action force," what is the "reaction force"?
A) The string pulling upward on the toy with an 8.0-N force.
B) The toy pulling upward on the Earth with an 8.0-N force.
C) The string pulling downward on the ceiling with an 8.0-N force.
D) The ceiling pulling upward on the string with an 8.0-N force.

Answer: B

20) A golf club hits a golf ball with a force of 2400 N. The golf ball hits the club with a force
A) slightly less than 2400 N.
B) close to 0 N.
C) slightly more than 2400 N.
D) exactly 2400 N.

Answer: D

21) Your bat hits the ball pitched to you with a 1500-N instantaneous force. The ball hits the bat with an instantaneous force, whose magnitude is
A) exactly equal to 1500 N.
B) somewhat less than 1500 N.
C) somewhat greater than 1500 N.
D) essentially zero.

Answer: A

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

22) State Newton's three laws.

Answer: Newton's first law: Every object continues in its state of rest, or of uniform velocity in a straight line, as long as no net force acts on it.

Newton's second law: The acceleration of an object is directly proportional to the net force acting on it, and is inversely proportional to its mass. The direction of the acceleration is in the direction of the net force acting on the object.

Newton's third law: Whenever one object exerts a force on a second object, the second exerts an equal force in the opposite direction on the first.

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

23) Mass and weight
A) are exactly equal.
B) both measure the same thing.
C) are two different quantities.
D) are both measured in kilograms.
Answer: C

24) The acceleration due to gravity is lower on the Moon than on Earth. Which of the following is true about the mass and weight of an astronaut on the Moon's surface, compared to Earth?
A) Both mass and weight are less.
B) Mass is same, weight is less.
C) Both mass and weight are the same.
D) Mass is less, weight is same.
Answer: B

25) An example of a force which acts at a distance is
A) static friction.
B) weight.
C) tension.
D) kinetic friction.
Answer: B

26) Who has a greater weight to mass ratio, a person weighing 400 N or a person weighing 600 N?
A) the person weighing 600 N
B) the person weighing 400 N
C) Neither; their ratios are the same.
D) The question can't be answered; not enough information is given.
Answer: C

27) A stone is thrown straight up. At the top of its path, the net force acting on it is
A) instantaneously equal to zero.
B) greater than its weight.
C) greater than zero, but less than its weight.
D) equal to its weight.
Answer: D

28) A 20-N weight and a 5.0-N weight are dropped simultaneously from the same height. Ignore air resistance. Compare their accelerations.
A) They both accelerate at the same rate because they have the same weight to mass ratio.
B) The 20 N weight accelerates faster because it has more inertia.
C) The 5.0 N weight accelerates faster because it has a smaller mass.
D) The 20 N weight accelerates faster because it is heavier.
Answer: A

29) A brick and a feather fall to the earth at their respective terminal velocities. Which object experiences the greater force of air friction?
A) the feather
B) the brick
C) Neither, both experience the same amount of air friction.
D) It cannot be determined because there is not enough information given.
Answer: B

30) An object of mass m is hanging by a string from the ceiling of an elevator. The elevator is moving up at constant speed. What is the tension in the string?
A) greater than mg
B) less than mg
C) exactly mg
D) cannot be determined without knowing the speed

Answer: C

31) An object of mass m is hanging by a string from the ceiling of an elevator. The elevator is moving upward, but slowing down. What is the tension in the string?
A) zero B) greater than mg C) exactly mg D) less than mg

Answer: D

32) The force that keeps you from sliding on an icy sidewalk is
A) normal force. B) weight. C) static friction. D) kinetic friction.

Answer: C

33) It's more difficult to start moving a heavy carton from rest than it is to keep pushing it with constant velocity, because
A) initially, the normal force is not perpendicular to the applied force.
B) the normal force is greater when the carton is at rest.
C) $\mu_S < \mu_K$.
D) $\mu_K < \mu_S$.

Answer: D

34) A horizontal force accelerates a box from rest across a horizontal surface (friction is present) at a constant rate. The experiment is repeated, and all conditions remain the same with the exception that the horizontal force is doubled. What happens to the box's acceleration?
A) It increases to less than double its original value.
B) It increases somewhat.
C) It increases to more than double its original value.
D) It increases to exactly double its original value.

Answer: C

35) A packing crate slides down an inclined ramp at constant velocity. Thus we can deduce that
A) a frictional force is acting on it.
B) it may be accelerating.
C) it is not acted on by appreciable gravitational force.
D) a net downward force is acting on it.

Answer: A

36) A block of mass M slides down a frictionless plane inclined at an angle θ with the horizontal. The normal reaction force exerted by the plane on the block is
A) zero, since the plane is frictionless. B) Mg cos θ.
C) Mg sin θ. D) Mg.

Answer: B

37) A block of mass M slides down a frictionless plane inclined at an angle θ with the horizontal. The normal reaction force exerted by the plane on the block is directed
A) parallel to the plane in the opposite direction as the movement of the block
B) perpendicular to the plane.
C) parallel to the plane in the same direction as the movement of the block.
D) toward the center of the Earth.

