PHYSA-CA · Physics A — Motion, Forces, Momentum and Gravitation (California)

Unit 1: Motion in One and Two Dimensions

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

Name _____ Period _____

Lesson 1.1 — Can the Car Stop? Position, Velocity and Motion Graphs

FLUENCY

1. Convert 25 m/s to km/h.

2. Convert 25 °C to kelvin.

3. Convert 100 g to kg.

4. You walk 450 m east to a bus stop in 6 min, then 150 m back west to a café in 3 min. Find your total distance, your displacement, your average speed and your average velocity in m/s.

5. On a position-time graph, a cyclist is at 20 m at t = 2 s and at 68 m at t = 8 s, on a straight line. What is the cyclist's velocity?

6. A car's velocity-time graph rises in a straight line from 0 to 10 m/s in 5 s, stays at 10 m/s for 10 s, then falls in a straight line to 0 in 4 s. Find the acceleration in each stage and the total displacement.

APPLICATION

7. A school bus drives at 35 mph. Convert to m/s, then find how far it travels in the 1.5 s a driver takes to react.

8. For the three-stage trip in the Fluency problem, what is the average velocity over the whole 19 s, and why is it less than 10 m/s?

9. A ball is thrown straight up. At the top of its path, what are its velocity and its acceleration? Explain.

CHALLENGE

10. Car A passes a stopped car B at a constant 12 m/s. At that instant B starts from rest with acceleration 2.0 m/s^2. When and where does B catch A?

REVIEW

11. Solve: $6x + 10 = 16$

12. Solve: $7x - 7 = 42$

13. Find the slope of the line through (1, 9) and (−4, −7).

Lesson 1.2 — Ramp Lab: Measuring Acceleration Frame by Frame

FLUENCY

1. An object starts at 0 m/s and accelerates at 1.5 m/s^2 for 11 s. How far does it travel?

2. An object starts at 11 m/s and accelerates at 1.5 m/s^2 for 10 s. How far does it travel?

3. An object starts at 8 m/s and accelerates at 3 m/s^2 for 12 s. How far does it travel?

4. A phone films at 30 frames per second. A cart released at frame 0 crosses a mark 0.30 m down the ramp at frame 21. Find the time and, assuming constant acceleration from rest, the acceleration.

5. A graph of x against t^2 for a cart released from rest has slope 0.26 m/s^2. What is the acceleration?

6. A ramp is 1.60 m long and raised 0.20 m at one end. What acceleration does the frictionless model $g \sin \theta$ predict?

APPLICATION

7. For the ramp above, the measured acceleration was 0.52 m/s^2. Find the percent difference from the model and say whether friction explains the direction of the difference.

8. A mark is crossed after about 0.90 s, timed by video at 30 fps with ±1 frame uncertainty. What is the percent uncertainty in the time, and roughly what is it in an acceleration computed from $2x/t^2$?

9. From rest with constant acceleration, a cart covers 0.10 m in the first 0.50 s. How far does it travel from rest in 1.00 s and in 1.50 s?

CHALLENGE

10. A student measures $a = 0.66\ m/s^2$ on a 2.00 m ramp. What height h of the raised end would make the frictionless model give exactly this value, and what does it mean if the actual height is 0.15 m?

REVIEW

11. Find the slope of the line through (6, 4) and (−7, −2).

12. Find the slope of the line through $(-5, -3)$ and $(5, 6)$.

13. Solve $x = \frac{1}{2}at^2$ for t, then find t when $x = 1.2$ m and $a = 0.60$ m/s^2.

Lesson 1.3 — Reaction Time or Braking Distance? Arguing from the Equations

FLUENCY

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

2. A car moving at 3 m/s speeds up at 1.5 m/s^2 for 10 s. What is its final speed?

3. A car moving at 5 m/s speeds up at 1.5 m/s^2 for 9 s. What is its final speed?

4. An object is dropped from rest 20 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?

5. 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?

6. A car at 30 mph (13.4 m/s) must stop. Reaction time 1.5 s, braking 7.0 m/s^2. Find the reaction, braking and total stopping distances.

