ch 5 problems

sections 1-24

Chapter 5: Force and Newton's Laws

Section 0: Introduction

5.0.1 (5.00) Use the simulation in the interactive problem in Section 5.0 to answer the following question. If the net force on the helicopter is zero, what must the helicopter be doing?

Section 2: Newton's first law

5.2.1 (5.00) An airplane of mass 2867 kg flies at a constant horizontal velocity. The force of air resistance on it is 2225 N. What is the net force on the plane (magnitude and direction)?

Section 4: Gravitational force: weight

5.4.1 (5.00) A weightlifter can exert an upward force of 3750 N. If a dumbbell has a mass of 225 kg, what is the maximum number of dumbbells this weightlifter could hold simultaneously if he were on the Moon? (The Moon's acceleration due to gravity is approximately 0.166 times freefall acceleration on Earth.) The weightlifter cannot pick up a fraction of a dumbbell, so make sure your answer is an integer.

dumbells

5.4.2 (5.00) (a) How much does a 70.0 kg person weigh on the Earth? (b) How much would she weigh on the Moon (g_{moon} = 0.166g)? (c) How much would she weigh on a neutron star where g_{star} = 1.43×10^{11}g?

(a) N

(b) N

(c) _____ N

Section 5: Newton's second law

5.5.1 **(5.00)** When empty, a particular helicopter of mass 3770 kg can accelerate straight upward at a maximum acceleration of *a* m/s^2. A careless crewman overloads the helicopter so that it is just unable to lift off. What is the mass of the cargo?

_____ kg

5.5.2 **(5.00)** A 0.125 kg frozen hamburger patty has two forces acting on it that determine its horizontal motion. A 2.30 N force pushes it to the left, and a 0.800 N force pushes it to the right. (a) Taking right to be positive, what is the net force acting on it? (b) What is its acceleration?

(a) _____ N

(b) _____ m/s^2

5.5.3 **(5.00)** In the illustration, you see the graph of an object's acceleration over time. (a) At what moment is it experiencing the most positive force? (b) The most negative force? (c) Zero force?

(a) _____ s

(b) _____ s

(c) _____ s

5.5.4 **(5.00)** The net force on a boat causes it to accelerate at 1.55 m/s^2. The mass of the boat is 215 kg. The same net force causes another boat to accelerate at 0.125 m/s^2. (a) What is the mass of the second boat? (b) One of the boats is now loaded on the other, and the same net force is applied to this combined mass. What acceleration does it cause?

(a) _____ kg

(b) _____ m/s^2

5.5.5 A flea has a mass of 4.9×10^{-7} kg. When a flea jumps, its rear legs act like

(5.00) catapults, accelerating it at 2400 m/s^2. What force do the flea's legs have to exert on the ground for a flea to accelerate at this rate?

_____ N

Section 9: Interactive problem: flying in formation

5.9.1 **(5.00)** Using the simulation in the interactive problem in Section 5.9, (a) what is the force required for the red ships to accelerate at the desired magnitude? (b) What force is required for the blue ships?

(a) _____ N

(b) _____ N

Section 10: Newton's third law

5.10.1 **(5.00)** A 75.0 kg man sits on a massless cart that is on a horizontal surface. The cart is initially stationary and it can move without friction or air resistance. The man throws a 5.00 kg stone in the positive direction, applying a force to it so that it has acceleration +3.50 m/s^2 as measured by a nearby observer on the ground. What is the man's acceleration during the throw, as seen by the same observer? Be careful to use correct signs.

_____ m/s^2

5.10.2 **(7.00)** Two motionless ice skaters face each other and put their palms together. One skater pushes the other away using a constant force for 0.80 s. The second skater, who is pushed, has a mass of 110 kg and moves off with a velocity of −1.2 m/s relative to the rink. If the first skater has a mass of 45 kg, what is her velocity relative to the rink after the push? (Consider any forces other than the push acting on the skaters as negligible.)

_____ m/s

Section 11: Normal force

5.11.1 **(5.00)** A cup and saucer rest on a table top. The cup has mass 0.176 kg and the saucer 0.165 kg. Calculate the magnitude of the normal force (a) the saucer exerts on the cup and (b) the table exerts on the saucer.

(a) _____ N

(b) _____ N

5.11.2 **(5.00)** Three blocks are arranged in a stack on a frictionless horizontal surface. The bottom block has a mass of 37.0 kg. A block of mass 18.0 kg sits on top of it and a *m* kg block sits on top of the middle block. A downward vertical force of 170 N is applied to the top block. What is the magnitude of the normal force exerted by the bottom block on the middle block?

N

Section 12: Tension

5.12.1 **(5.00)** An ice rescue team pulls a stranded hiker off a frozen lake by throwing him a rope and pulling him horizontally across the essentially frictionless ice with a constant force. The hiker weighs 1040 N, and accelerates across the ice at *a* m/s^2. What is the magnitude of the tension in the rope? (Ignore the mass of the rope.)

