Name:_____ Due Date:_____

14

SACE Stage 1 Conceptual Physics
Inertia – Worksheet 1

1. The speed of a ball increases as it rolls down an incline, and the speed decreases as the ball rolls up an incline. What happens to the speed on a smooth horizontal surface? (1 mark)

2. The law of inertia states that no force is required to maintain motion. Why, then, do you have to keep pedalling your bicycle to maintain motion? (1 mark)

3. If you were in a spaceship and fired a cannonball into frictionless space, how much force would have to be exerted on the ball to keep it going? (1 mark)

4. An elephant and a mouse would both have the same weight-zero-in gravitation-free space. If they were moving toward you with the same speed, would they bump into you with the same effect? (1 mark)

5. What is the weight of 2 kg of yogurt? (3 marks)

6. a. A massive ball is suspended by a string from above, and slowly pulled by a string from below (Figure A). Is the string tension greater in the upper or the lower string? Which string is more likely to break? Which property—mass or weight—is important here? (3 marks)

   b. If the string is instead snapped downward, which string is more likely to break? Which property—mass or weight—is important this time? (2 marks)

7. If the head of a hammer is loose, and you wish to tighten it by banging it against the top of a work bench, why is it best to hold it with the handle down (Figure B) rather than with the head down? Explain in terms of inertia. (2 marks)

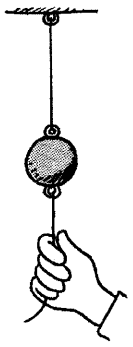

Fig. A

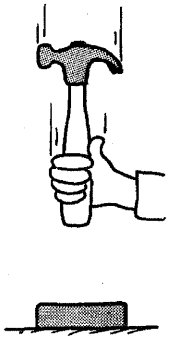

Fig. B

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Concept-Development Practice Page 3–1

Chapter 3: Newton's First Law of Motion – Inertia

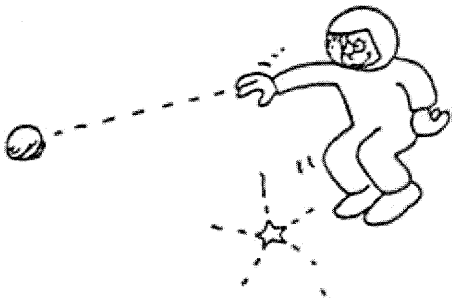
1. (*Circle the correct answer.*) An astronaut in outer space away from gravitational or frictional forces throws a rock. The rock will

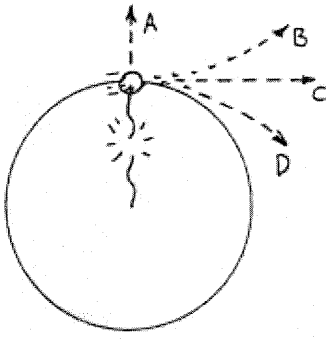
   (gradually slow to a stop)

   (continue moving in a straight line at constant speed)

   The rock's tendency to do this is called

   (inertia) (weight) (acceleration)



2. 

   The sketch shows a top view of a rock being whirled at the end of a string (clockwise). If the string breaks, the path of the rock is

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

3. Suppose you are standing in the aisle of a bus that travels along a straight road at 100 km/h, and you hold a pencil still above your head. Then relative to the bus, the velocity of the pencil is 0 km/h, and relative to the road, the pencil has a horizontal velocity of

   (less than 100 km/h) (100 km/h) (more than 100 km/h)

   Suppose you release the pencil. While it is dropping, and relative to the road, the pencil still has a horizontal velocity of

   (less than 100 km/h) (100 km/h) (more than 100 km/h)

   This means that the pencil will strike the floor at a place directly

   (behind you) (at your feet below your hand) (in front of you)

   Relative to you, the way the pencil drops

   (is the same as if the bus were at rest)

   (depends on the velocity of the bus)

   How does this example illustrate the law of inertia?

   _____

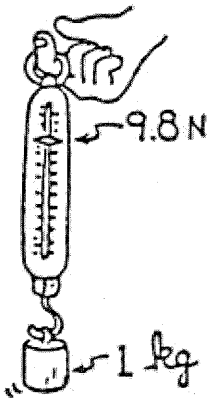
   _____

   _____

4. Use the words *mass*, *weight*, and *volume*, to complete the table.

The force due to gravity on an object	
The quantity of matter in an object	
The amount of space an object occupies	

5. Different masses are hung on a spring scale calibrated in newtons.



The force exerted by gravity on 1 kg = 9.8 N.

The force exerted by gravity on 5 kg = _____ N.

The force exerted by gravity on _____ kg = 98 N.

Make up your own mass and show the corresponding weight:

The force exerted by gravity on _____ kg = _____ N.

6. By whatever means (spring scales, measuring balance, etc.), find the mass of your physics book. Then complete Table I.

