

Equations of motion for constant acceleration

Physics grades 11-12 (A Level · IB · Class 11-12) · Worksheet

Name: _____ Date: _____ Class: _____

These problems train you to choose the right equation of motion, apply sign conventions and read velocity-time graphs. They move from single-step substitutions to free fall, stopping distances, data analysis and two-body chase problems.

They are written for A Level, IB Physics and CBSE Class 11-12 students. Work from level 1 to level 3, write the known variables first and always include units.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** A Level 3.4, IB A.1

Problem 1 Choose the equation (easy)

For each situation, name the suvat equation that contains the three known variables and the one wanted variable.

1. Known: u , a , t . Wanted: s .
2. Known: u , v , s . Wanted: a .
3. Known: u , v , t . Wanted: s .
4. Known: u , a , t . Wanted: v .

Problem 2 Tram departure (easy)

A tram in Singapore starts from rest and accelerates uniformly at 1.2 m/s^2 for 15 s.

1. Calculate its final speed in m/s.
2. Convert the speed to km/h.

Problem 3 Cyclist speeding up (easy)

Wanjiru in Nairobi cycles from 4.0 m/s to 10.0 m/s in 12 s.

1. Calculate her acceleration.
2. Calculate the distance she covers.

Problem 4 Falling mango (easy)

A ripe mango falls from a branch 5.0 m above the ground in a garden in Lagos. Ignore air resistance.

1. Calculate the time to reach the ground.
2. Calculate its speed on impact.

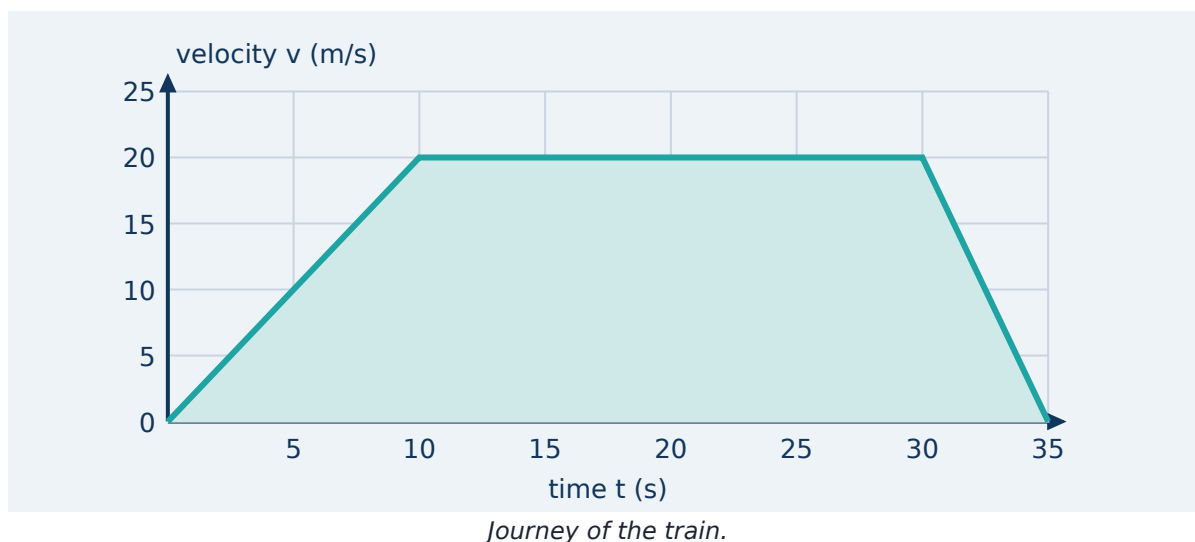
Problem 5 Emergency stop (easy)

A car travels at 90 km/h and the driver brakes steadily to rest in 6.0 s.

1. Convert 90 km/h to m/s.
2. Calculate the acceleration.
3. Calculate the braking distance.

Problem 6 Train journey graph (easy)

The figure shows the velocity-time graph of a train between two stations.



1. