RLP-PHYA · RLP Physics A — Motion, Forces, Momentum and Gravitation

Unit 2: Forces and Newton's Laws

Practice Workbook. The same problems, in the same order, as the Practice sections of the online lessons.

Name _____ Period _____

Lesson 2.1 — Runaway Trucks on I-70: Forces, Free-Body Diagrams and Newton's Laws

FLUENCY

1. A net force of 6 N acts on a 2 kg object. What is its acceleration?

2. A net force of 1.0 N gives an object an acceleration of 2 m/s^2. What is its mass?

3. A net force of 15 N gives an object an acceleration of 3 m/s^2. What is its mass?

4. A 20 kg box is pushed with 107 N to the right against 17 N of friction. Find the net force and the acceleration.

5. A 12 kg box rests on the floor while you push straight down on it with 30 N. What is the normal force on the box?

6. A 70 kg astronaut weighs how much on Earth and on Mars ($g = 3.71\ m/s^2$, NASA Mars fact sheet)? What is the astronaut's mass on Mars?

APPLICATION

7. A 40 kg crate is pulled right with 150 N while friction pushes left with 90 N. Draw the free-body diagram in words and find the acceleration.

8. A 30,000 kg truck coasts down a 7% grade with no braking. Ignoring drag, find its acceleration and the braking force needed to hold a steady speed.

9. Two skaters (50 kg and 70 kg) stand still on ice and push apart with a 140 N force. Find each skater's acceleration and explain why they differ.

CHALLENGE

10. A 25 kg sled is pulled with 80 N along a rope at 30° above horizontal against 40 N of kinetic friction. Find the acceleration and the normal force.

REVIEW

11. A car moving at 2 m/s speeds up at 3 m/s^2 for 9 s. What is its final speed?

12. A car moving at 13 m/s speeds up at 2 m/s^2 for 4 s. What is its final speed?

13. Resolve a 50 N force at 25° above horizontal into components.

Lesson 2.2 — Cart Lab: Testing Newton's Second Law with Data

FLUENCY

1. A net force of 18.0 N gives an object an acceleration of 1.5 m/s^2. What is its mass?

2. What net force gives a 1.2 kg object an acceleration of 4.5 m/s^2?

3. A 4 kg box is pushed with 37 N to the right against 18 N of friction. Find the net force and the acceleration.

4. An object starts at 3 m/s and accelerates at 3 m/s^2 for 8 s. How far does it travel?

5. An object starts at 3 m/s and accelerates at 1 m/s^2 for 7 s. How far does it travel?

6. A cart starts from rest and covers 0.90 m in 1.40 s. What is its acceleration?

7. An a-versus-F graph has slope 1.60 kg^{-1}. What mass was accelerated?

APPLICATION

8. A 30 g hanger pulls a cart; the total system mass is 0.80 kg and friction is negligible. Find the acceleration and the tension in the string.

9. A student's a-versus-F line crosses the force axis at 0.05 N instead of the origin. Explain what this intercept means and how to correct the net force.

10. Why must the slotted masses move from the cart to the hanger, rather than being added from a separate pile, when testing $a \propto F$?

CHALLENGE

11. Six trials give (F in N, a in m/s^2): (0.10, 0.15), (0.20, 0.35), (0.30, 0.52), (0.40, 0.71), (0.50, 0.90), (0.60, 1.08). Find the least-squares slope and intercept, then the mass and friction force.

REVIEW

12. An object is dropped from rest 1.2 m above the ground. Ignoring air resistance ($g = 9.8\ m/s^2$), how long does it fall and how fast is it moving at impact?

13. An object is dropped from rest 45 m above the ground. Ignoring air resistance ($g = 9.8\ m/s^2$), how long does it fall and how fast is it moving at impact?

Lesson 2.3 — Does Area Matter? Arguing About Friction from Data

FLUENCY

1. A net force of 18.0 N acts on a 12 kg object. What is its acceleration?

2. What net force gives a 0.5 kg object an acceleration of 3 m/s^2?

3. A net force of 0.75 N acts on a 0.5 kg object. What is its acceleration?

4. A 35 kg dresser has $\mu_s = 0.45$ and $\mu_k = 0.30$ on the floor. What push starts it moving, and what friction acts once it slides?