Table I

OBJECT	MASS	WEIGHT
MELON	1 kg	
APPLE		1 N
PHYSICS BOOK		
UNCLE HARRY	90 kg	

7. Why isn't the girl hurt when the nail is driven into the block of wood?

_____

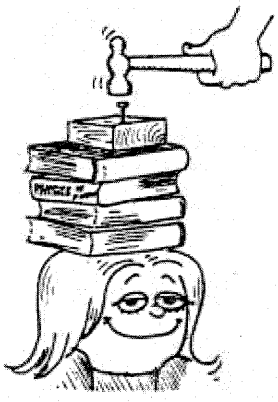
_____

Would this be more dangerous or less dangerous if the block were less massive _____ Explain.

_____

_____

_____



CAUTION: Safety dictates you not try this this experiment yourself.

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Concept-Development Practice Page 4–2

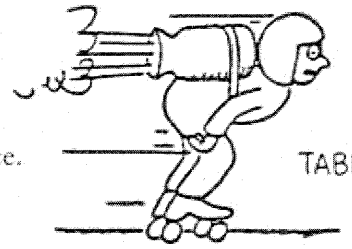
Chapter 4: Newton's Second Law — Force and Acceleration

1. Skelly the skater, 25-kg total mass, is propelled by rocket power.

   a. Complete Table I (neglect resistance).

   TABLE I

FORCE	ACCELERATION
100 N	
200 N	
	10 m/s²



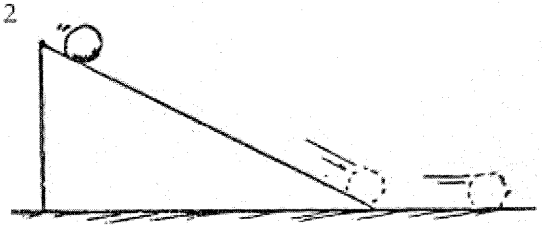
   b. Complete Table II for a constant 50-N resistance.

   TABLE II

FORCE	ACCELERATION
50 N	0 m/s²
100 N	
200 N	

(Circle the correct answers.)

2



A ball rolls down a uniform-slope ramp.

a. The acceleration is

(decreasing) (constant) (increasing)

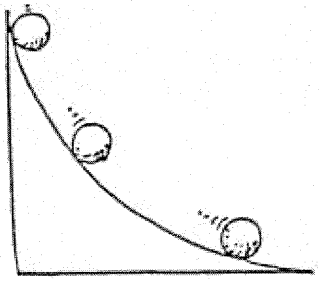
b. If the ramp were steeper, the acceleration would be

(more) (the same) (less).

c. When the ball reaches the bottom and rolls along the smooth level surface it

(continues to accelerate) (does not accelerate)

3. This time a ball rolls down a ramp of varying slope.



   a. The ball's acceleration along the ramp is greater

   (at the top) (at the middle) (at the bottom)

   (same everywhere)

   b. The speed of the ball is greater

   (at the top) (at the middle) (at the bottom)

   (same everywhere)

   c. For this case the speed is greatest when the acceleration is

   (greatest) (least)

   (Remember this example when somebody tells you that acceleration and speed are both the same...because they are not!)