Answer: B

38) A block of mass M slides down a frictionless plane inclined at an angle θ with the horizontal. The gravitational force is directed
A) parallel to the plane in the opposite direction as the movement of the block
B) toward the center of the Earth.
C) perpendicular to the plane.
D) parallel to the plane in the same direction as the movement of the block.

Answer: B

39) Two toy cars (16 kg and 2.0 kg) are released simultaneously on an inclined plane that makes an angle of 30° with the horizontal. Make a statement which best describes their acceleration after being released.
A) Both cars accelerate at the same rate.
B) The 16-kg car accelerates 8 times faster than the 2.0-kg car.
C) The 2.0-kg car accelerates 8 times faster than the 16-kg car.
D) none of the above

Answer: A

40) An object sits on a frictionless surface. A 16-N force is applied to the object, and it accelerates at 2.0 m/s^2. What is the mass of the object?
A) 4.0 kg B) 78 N C) 32 kg D) 8.0 kg

Answer: D

41) A sports car of mass 1000 kg can accelerate from rest to 27 m/s in 7.0 s. What is the average forward force on the car?
A) 2.7×10^4 N B) 3.9×10^3 N C) 1.9×10^5 N D) 2.6×10^2 N

Answer: B

42) Starting from rest, a 4.0-kg body reaches a speed of 8.0 m/s in 2.0 s. What is the net force acting on the body?
A) 32 N B) 8.0 N C) 4.0 N D) 16 N

Answer: D

43) An antitank weapon fires a 3.00-kg rocket which acquires a speed of 50.0 m/s after traveling 90.0 cm down a launching tube. Assuming the rocket was accelerated uniformly, what is the average force acted on it?
A) 2.82×10^3 N B) 3.62×10^3 N C) 4.17×10^3 N D) 2.00×10^3 N

Answer: C

44) If you push a 4.0-kg mass with the same force that you push a 10-kg mass from rest,
A) both masses accelerate at the same rate.
B) the 4.0-kg mass accelerates 2.5 times faster than the 10-kg mass.
C) the 10-kg mass accelerates 2.5 times faster than the 4.0-kg mass.
D) None of the above is true.

Answer: B

45) What is the mass of a person who weighs 110 lb?
A) 50 kg B) 55 kg C) 242 kg D) 110 kg
Answer: A

46) What is the mass of an object that weighs 250 N on the surface of the Earth where the acceleration due to gravity is 9.80 m/s^2?
A) 25.5 kg B) 250 kg C) 2,450 kg D) 24.5 kg
Answer: A

47) An object has a mass of 60 kg on the Earth. What is the mass of the object on the surface of the Moon where the acceleration due to gravity is only 1/6 of that on the Earth?
A) 60 kg B) 360 kg C) 10 kg D) 6.0 kg
Answer: A

48) Object A weighs 40 N on Earth, and object B weighs 40 N on the Moon. The Moon's gravity is one sixth of Earth's. Compare the masses of the objects.
A) A has 6 times the mass of B. B) A and B have equal mass.
C) B has 6 times the mass of A. D) The situation as stated is impossible.
Answer: C

49) Sue and Sean are having a tug-of-war by pulling on opposite ends of a 5.0-kg rope. Sue pulls with a 15-N force. What is Sean's force if the rope accelerates toward Sue at 2.0 m/s^2?
A) 5.0 N B) 3.0 N C) 25 N D) 50 N
Answer: A

50) A stack of books rests on a level frictionless surface. A force F acts on the stack, and it accelerates at 3.0 m/s^2. A 1.0 kg book is then added to the stack. The same force is applied, and now the stack accelerates at 2.0 m/s^2. What was the mass of the original stack?
A) 3.0 kg B) 2.0 kg C) 1.0 kg D) none of the above
Answer: B

51) A person of weight 480 N stands on a scale in an elevator. What will the scale be reading when the elevator is accelerating downward at 4.00 m/s^2?
A) 284 N B) 196 N C) 480 N D) 676 N
Answer: A

52) A person on a scale rides in an elevator. If the mass of the person is 60.0 kg and the elevator accelerates downward with an acceleration of 4.90 m/s^2, what is the reading on the scale?
A) 882 N B) 294 N C) 147 N D) 588 N
Answer: B

53) A person on a scale rides in an elevator. If the mass of the person is 60.0 kg and the elevator accelerates upward with an acceleration of 4.90 m/s^2, what is the reading on the scale?
A) 588 N B) 294 N C) 882 N D) 147 N
Answer: C

54) Two horizontal forces act on a 5.0-kg mass. One force has a magnitude of 8.0 N and is directed due north. The second force toward the east has a magnitude of 6.0 N. What is the acceleration of the mass?

A) 1.6 m/s^2 due north
B) 2.0 m/s^2 at 53 m E of N
C) 2.0 m/s^2 at 53° N of E
D) 1.2 m/s^2 due east

Answer: C

55) An object of mass 6000 kg rests on the flatbed of a truck. It is held in place by metal brackets that can exert a maximum horizontal force of 9000 N. When the truck is traveling 15 m/s, what is the minimum stopping distance if the load is not to slide forward into the cab?

A) 15 m
B) 30 m
C) 150 m
D) 75 m

Answer: D

56) An object of mass 6000 kg rests on the flatbed of a truck. It is held in place by metal brackets that can exert a maximum horizontal force of 9000 N. When the truck is traveling 15 m/s, what is the minimum stopping time if the load is not to slide forward into the cab?

A) 23 s
B) 5.0 s
C) 13 s
D) 10 s

Answer: D

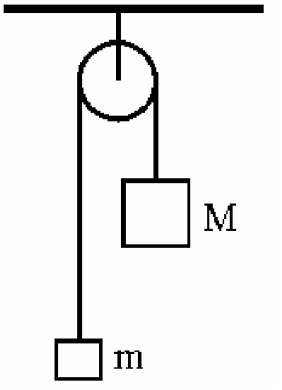

FIGURE 4-1

57) In the Atwood machine shown in Fig. 4-1, if M = 0.60 kg and m = 0.40 kg, what is the magnitude of the acceleration of the system? (Ignore friction and the mass of the pulley.)

A) 5.3 m/s^2
B) 3.9 m/s^2
C) 0.98 m/s^2
D) 2.0 m/s^2

Answer: D

58) In the Atwood machine shown in Fig. 4-1, if M = 0.60 kg and m = 0.40 kg, what is the tension in the string? (Ignore friction and the mass of the pulley.)

A) 7.1 N
B) 3.1 N
C) 4.7 N
D) 7.5 N

Answer: C

59) A student pulls a box of books on a smooth horizontal floor with a force of 100 N in a direction of 37° above the horizontal. If the mass of the box and the books is 40.0 kg, what is the acceleration of the box?

A) 1.5 m/s^2
B) 2.0 m/s^2
C) 1.9 m/s^2
D) 3.3 m/s^2

Answer: B

60) A student pulls a box of books on a smooth horizontal floor with a force of 100 N in a direction of 37.0° above the horizontal. If the mass of the box and the books is 40.0 kg, what is the normal force on the box?

A) 332 N B) 292 N C) 392 N D) 312 N

Answer: A

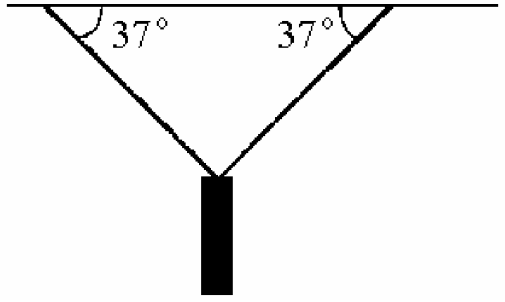

FIGURE 4-2

61) A traffic light of weight 100 N is supported by two ropes as shown in Fig. 4-2. What are the tensions in the ropes?

A) 83 N B) 66 N C) 50 N D) 63 N

Answer: A

62) In Fig. 4-2, if the tensions in the ropes are 50 N, what is the mass of the traffic light?

A) 4.1 kg B) 8.1 kg C) 6.1 kg D) 3.1 kg

Answer: C

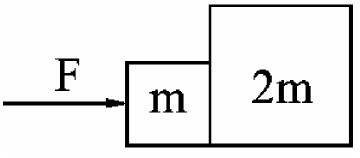

FIGURE 4-3

63) Two boxes of masses m and 2m are in contact with each other on a frictionless surface. (See Fig. 4-3.) What is the acceleration of the more massive box?

A) F/(4m) B) F/(2m) C) F/(3m) D) F/m

Answer: C

64) Two boxes of masses m and 2m are in contact with each other on a frictionless surface. (See Fig. 4-3.) What is the net force on the more massive box?

A) 2F B) 2/3 F C) 3/2 F D) F

Answer: B

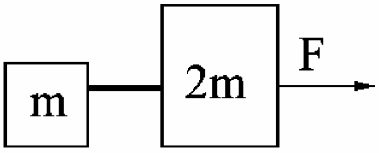

FIGURE 4-4

65) Two boxes of masses m and 2m are connected by a rope. (See Fig. 4-4.) If the forward force on the more massive box is F, what is the tension in the connecting rope?

A) 3F B) F C) F/3 D) F/2

Answer: C

66) Two boxes of masses m and 2m are connected by a rope. (See Fig. 4-4.) If the forward force on the more massive box is F, what is the acceleration of the less massive box?

A) F/(3m) B) 2F/m C) F/(2m) D) F/m

Answer: A

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

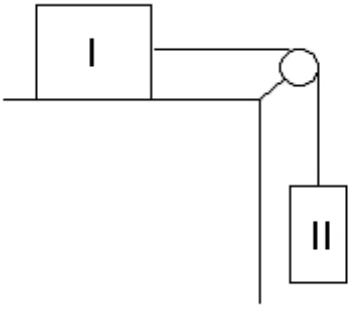

FIGURE 4-5

67) Two boxes are connected by a cord running over a pulley as shown in Fig. 4-5. Box I of mass 8.0 kg rest on the top of the table; the coefficient of kinetic friction between box I and the table is 0.10. Box II has a mass of 15.0 kg.
(a) Draw the free-body diagrams for the two boxes, identifying all of the forces acting on each of the masses.
(b) Calculate the acceleration of the system.
(c) Calculate the tension in the cord.