5. A 6.0 kg block slides at constant speed when pulled with 18 N horizontally. Find μ_k.

6. Once the dresser above is sliding, you push with 200 N. What is its acceleration?

APPLICATION

7. A car at 27 m/s brakes as hard as possible. Compare stopping distances on dry pavement ($\mu = 0.75$) and wet ($\mu = 0.45$), illustrative values.

8. Investigators measure 45 m skid marks from a car whose driver claims to have been going 27 m/s. What effective μ would that require, and is it plausible for dry pavement?

9. A friend claims doubling the load on a block doubles its coefficient of friction. Use the model $f = \mu F_N$ to respond.

CHALLENGE

10. You push a 20 kg box with 100 N directed 30° below horizontal; $\mu_k = 0.30$. Find the normal force and the acceleration. Why is pushing down less effective than pulling up?

REVIEW

11. An object starts at 3 m/s and accelerates at 3 m/s^2 for 8 s. How far does it travel?

12. An object starts at 3 m/s and accelerates at 1.5 m/s^2 for 7 s. How far does it travel?

Lesson 2.4 — Inclines, Pulleys and Elevators: Modeling with Newton's Second Law

FLUENCY

1. In a right triangle, an acute angle is 30° and the hypotenuse is 19. Find the side opposite the angle. Round to the nearest tenth.

2. In a right triangle, an acute angle is 30° and the adjacent leg is 33. Find the opposite leg. Round to the nearest tenth.

3. A 10 kg box is pushed with 25 N to the right against 5 N of friction. Find the net force and the acceleration.

4. A 4 kg box is pushed with 60 N to the right against 19 N of friction. Find the net force and the acceleration.

5. A 15 kg box sits on a 20° incline. Find the components of its weight parallel and perpendicular to the incline.

6. The same box slides down with $\mu_k = 0.20$. What is its acceleration?

7. A 55 kg student rides an elevator that accelerates downward at 2.0 m/s^2. What does a scale under the student read in newtons?

APPLICATION

8. An Atwood machine holds 5.0 kg and 3.0 kg. Find the acceleration and the string tension.

9. An escape ramp has an 8% upgrade and gravel with effective $\mu = 0.30$ (illustrative). A truck enters at 28 m/s. Find the deceleration and the stopping length.

10. Explain why the escape-ramp length does not depend on the truck's mass in the model $a = g(\sin\theta + \mu\cos\theta)$.

CHALLENGE

11. A 2.0 kg block on a table ($\mu_k = 0.25$) is tied over a pulley to a hanging 1.0 kg mass. Find the acceleration and the tension.

REVIEW

12. A car moving at 4 m/s speeds up at 4 m/s^2 for 7 s. What is its final speed?

13. A car moving at 2 m/s speeds up at 4 m/s^2 for 3 s. What is its final speed?

Unit 2 checkpoint

1. Which pair is a Newton's third-law pair?
   A. Earth pulls a book down; the table pushes the book up
   B. Earth pulls a book down; the book pulls Earth up
   C. A push on a box; friction on the box
   D. Tension up on a lamp; weight of the lamp
2. A net force of 36 N acts on a 12 kg cart. Its acceleration is _____ m/s².
3. True or false: An object moving at constant velocity must have zero net force on it.
4. A cart's a-versus-F graph has slope 2.0 kg^{−1}. What mass was accelerated?
   A. 2.0 kg
   B. 0.50 kg
   C. 4.0 kg
   D. 0.25 kg
5. A 10 kg crate with μ_s = 0.40 stays at rest until the push exceeds _____ N.

6. True or false: Kinetic friction on a sliding block roughly doubles if the block's contact area doubles at the same load.

7. On a 30° frictionless incline, what is a sliding block's acceleration?
   A. 9.8 m/s²
   B. 4.9 m/s²
   C. 8.5 m/s²
   D. 0 m/s²

8. A 60 kg person in an elevator accelerating up at 2.0 m/s² reads _____ N on a scale.

9. The string tension on a cart pulled by a falling hanger is
   A. equal to the hanger's weight
   B. less than the hanger's weight
   C. greater than the hanger's weight
   D. zero

10. True or false: A truck entering an escape ramp at twice the speed needs twice the ramp length.

11. Which best breaks an escape-ramp design into sub-problems (HS-ETS1-2)?
    A. Choose a paint color
    B. Design speed; deceleration from grade and bed; length with safety factor; site constraints
    C. Ask one driver
    D. Use the longest ramp possible

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