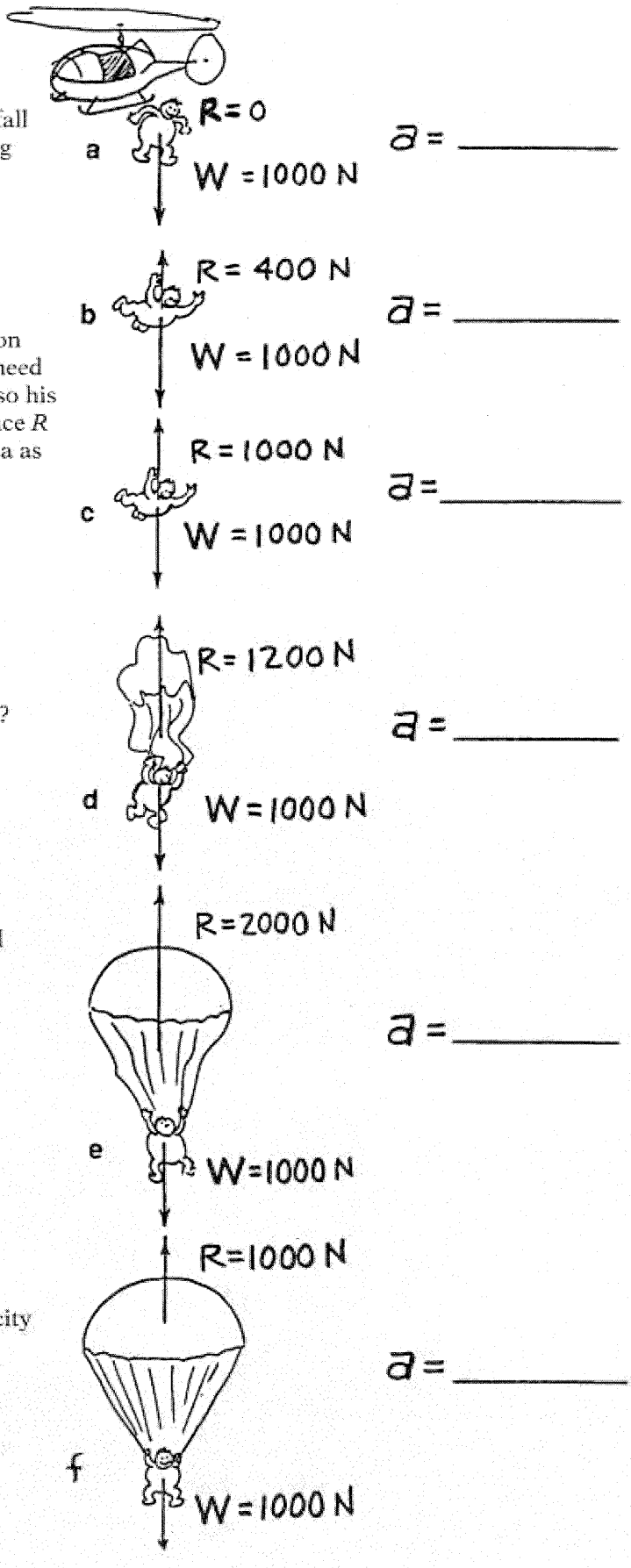
4. In the box at the right, sketch a ramp on which the acceleration of the ball will be very little at the top and progressively greater as it moves down the ramp.

Falling and Air Resistance

Bronco skydives and parachutes from a stationary helicopter. Various stages of fall are shown in positions *a* through *f*. Using Newton's 2nd law,

$$a = \frac{F_{NET}}{m} = \frac{W-R}{m}$$

find Bronco's acceleration at each position (answer in the blanks to the right). You need to know that Bronco's mass *m* is 100 kg so his weight is a constant 1000 N. Air resistance *R* varies with speed and cross-sectional area as shown.



Circle the correct answers.

1. When Bronco's speed is least, his acceleration is

   (least) (most)

2. In which position(s) does Bronco experience a downward acceleration?

   (a) (b) (c) (d) (e) (f)

3. In which position(s) does Bronco experience an upward acceleration?

   (a) (b) (c) (d) (e) (f)

4. When Bronco experiences an upward acceleration, his velocity is

   (still downward) (upward also).

5. In which position(s) is Bronco's velocity constant?

   (a) (b) (c) (d) (e) (f)

6. In which position(s) does Bronco experience terminal velocity?

   (a) (b) (c) (d) (e) (f)

7. In which position(s) is terminal velocity greatest?

   (a) (b) (c) (d) (e) (f)

8. If Bronco were heavier, his terminal velocity would be

   (greater) (less) (the same).

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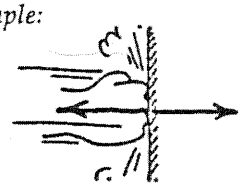
Concept-Development Practice Page 5–1

Chapter 5: Newton's Third Law — Action and Reaction

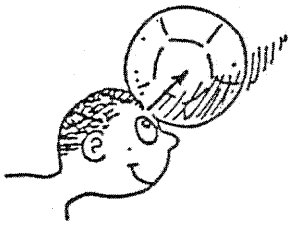
1. In the example below, the action-reaction pair is shown by the arrows (vectors), and the action-reaction described in words. In (*a*) through (*g*) draw the other arrow (vector) and state the reaction to the given action. Then make up your own example in (*h*).

Example:



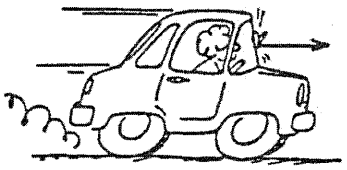
Fist hits wall.

Wall hits fist.



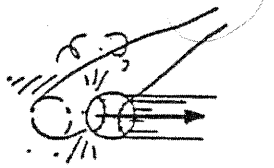
Head bumps ball.

(*a*)_____



Windshield hits bug.

(*b*)_____

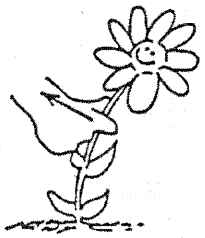


Bat hits ball.

(*c*)_____

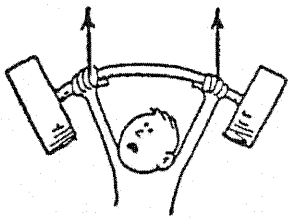
Hand touches nose.

(*d*)_____



Hand pulls on flower.