Answer: (a) Box one is acted on by the force of gravity in a downward direction, the normal force due to the table top in an upward direction, the tension in the string toward the right, and the force of friction due to the table top toward the left. Box two is acted on by the force of gravity in a downward direction and the tension in the string in an upward direction.
(b) 6.1 m/s^2
(c) 56 N

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

68) The coefficient of static and kinetic frictions between a 3.0-kg box and a desk are 0.40 and 0.30, respectively. What is the net force on the box when a 15 N horizontal force is applied to the box?

A) zero B) 12 N C) 8.8 N D) 6.2 N

Answer: D

69) The coefficients of static and kinetic frictions for plastic on wood are 0.50 and 0.40, respectively. How much horizontal force would you need to apply to a 3.0 N plastic calculator to start it moving from rest?

A) 1.5 N B) 2.7 N C) 0.15 N D) 1.2 N

Answer: A

70) An object slides on a level surface in the +x direction. It slows and comes to a stop with a constant acceleration of -2.45 m/s^2. What is the coefficient of kinetic friction between the object and the floor?

A) 4.9
B) 0.50
C) 0.25
D) Impossible to determine without knowing the mass of the object.

Answer: C

71) A 10-kg box sitting on a horizontal surface is pulled by a 5.0-N force. A 3.0-N friction force retards the motion. What is the acceleration of the object?

A) 5.0 m/s^2 B) 0.30 m/s^2 C) 0.50 m/s^2 D) 0.20 m/s^2

Answer: D

72) A horizontal force of 5.0 N accelerates a 4.0-kg mass, from rest, at a rate of 0.50 m/s^2 in the positive direction. What friction force acts on the mass?

A) 2.0 N B) 5.0 N C) 3.0 N D) 4.0 N

Answer: C

73) During a hockey game, a puck is given an initial speed of 10 m/s. It slides 50 m on the ice before it stops. What is the coefficient of kinetic friction between the puck and the ice?

A) 0.11 B) 0.12 C) 0.090 D) 0.10

Answer: D

74) During the investigation of a traffic accident, police find skid marks 90.0 m long. They determine the coefficient of friction between the car's tires and the roadway to be 0.500 for the prevailing conditions. Estimate the speed of the car when the brakes were applied.

A) 21.0 m/s B) 9.49 m/s C) 42.0 m/s D) 29.7 m/s

Answer: D

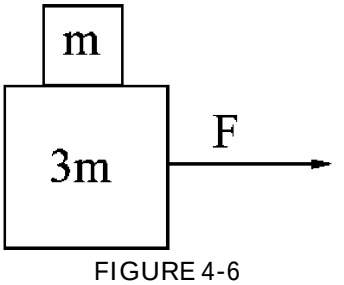

FIGURE 4-6

75) Two boxes of masses m and 3m are stacked. (See Fig. 4-6.) The surface between the more massive box and the horizontal surface is smooth and the surface between the boxes is rough. If the less massive box does not slide on the more massive box, what is the static friction force on the less massive box?

A) F/2 B) F C) F/4 D) F/3

Answer: D

76) Two boxes of masses m and 3m are stacked. (See Fig. 4-6.) The surface between the more massive box and the horizontal surface is smooth and the surface between the boxes is rough. If the less massive box does not slide on the more massive box, what is the coefficient of static friction between the boxes?

A) F/(mg) B) F/(4mg) C) F/(2mg) D) F/(3mg)

Answer: D

77) An object is on a frictionless inclined plane. The plane is inclined at an angle of 30° with the horizontal. What is the object's acceleration?

A) 1.0 g B) 0.56 g C) 0.87 g D) 0.50 g

Answer: D

78) A 10-kg mass slides down a flat hill that makes an angle of 10° with the horizontal. If friction is negligible, what is the resultant force on the sled?

A) 97 N B) 1.7 N C) 17 N D) 98 N

Answer: C

79) A mass is placed on a smooth inclined plane with an angle of 37° to the horizontal. If the inclined plane is 5.0-m long, how long does it take for the mass to reach the bottom of the inclined plane after it is released from rest?

A) 1.3 s B) 1.0 s C) 1.2 s D) 1.1 s

Answer: A

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

80) A block lies on a smooth inclined plane tilted at an angle of 35° to the horizontal.
(a) Draw the free-body diagram for the block.
(b) Determine the block's acceleration as it slides down the inclined plane.
(c) If the block started from rest 8.5 m up the incline from its base, determine the block's speed when it reaches the bottom of the incline.
(d) How long did it take the block to reach the bottom of the inclined plane?

Answer: (a) The block is acted on by the force of gravity directed downward and the normal force due to the inclined plane directed perpendicular to the inclined surface.
(b) 5.6 m/s^2
(c) 9.7 m/s
(d) 1.7 s

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

81) A wooden block slides directly down an inclined plane, at a constant velocity of 6.0 m/s. What is the coefficient of kinetic friction, if the plane makes an angle of 25° with the horizontal?