7. A ruler dropped between your fingers is caught after falling 18 cm. What is your reaction time?

APPLICATION

8. Repeat the 30 mph stop on wet pavement where braking is only 4.5 m/s^2. By how much does the stopping distance grow?

9. A driver at 65 mph looks at a phone for 2.0 s. How far does the car travel blind?

10. With t_r = 1.5 s and a = 7.0 m/s^2, at what speed are reaction distance and braking distance equal? Use it to support or rebut: "At 25 mph, better brakes matter more than attention."

CHALLENGE

11. A driver can see a crosswalk 30 m ahead. With a 1.0 s reaction time and 6.0 m/s^2 braking, what is the highest speed at which the car can stop in time?

REVIEW

12. Solve: $x^2 - 14x + 45 = 0$

13. Solve: $x^2 - 2x - 24 = 0$

Lesson 1.4 — Vectors and Projectiles: Predicting Where It Lands

FLUENCY

1. In a right triangle, an acute angle is 32° and the adjacent leg is 13. Find the opposite leg. Round to the nearest tenth.

2. In a right triangle, an acute angle is 63° and the hypotenuse is 36. Find the side adjacent to the angle. Round to the nearest tenth.

3. A soccer ball is kicked at 15 m/s, 35° above the horizontal. Find its horizontal and vertical velocity components.

4. A marble rolls off a 1.25 m high counter at 2.0 m/s. How long is it in the air and how far from the counter does it land?

5. A ball is launched at 20 m/s at 30° on level ground. Find the flight time, range and maximum height.

APPLICATION

6. A firefighting air tanker flying level at 60 m/s, 45 m above the ground, releases retardant (ignore air resistance, which in reality is large). How far before the target must it release?

7. A kayaker paddles straight across an 80 m river at 4.0 m/s relative to the water, and the current flows at 3.0 m/s. Find the kayak's speed relative to the bank, its direction, the crossing time and the downstream drift.

8. Two balls leave a table at the same moment: one rolls off at 3 m/s, the other drops straight down. Which hits the floor first? Justify with the model.

CHALLENGE

9. A ball leaves a player's hand 1.8 m above flat ground at 12 m/s, 40° above horizontal. How far away does it land?

REVIEW

10. An object starts at 1 m/s and accelerates at 2 m/s^2 for 6 s. How far does it travel?

11. An object starts at 9 m/s and accelerates at 1 m/s^2 for 4 s. How far does it travel?

12. A right triangle has hypotenuse 20 and the leg opposite angle A is 5. Find angle A. Round to the nearest tenth of a degree.

Unit 1 checkpoint

1. On a velocity-time graph, what does the area between the line and the time axis give?
   A. Acceleration
   B. Displacement
   C. Position at the end
   D. Average speed

2. A car's velocity falls from 20 m/s to 8 m/s in 3.0 s. What is its acceleration?
   A. 4.0 m/s²
   B. −4.0 m/s²
   C. −9.3 m/s²
   D. 9.3 m/s²

3. A graph of x against t² for a cart starting from rest has slope 0.35 m/s², so a = _____ m/s².

4. True or false: Doubling a car's speed doubles its braking distance.

5. At 20 m/s with a 1.5 s reaction time and 5.0 m/s² braking, the stopping distance is _____ m.

6. Which equation follows from eliminating time from v = v₀ + at and Δx = v₀t + ½at²?
   A. v = Δx/t
   B. v² = v₀² + 2aΔx
   C. Δx = vt
   D. a = v/t²

7. A velocity of 25 m/s at 53° above horizontal has v_x = _____ m/s and v_y = _____ m/s.

8. True or false: At the highest point of a projectile's path, its velocity is zero.

9. Without air resistance, which launch angle gives the same range as 25° at the same speed?
   A. 50°
   B. 65°
   C. 75°
   D. 45°

10. A ball rolls off a 0.80 m table at 1.5 m/s. It lands _____ m from the table's base.

11. In a video lab at 30 fps, why is the time to the farthest mark the most reliable?
    A. The cart is slowest there
    B. A ±1 frame error is a smaller fraction of a longer time
    C. Friction is zero there
    D. The camera focuses better

12. True or false: In a yellow-light design report, the federal 3-6 s range is a constraint, not a criterion.