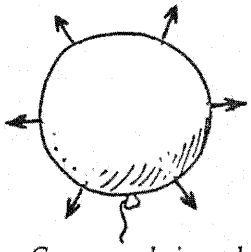
(*e*)_____



Athlete pushes bar upward.

(*f*)_____

_____



Compressed air pushes balloon surface outward.

(*g*)_____

_____

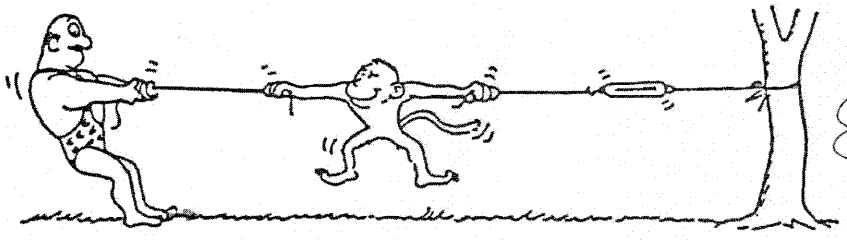
(*h*)_____

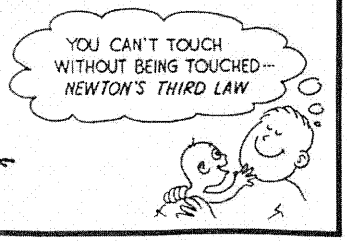
_____

_____

_____

2. Draw arrows to show the chain of at least six pairs of action-reaction forces below.

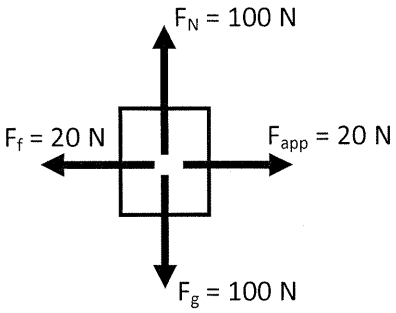


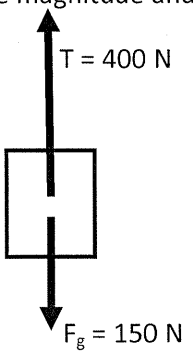


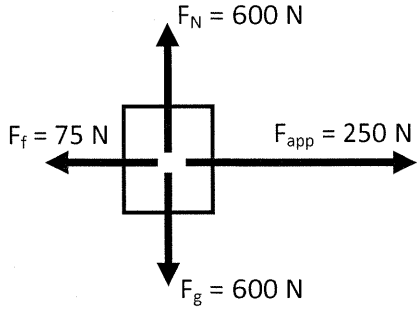
Worksheet 4.1

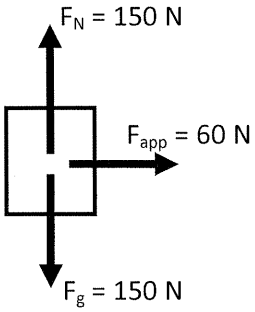
Newton's 2nd Law

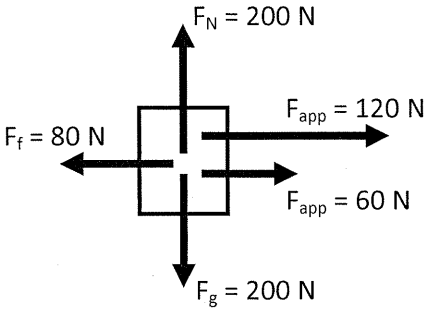
1) For each of the following diagrams determine the magnitude and direction of the net force.

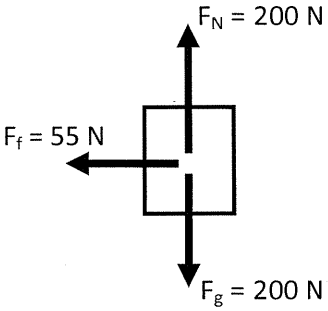




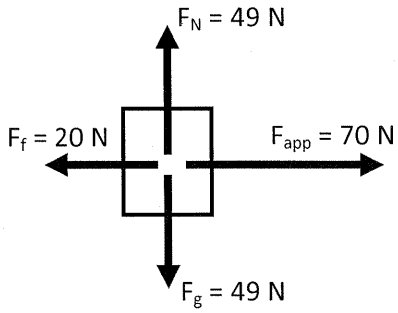






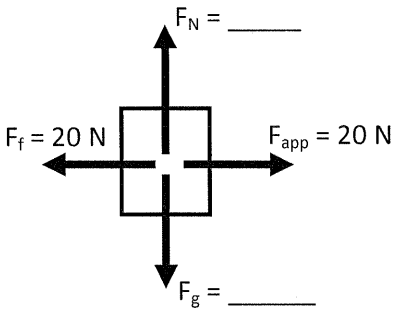


2) Use the information given for each diagram to fill in all missing blanks.