A) 0.42 B) 0.37 C) 0.47 D) 0.91

Answer: C

82) An object with a mass m slides down a rough 37° inclined plane where the coefficient of kinetic friction is 0.20. What is the acceleration of the object?

A) 4.3 m/s^2 B) 7.8 m/s^2 C) 6.6 m/s^2 D) 5.9 m/s^2

Answer: A

83) An object with a mass m slides down a rough 37° inclined plane where the coefficient of kinetic friction is 0.20. If the plane is 10 m long and the mass starts from rest, what will be its speed at the bottom of the plane?

A) 9.7 m/s B) 11 m/s C) 9.3 m/s D) 12 m/s

Answer: C

84) A bulldozer drags a log weighing 500 N along a rough surface. The cable attached to the log makes an angle of 30.0° with the ground. The coefficient of static friction between the log and the ground is 0.500. What minimum tension is required in the cable in order for the log to begin to move?

A) 268 N B) 224 N C) 500 N D) 289 N

Answer: B

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

85) A 25.0-kg box is released from rest on a rough inclined plane tilted at an angle of 33.5° to the horizontal. The coefficient of kinetic friction between the box and the inclined plane is 0.200.
(a) Draw the free-body diagram for the box.
(b) Determine the force of kinetic friction acting on the box.
(c) Determine the acceleration of the box as it slides down the inclined plane.

Answer: (a) The box is acted on by the force of gravity directed downward, the normal force due to the inclined plane directed perpendicular to the surface of the incline, and the force of friction due to the inclined plane directed parallel to the inclined surface in the direction opposite of the motion.
(b) 40.9 N
(c) 3.77 m/s^2

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

86) An object is placed on an inclined plane. The angle of incline is gradually increased until the object begins to slide. The angle at which this occurs is θ. What is the coefficient of static friction between the object and the plane?

A) $\tan \theta$ B) $1/\tan \theta$ C) $\sin \theta$ D) $\cos \theta$

Answer: A

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

87) If the acceleration of an object is zero, are no forces acting on it? Explain.

Answer: If the acceleration of an object is zero, then by Newton's second law, the net force must be zero. There can be forces acting on the object as long as the vector sum of the forces is zero.

88) If you walk along a log floating on a lake, why does the log move in the opposite direction?

Answer: When you try to walk east, you push on the ground (or on the log in this case) with a westward force. When you push westward on the massive Earth, the Earth moves imperceptibly, but by Newton's third law there is an eastward force on you, which propels you forward. When walking on the log, the relatively light and unrestricted log is free to move, and so when you push it westward, it moves westward as you move eastward.

89) You pull a box with a constant force across a frictionless table using an attached rope held horizontally. If you now pull the rope with the same force at angle to the horizontal (with the box remaining flat on the table), does the acceleration of the box (a) remain the same, (b) increase, or (c) decrease? Explain.

Answer: When you pull the rope at an angle, only the horizontal component of the pulling force will be accelerating the box across the table. This is a smaller horizontal force than originally used, and so the horizontal acceleration of the box will decrease.

90) When an object falls freely under the influence of gravity there is a net force *mg* exerted on it by the Earth. Yet by Newton's third law the object exerts an equal and opposite force on the Earth. Why doesn't the Earth move?

Answer: Let us find the acceleration of the Earth, assuming the mass of the freely falling object is 1 kg. If the mass of the Earth is M, then the acceleration of the Earth would be found from Newton's third law and Newton's second law.

$$F_{earth} = F_{object} \rightarrow Ma_{earth} = mg \rightarrow a_{earth} = \frac{mg}{M}$$

Since the Earth has a mass that is on the order of 10^{25} kg, then the acceleration of the Earth approximately 10^{-24} m/s^2. This tiny acceleration is undetectable.

91) Compare the effort (or force) needed to lift a 10-kg object when you are on the Moon with the force needed to lift it on Earth. Compare the force needed to throw a 2-kg object horizontally with a given speed on the Moon and on Earth.

Answer: To lift the object on the Earth requires a force the same size as its weight on Earth, 98 N. To lift the object on the Moon requires a force the same size as its weight on the Moon, 16 N.

The horizontal accelerating force would be the same in each case, because the mass of the object is the same on both the Earth and the Moon, and both objects would have the same acceleration to throw them with the same speed. So by Newton's second law, the forces would have to be the same.

92) What would your bathroom scale read if you weighed yourself on an inclined plane? Assume the mechanism functions properly, even at an angle.

Answer: Assume your weight is *W*. If you weighed yourself on an inclined plane that is inclined at angle θ, the bathroom scale would read the magnitude of the normal force between you and the plane, which would be $W\cos\theta$.