N

Section 14: Free-body diagrams

5.14.1 **(5.00)** A tugboat is towing an oil tanker on a straight section of a river. The current in the river applies a force on the tanker that is one-half the magnitude of the force that the tugboat applies. Draw a free-body diagram for the tanker when the force provided by the tugboat is directed (a) straight upstream (b) directly cross-stream, and (c) at a 30° angle to upstream. In your drawing, let the current flow in the "left" direction, and have the tugboat pull "up" when applying a cross-stream force. Label the force vectors.

Submit answer on paper.

5.14.2 **(5.00)** A person lifts a 3.60 kg textbook (remember when they were made of paper and so heavy?) with a 52.0 N force at a 60.0° angle from the horizontal. (a) Draw a free-body diagram of the forces acting on the book, ignoring air resistance. Label the forces. (b) Draw a free-body diagram showing the net force acting on the book.

Submit answer on paper.

Section 15: Interactive problem: free-body diagram

5.15.1 **(5.00)** Using simulation in the interactive problem in Section 5.15, what are the direction and magnitude of (a) the weight, (b) the normal force, (c) the tension, and (d) the frictional force that meet the stated requirements and give the desired acceleration?

(a) N,
(b) N,
(c) N,
(d) N,

Section 17: Interactive problem: lifting crates

5.17.1 **(5.00)** Use the helicopter in the simulation in the interactive problem in Section 5.17 to find the crate with the given mass.

Section 19: Static friction

5.19.1 **(5.00)** A piece of steel is held firmly in the jaws of a vise. A force larger than 3350 N will cause the piece of steel to start to move out of the vise. If the coefficient of friction between the steel and each of the jaws of the vise is 0.825 and each jaw applies an equal force, what is the magnitude of the normal force exerted on the steel by each jaw?

N

5.19.2 **(5.00)** A wooden block of mass 29.0 kg sits on a horizontal table. A wire of negligible mass is attached to the right side of the block and goes over a pulley (also of negligible mass, and frictionless), where it is allowed to dangle vertically. When a mass of 15.5 kg is attached to the dangling wire, the block on the table just barely starts to slide. What is the coefficient of static friction between the block and the table?

5.19.3 **(5.00)** The Occupational Safety and Health Administration (OSHA) suggests a minimum coefficient of static friction of μ_s = 0.50 for floors. If Ethan, who has mass of *m* kg, stands passively, how much horizontal force can be applied on him before he will slip on a floor with OSHA's minimum coefficient of static friction?

N

Section 20: Kinetic friction

5.20.1 **(5.00)** A 1.0 kg brick is pushed against a vertical wall by a horizontal force of 24 N. If μ_s = 0.80 and μ_k = 0.70 what is the acceleration of the brick?

m/s^2

5.20.2 A firefighter whose weight is 812 N is sliding down a vertical pole, her speed

(5.00) increasing at the rate of 1.45 m/s^2. Gravity and friction are the two significant forces acting on her. What is the magnitude of the frictional force?

N

5.20.3 (5.00) A plastic box of mass 1.1 kg slides along a horizontal table. Its initial speed is 3.9 m/s, and the force of kinetic friction opposes its motion, causing it to stop after 3.1 s. What is the coefficient of kinetic friction between the block and the table?

5.20.4 (5.00) An old car is traveling down a long, straight, dry road at 25.0 m/s when the driver slams on the brakes, locking the wheels. The car comes to a complete stop after sliding *x* m in a straight line. If the car has a mass of 755 kg, what is the coefficient of kinetic friction between the tires and the road?

5.20.5 (7.00) A rescue worker pulls an injured skier lying on a toboggan (with a combined mass of 127 kg) across flat snow at a constant speed. A *L* m rope is attached to the toboggan at ground level, and the rescuer holds the rope taut at shoulder level. If the rescuer's shoulders are 1.65 m above the ground, and the tension in the rope is 148 N, what is the coefficient of kinetic friction between the toboggan and the snow?

Section 24: Interactive problem: forces on a sliding block

5.24.1 (5.00) Using the simulation in the interactive problem in Section 5.24, what are the direction and magnitude of (a) the weight, (b) the normal force, (c) the frictional force, and (d) the tension that meet the stated requirements and give the desired acceleration?

(a) N,
(b) N,
(c) N,
(d) N,

Section 25: Sample problem: moving down a frictionless plane

5.25.1 (5.00) A child sits on a freshly oiled, straight stair rail that is effectively frictionless and slides down it. She has a mass of 25 kg, and the rail makes an angle of 40° above the ground. If she slides 4.0 m before reaching the bottom, what is her speed there?

m/s

5.25.2 **(5.00)** A shipping container is hauled up a roller ramp that is effectively frictionless at a constant speed of 2.10 m/s by a 2250 N force that is parallel to the ramp. If the ramp is at a *theta*° incline, what is the container's mass?

kg

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