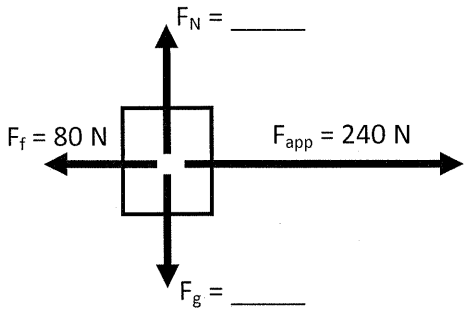
m = 5 kg

a = _____ m/s^2



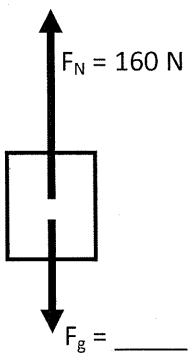
m = 12 kg

a = _____ m/s^2



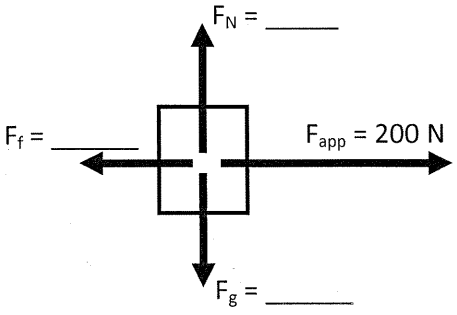
m = _____

a = 4 m/s^2 right



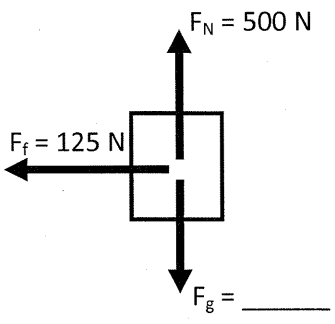
m = 8 kg

a = _____ m/s^2



m = 40 kg

a = 4 m/s^2 right



m = _____

a = _____ m/s^2

PHYSICS 11 FORCES & NEWTON'S LAWS WORKSHEET 1

1. Phoebe Physics pulls a wagon with a force of 80 N.
   a) What is the net force if the force of friction between the wagon and the ground is 12 N?
   b) If she uses 80 N to pull the wagon through a mud puddle, and the net force on the wagon is 38 N, what friction force acts on the wagon?

2. How much force is required to keep a 780 N box moving at <u>constant</u> velocity across the floor if the friction force between the box and the floor is 160 N?

3. A rocket weighs 2.0×10^7 N. Its engines exert 2.5×10^7 N of force at lift-off. What is the net force applied to the rocket?

4. Two children having a disagreement pull on a sled in opposite directions. One pulls with a force of 200 N east, the other with a force of 175 N west. A friction force of 10 N exists between the sled and the surface. Determine the net force on the sled.

5. A heavy wagon is pulled along the sidewalk by a force of 12 N, with a 10 N force opposing the motion. The force of gravity on the wagon is 20 N.
   a) Draw a f.b. diagram showing <u>all</u> the forces acting on the wagon.
   b) Determine the net force on the wagon.

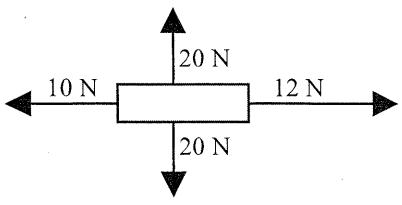
6. A 400 N force pulls due north on a crate. What other force must act on the crate if:
   a) the net force on the crate is 386 N due south?
   b) the net force on the crate is 152 N due north?

7. Hayley Davidson is riding her motorbike south along a flat, horizontal road. The total weight of Hayley and her hog is 1800 N. The engine exerts a 600 N force forward. The air resistance acting on Hayley and the bike is 200 N. The total friction between the tires and the road is 100 N.
   a) Draw a f.b. diagram for the system that includes Hayley and her motorbike.
   b) Calculate the net force on the system.

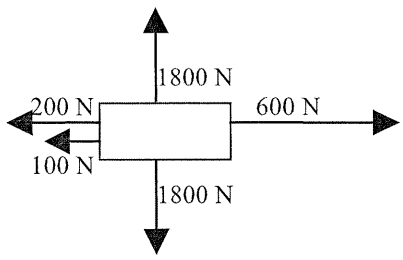
8. A textbook sitting on a table weighs 3.6 N. If you push straight down on the book with a force of 8.4 N, what is the normal force acting on the book?