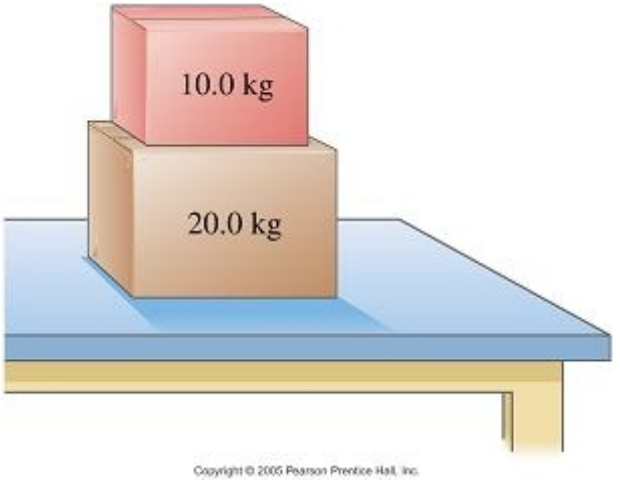

FIGURE 4-38

93) A 20.0-kg box rest on a table. (a) What is the weight of the box and the normal force acting on it? (b) A 10.0-kg box is placed on top of the 20.0-kg box, as shown in Fig. 4-38. Determine the normal force that the table exerts on the 20.0-kg box and the normal force that the 20.0-kg box exerts on the 10.0-kg box.

Answer: (a) The weight and normal force are both 196 N.
(b) The normal force due to the table on the 20.0 kg box is 294 N. The normal force that the 20.0-kg box exerts on the 10.0-kg box is 98.0 N.

94) What average force is required to stop an 1100-kg car in 8.0 s if the car is traveling at 95 km/h?

Answer: -3.6×10^3 N

95) A 12.0-kg bucket is lowered vertically by a rope in which there is 163 N of tension at a given instant. What is the acceleration of the bucket? Is it up or down?

Answer: 3.8 m/s^2, upward

96) A person stands on a bathroom scale in a motionless elevator. When the elevator begins to move, the scale briefly reads only 0.75 of the person's regular weight. Calculate the acceleration of the elevator, and find the direction of acceleration.

Answer: 2.5 m/s^2, down

97) (a) What is the acceleration of two falling sky divers (mass 132 kg including parachute) when the upward force of air resistance is equal to one-fourth of their weight? (b) After popping open the parachute, the divers descend leisurely to the ground at constant speed. What now is the force of air resistance on the sky divers and their parachute?

Answer: (a) 7.4 m/s^2
(b) 1.29×10^3 N

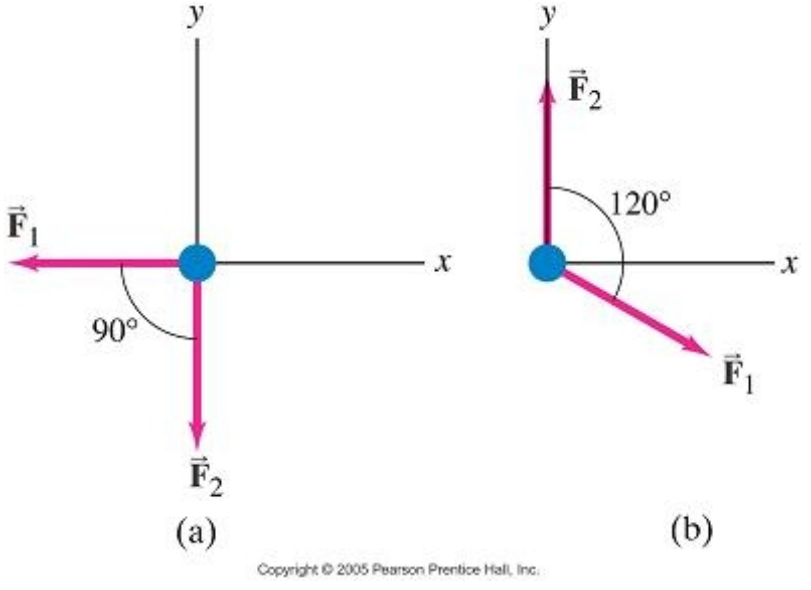

FIGURE 4-43

98) The two forces $\vec{F}_1$ and $\vec{F}_2$ shown in Fig. 4-43a and b (looking down) act on a 27.0-kg object on a frictionless tabletop. If F_1 = 10.2 N and F_2 = 16.0 N, find the net force on the object and its acceleration for (a) and (b).

Answer: (a) 19.0 N at 237.5° from the positive x axis, 0.703 m/s^2 at 237° from the positive x axis
(b) 14.0 N at 51.0° from the positive x axis, 0.520 m/s^2 at 51.0° from the positive x axis

FIGURE 4-44

99) One 3.2-kg paint bucket is hanging by a massless cord from another 3.2-kg paint bucket, also hanging by a massless cord, as shown in Fig. 4-44. (a) If the buckets are at rest, what is the tension in each cord? (b) If the two buckets are pulled upward with an acceleration of 1.60 m/s^2 by the upper cord, calculate the tension in each cord.

Answer: (a) The tension in the bottom cord is 31 N. The tension in the top cord is 63 N.
(b) The tension in the bottom cord is 36 N. The tension in the top cord is 73 N.

