

# PHYSICS – problem solving exercises

## 1. Kinematics: one-dimensional motion

**Notes:** magnitude of free fall acceleration  $g = 10 \text{ m/s}^2$ , air friction is neglected in all cases

### **Problem 1:**

During a hard sneeze, your eyes might shut for 0.50 s. If you are driving a car at 90 km/h during such a sneeze, how far does the car move during that time?

### **Problem 2:**

An automobile travels on a straight road for 40 km at 30 km/h. It then continues in the same direction for another 40 km at 60 km/h.

(a) What is the average velocity of the car during the full 80 km trip? (Assume that it moves in the positive  $x$  direction.)

(b) What is the average speed?

### **Problem 3:**

An automobile travels on a straight road for 40 km at 30 km/h. It then continues in the *opposite* direction for another 40 km at 60 km/h.

(a) What is the average velocity of the car during the full 80 km trip?

(b) What is the average speed?

**Problem 4:**

A speed of a bullet fired from the 1.2 m long gun barrel is 640 m/s. How long is the bullet accelerated in the barrel? (Assume motion with constant acceleration).

**Problem 5:**

A car accelerates from rest with a constant acceleration for 0.5 minutes. It travels 150 m during this time. What is its velocity now?

**Problem 6:**

A jet plane takeoff speed must be at least 360 km/h. What is a minimal constant acceleration for takeoff using the 1.8 km long runway?

**Problem 7:**

A car starts to decelerate from an initial velocity of +20 m/s and stops after 4 s. What is its acceleration (magnitude and direction)?

**Problem 8:**

A car uniformly accelerates from rest with an acceleration of 5 m/s<sup>2</sup>. What is its velocity after traveling to a distance of 90 m from the starting point?

**Problem 9:**

A uniformly accelerating car ( $a = 6 \text{ m/s}^2$ ) increased its velocity to 35 m/s in time of 4 s. What was its initial velocity?

**Problem 10:**

A car accelerates from rest with a uniform acceleration. After traveling a distance of 160 m its velocity is 26 m/s. What is its acceleration?

**Problem 11:**

A jet plane lands with a speed of 100 m/s and can accelerate at a maximum rate of  $-5 \text{ m/s}^2$  as it comes to rest. Can this plane land at a small airport where the runway is 0.8 km long?

**Problem 12:**

A landing jet plane stops after 1 min at the end of a 2.4 km long runway. What was its initial speed before landing?

**Problem 13:**

A construction site a pipe wrench struck the ground with a speed of 24 m/s.

- (a) From what height was it inadvertently dropped?
- (b) How long was it falling?

**Problem 14:**

A stone is thrown upwards from Earth's surface with an initial velocity of 18 m/s. What is the maximal height reached by the stone?

**Problem 15:**

A ball was dropped from a top of a building. Its impact speed was 14 m/s.

- (a) How long did it fall?
- (b) How high is the building?

**Problem 16:**

A freely falling ball of 0.5 kg mass reaches the ground at time 1.5 s. From what height was it dropped?

**Problem 17:**

A stone is thrown upwards from a ground with an initial velocity of 20 m/s.

- (a) When does it get to the maximal height?
- (b) What is its final speed at impact?

**Problem 18:**

A stone was thrown downwards from a height of 30 m and reached the ground after 2 s. What was its initial speed?

**Problem 19:**

A rock is thrown vertically upward from ground level at time  $t = 0$ . At  $t = 1.5$  s it passes the top of a tall tower, and 1.0 s later it reaches its maximum height. What is the height of the tower?

**Problem 20:**

A car traveling 56.0 km/h is 24.0 m from a barrier when the driver slams on the brakes. The car hits the barrier 2.00 s later.

- (a) What is the magnitude of the car's constant acceleration before impact?
- (b) How fast is the car traveling at impact?

**Problem 21:**

A hoodlum throws a stone vertically downward with an initial speed of 12.0 m/s from the roof of a building, 30.0 m above the ground.

- (a) How long does it take the stone to reach the ground?
- (b) What is the speed of the stone at impact?