1. a) 68 N b) 22 N 2. 160 N 3. 5.0×10^6 N 4. 15 N east 5 a) see below b) 2 N 6. a) 786 N south b) 248 N south 7. a) see below b) 300 N 8. 12 N up

5 a)



7 a)



PHYSICS & ENGINEERING 11 FORCES & NEWTON'S LAWS WORKSHEET 2

1. Determine the mass of the following:
   a) a 30.0 N cat. b) a 75.0 N dog.

2. What is the weight of a 750 kg Volkswagen:
   a) on the Earth's surface?
   b) on Mars, where g = 3.3 N/kg?

3. If a net force of 6.0 N acts on a 4.0 kg mass, what is its acceleration?

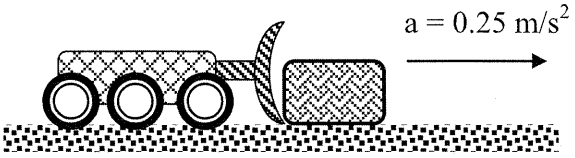
4. Referring to worksheet 1 of this section, determine the following:
   a) from question 1: i) the mass of the 20 N wagon.
      ii) the acceleration of the wagon.
   b) from question 2: i) the mass of Hayley + motorcycle.
      ii) the acceleration of bike and rider.

5. What is the net force acting on a car moving at a constant velocity of 55 km/h?

6. A model rocket weighs 4.5 N. Its engine exerts an upward thrust of 13.1 N at lift-off.
   a) What is the mass of the rocket?
   b) What is the acceleration of the rocket at lift-off?

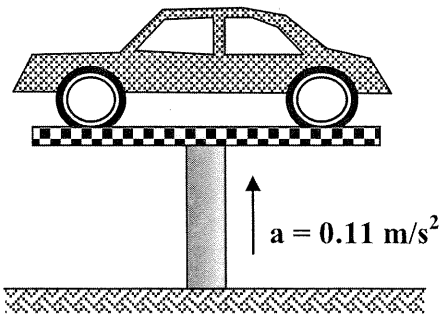
7. An elevator of mass 890 kg has an upward force of 1.10×10^4 N applied to it. Determine the following:
   a) the net force on the elevator.
   b) the acceleration of the elevator.

8. In a competition, a small robot accelerates forward at 0.25 m/s^2 as it pushes a wood block of mass 1.6 kg towards a basket. A friction force of 3.7 N exists between the block and floor.



   a) What is the net force acting on the block?
   b) What force is the robot applying to accelerate the block?

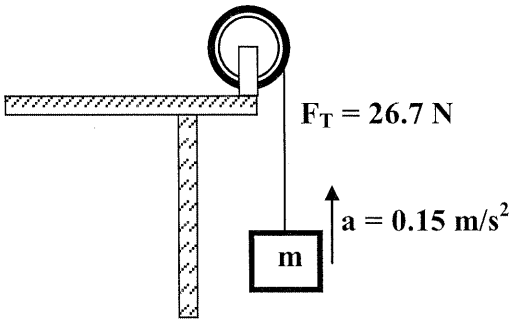
9. A hoist is used to lift a 780 kg car upward with an acceleration of 0.110 m/s^2.



   a) What is the net force acting on the car?
   b) What force was used to lift the car?

10. (Challenge) In an experiment, an electric motor is used to pull an unknown mass '**m**' directly upward. By repeating the experiment, students measure the average tension on the cable as 16.7 N, and an upward acceleration of the mass as 0.40 m/s^2.

    What is the magnitude of mass '**m**'?



1. a) 3.1 kg b) 7.7 kg 2. a) 7350 N b) 2480 N 3. 1.5 m/s^2 4. a) i) 2.04 kg ii) 0.98 m/s^2 b) i) 184 kg ii) 1.63 m/s^2
5. zero N 6. a) 0.46 kg b) 19 m/s^2 7. a) 2.23 x 10^3 N b) 2.56 m/s^2 8. a) 0.4 N b) 4.1 N 9. a) 86 N b) 7.73 x 10^3 N
10. 1.6 kg (NOT 1.7 kg!)

PHYSICS 11 FORCES & NEWTON'S LAWS WORKSHEET 3

1. A 2.5 kg block has a force of sliding friction between it and a level surface of 3.5 N. This block is pulled by an applied force of 14 N.
   a) Find the coefficient of sliding friction between block and surface.
   b) What is the unbalanced force as the block is moved?
   c) What is the acceleration of the block?

2. A 15 kg mass is accelerated at 2.0 m/s^2 along a horizontal table.
   a) What net force is acting on this mass?
   b) A friction force of 7.0 N acts on the mass above. What is the coefficient of sliding friction between mass and table?
   c) Given the friction force in b), what applied force is needed to accelerate this mass at 2.0 m/s^2?

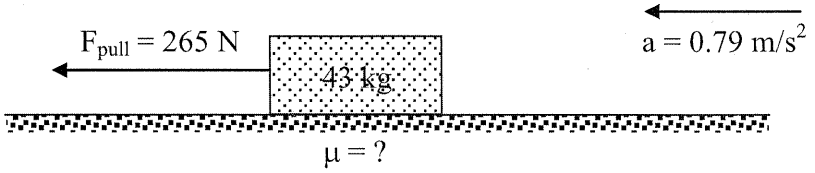
3. What is the coefficient of sliding friction if a force of 400 N is required to pull a 55 kg crate on a horizontal warehouse floor at constant speed?