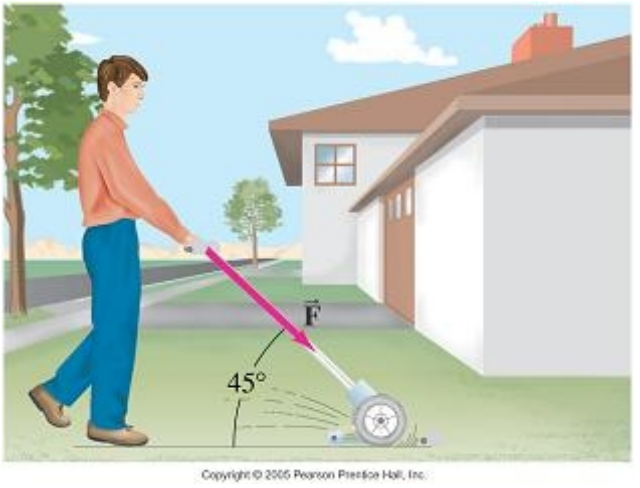

FIGURE 4-45

100) A person pushes a 14.0-kg lawn mower at constant speed with a force of F = 88.0 N directed along the handle which is at an angle of 45.0° to the horizontal (Fig. 4-45). (a) Draw the free-body diagram showing all forces acting on the mower. Calculate (b) the horizontal friction force on the mower, then (c) the normal force exerted vertically upward on the mower by the ground. (d) What force must the person exert on the lawn mower to accelerate it fro rest to 1.5 m/s in 2.5 seconds, assuming the same friction force?

Answer: (a) The forces acting on the mower are the force due to gravity, the normal force due to the ground, the force due to kinetic friction, and the external force directed along the handle.
(b) 62.2 N
(c) 199 N
(d) 99.9 N

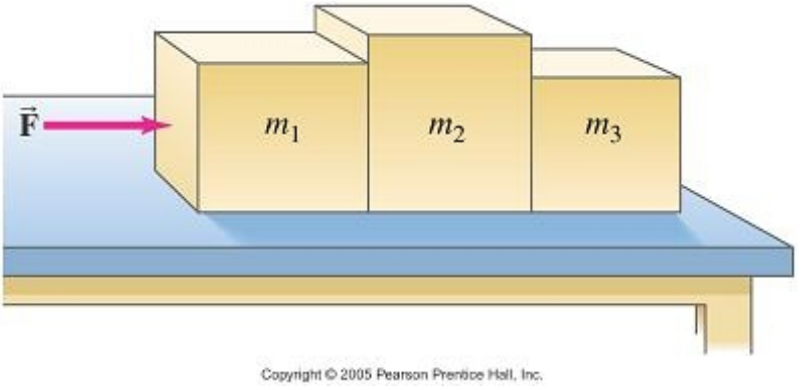

FIGURE 4-51

101) Three blocks on a frictionless horizontal surface are in contact with each other, as shown in Fig. 4-51. A force $\vec{F}$ is applied to block 1 (mass m_1). (a) Draw a free-body diagram for each block. Determine (b) the acceleration of the system (in terms of m_1, m_2, and m_3), (c) the net force on each block, and (d) the force of contact that each block exerts on its neighbor. (e) If $m_1 = m_2 = m_3 = 12.0$ kg and $F = 96.0$ N, give numerical answers to (b), (c), and (d). Do your answers make sense intuitively?

Answer: (a) The forces acting on m_1 are the force due to gravity, the normal force due to the table, the force due to mass m_2, and the external force $\vec{F}$. The forces acting on m_2 are the force due to gravity, the normal force due to the table, the force due to mass m_3, and the force due to mass m_1. The forces acting on m_3 are the force due to gravity, the normal force due to the table, and the force due to mass m_2.

(b) $a = \dfrac{F}{m_1 + m_2 + m_3}$

(c) $F_{1net} = \dfrac{m_1 F}{m_1 + m_2 + m_3}$, $F_{2net} = \dfrac{m_2 F}{m_1 + m_2 + m_3}$, $F_{3net} = \dfrac{m_3 F}{m_1 + m_2 + m_3}$

(d) $F_{12} = F_{21} = \dfrac{(m_2 + m_3) F}{m_1 + m_2 + m_3}$, $F_{23} = F_{32} = \dfrac{m_3 F}{m_1 + m_2 + m_3}$

(e) $a = 2.67$ m/s^2, $F_{1net} = F_{2net} = F_{3net} = 32.0$ N, $F_{12} = F_{21} = 64.0$ N, $F_{23} = F_{32} = 32.0$ N
The values make sense in that in order of magnitude, we should have $F > F_{21} > F_{32}$, since F is the net force pushing the entire set of blocks, F_{21} is the net force pushing the right two blocks, and F_{32} is the net force pushing the right block only.

102) A 15.0-kg box is released on a 32° incline and accelerates down the incline at 0.30 m/s^2. Find the friction force impeding its motion. What is the coefficient of kinetic friction?

Answer: The friction force is 73 N. The coefficient of kinetic friction is 0.59.

103) A box is given a push so that it slides across the floor. How far will it go, given that the coefficient of kinetic friction is 0.30 and the push imparts an initial speed of 4.0 m/s?