4. A force of 10 N is used to pull a 2.3 kg block along a horizontal surface with a coefficient of friction of 0.25.
   a) Find the unbalanced force. b) Find the acceleration.

5. A 6.0 kg mass is pulled along a horizontal surface where the coefficient of friction is 0.20.
   a) What is the friction force acting on the mass?
   b) What force is needed to accelerate it at 0.68 m/s^2?

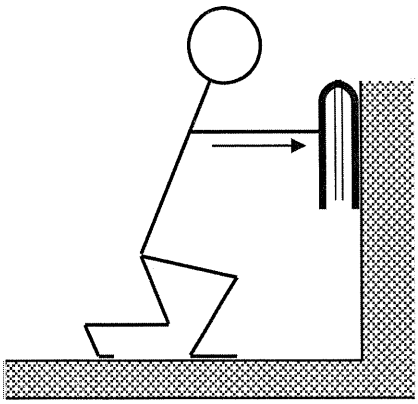
6. A 15 kg box is given an initial push so that it slides across the floor and comes to a stop. If the coefficient of friction is 0.30,
   a) find the friction force.
   b) find the acceleration of the box.
   c) how far will the box go if its initial speed is 3.0 m/s?

7. From the information given in the diagram below, find the coefficient of friction between the 43 kg box and the surface on which it is pulled. Note that the box is accelerating at 0.79 m/s^2.



8. A 140 kg stationary crate is pulled by a force of 390 N along a horizontal surface.
   a) The coefficient of static friction between crate and surface is $\mu_s = 0.25$. Is the applied force large enough to begin moving the crate? Use physics calculations to prove that it is.
   b) The coefficient of sliding friction between crate and surface is $\mu_k = 0.17$. Find the net force and the acceleration of the crate once it does move.
   c) If the acceleration occurs for 2.80 s, how far will the box move in this time?

9. A student pushes horizontally on a textbook of mass 0.250 kg and holds it stationary against the classroom wall.

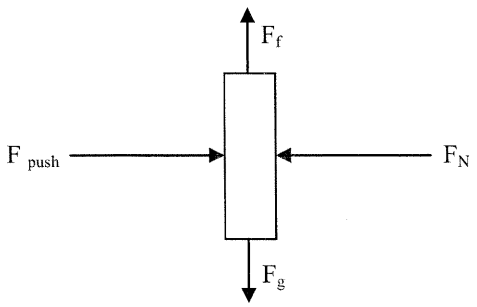


   a) Draw a free body diagram showing all the forces acting on the textbook.
   b) From your diagram, what is the friction force that holds the text in place?
   c) The coefficient of static friction between book and surface is 0.190. Use this and your f.b. diagram to determine the minimum force needed to hold the textbook in place.
   Note: in this case, use the standard formula for friction: $F_f = \mu F_N$

10. Given $\mu = 0.6$ for wet asphalt, $\mu = 0.006$ for ice, answer the following:
   a) On a rainy day, what is the maximum force that a wheelchair athlete, starting from rest, can apply to her tires to begin a road (asphalt) race without spinning out? Assume a total mass for athlete and chair of 80.0 kg.
   b) How would the answer to (a) change if the temperature outside was -5° C?

1. a) $\mu = 0.14$ b) 10.5 N c) 4.2 m/s^2 2. a) 30 N b) $\mu = 0.048$ c) 37 N 3. 0.74 4. a) 4.4 N b) 1.9 m/s^2
5. a) 12 N b) 16 N 6. a) 44 N b) 2.9 m/s^2 c) 1.5 m 7. $\mu = 0.55$ 8. a) static $F_f = 343$ N, less than 390 N, so yes
b) $F_{Net} = 157$ N, a = 1.12 m/s^2 c) 4.39 m 9. a) see below b) 2.45 N c) 12.9 N 10. a) 470 N b) 4.7 N

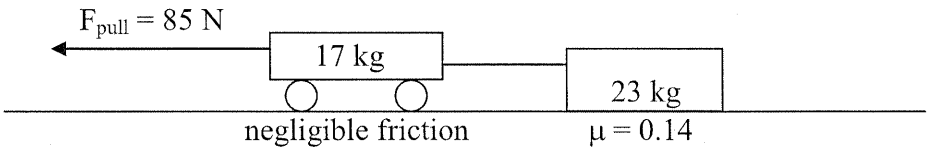
9a)



PHYSICS 11 FORCES & NEWTON'S LAWS WORKSHEET 4

1. Two boxes of mass 12 kg and 10 kg are resting on a frictionless surface and connected by a lightweight cord. The 12 kg mass is pulled by a force of 40 N. Calculate the acceleration of the system.

2. Find the acceleration of the system below:



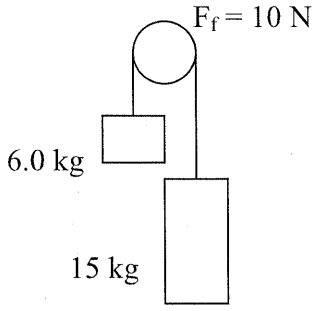
3. Three small children of mass 20.0, 24.0 and 16.0 kg hold hands and are pulled across a frozen pond (assume no friction) by a larger Physics 11 student who is on skates (physics students always help out those in need). The student pulls on rope attached to the 20.0 kg child with a force of 135 N. Calculate the acceleration of the group.

4. Three children argue over a 15 kg wagon, and a tug-of war breaks out. The largest child pulls on one side with a force of 35 N, while the other two pull from the other side <u>each</u> with a force of 30 N. If $\mu = 0.12$ between wagon and ground, determine the resultant acceleration.

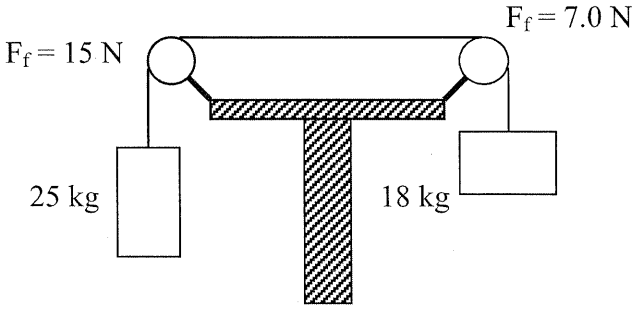
5. Can an applied force of 400 N move a 75 kg object sitting on a surface with $\mu_s = 1.2$? Explain your answer.

6. Calculate the acceleration of the following systems:

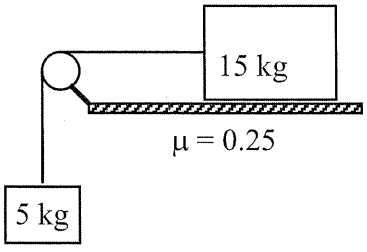
a)



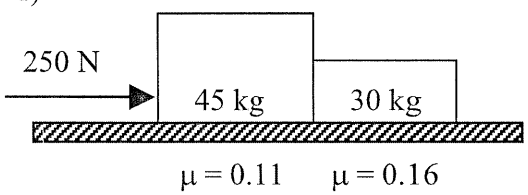
b)



c)



d)



1. 1.8 m/s^2 2. 1.3 m/s^2 3. 2.3 m/s^2 4. 0.49 m/s^2 in direction of two smaller kids 5. no; needs to overcome a friction force of 882 N 6. a) 3.72 m/s^2 b) 1.08 m/s^2 c) 0.61 m/s^2 d) 2.06 m/s^2

F_{net} Applications Worksheet

1) A 1250 kg car is traveling at a speed of 50.0 km/h when it needs to stop suddenly. The brakes can exert a maximum force on the tires which is equal to the friction force between the tires and the road. If the brakes apply any more force than this, the tires will start to skid. How far does it travel while stopping, under the following conditions?

a. On a dry road (rubber on asphalt, $\mu = 0.83$)
b. On a wet road (rubber on wet asphalt, $\mu = 0.53$)
c. On an icy road (rubber on ice, $\mu = 0.22$)
d. Skidding on an icy road (sliding rubber on icy road, $\mu = 0.15$)

HINTS:
- Find out the max F_f it can exert without slipping
- From this determine the max deceleration it can have
- Finally, use kinematics to find the displacement…

2) While riding the Coaster at Playland (you know that rickety looking wooden one that looks like it might collapse at any moment…) a 75.0 kg physics student seems to feel much **heavier** sometimes and much *lighter* at others. Calculate their apparent weight when:

a. traveling at a constant velocity to the top of the 1st hill.
b. at the bottom of a hill they accelerate upwards at 7.26 m/s^2.
c. at the top of a hill they accelerate downwards at 6.54 m/s^2.

3) Tides in the Earth's oceans are caused by gravitational attraction of the water to the moon and the sun. When the moon and sun are aligned on the same side of the Earth we notice an especially large tide called spring tide.

a. Calculate the acceleration due to gravity of the water caused by the moon and sun.
b. Which is the larger contributor to tidal action, the sun or the moon? Determine what percentage of the acceleration is provided by each.

$d_{Earth\text{-}moon} = 3.85 \times 10^8$ m; $d_{Earth\text{-}Sun} = 1.50 \times 10^{11}$ m;
$m_{moon} = 7.35 \times 10^{22}$ kg; $m_{sun} = 1.99 \times 10^{30}$ kg