Answer: 4.1 m

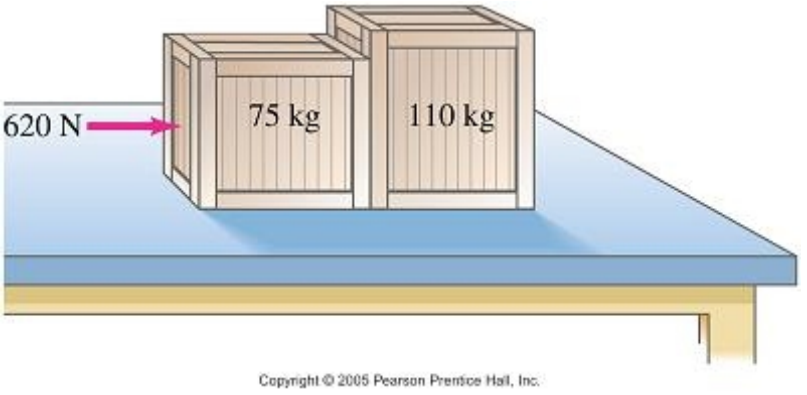

FIGURE 4-54

104) Two crates, of mass 75 kg and 110 kg, are in contact and at rest on a horizontal surface (Fig. 4-54). A 620 N force is exerted on the 75 kg crate. If the coefficient of kinetic friction is 0.15, calculate (a) the acceleration of the system, and (b) the force that each crate exerts on the other. (c) Repeat with the crates reversed.

Answer: (a) 1.9 m/s^2

(b) 3.7×10^2 N

(c) The acceleration will remain the same. The force that each crate exerts on the other is 2.5×10^2N.

105) A flatbed truck is carrying a heavy crate. The coefficient of static friction between the crate and the bed of the truck is 0.75. What is the maximum rate at which the driver can decelerate and still avoid having the crate slide against the cab of the truck?

Answer: 7.4 m/s^2

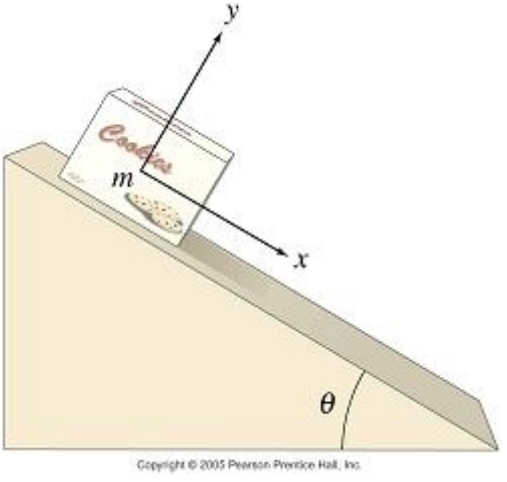

FIGURE 4-55

106) The carton shown in Fig. 4-55 lies on a plane tilted at an angle $\theta = 22.0°$ to the horizontal, with $\mu_k = 0.12$. (a) Determine the acceleration of the carton as it slides down the plane. (b) If the carton starts from rest 9.30 m up the plane from its base, what will be the carton's speed when it reaches the bottom of the incline?

Answer: (a) 2.6 m/s^2

(b) 6.9 m/s

107) A small box is held in place against a rough wall by someone pushing on it with a force directed upward at 28° above the horizontal. The coefficients of static and Kinetic friction between the box and wall are 0.40 and 0.30, respectively. The box slides down unless the applied force has magnitude 13 N. What is the mass of the box?

Answer: 1.1 kg

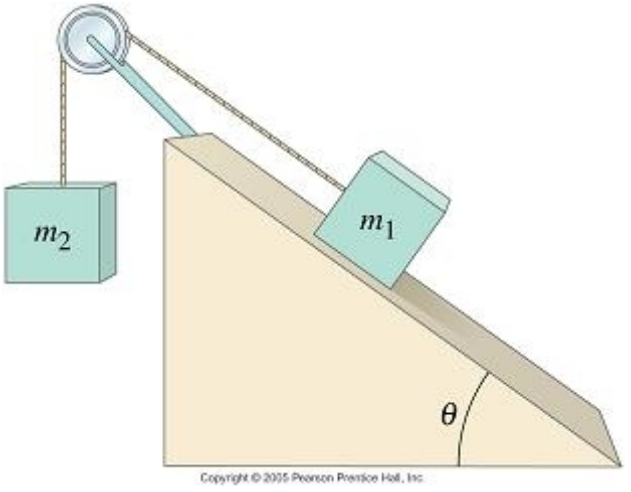

FIGURE 4-57

108) A block (mass m_1) lying on a frictionless inclined plane is connected to a mass m_2 by a massless cord passing over a pulley, as shown in Fig. 4-57. (a) Determine a formula for the acceleration of the system of the two blocks in terms of m_1, m_2, θ, and g. (b) What conditions apply to masses m_1 and m_2 for the acceleration to be in one direction (say, m_1 down the plane), or in the opposite direction?

Answer: (a) $a = g\dfrac{(m_1 \sin\theta - m_2)}{(m_1 + m_2)}$

(b) For acceleration down the plane $m_1 \sin\theta > m_2$. For acceleration up the plane $m_1 \sin\theta < m_2$.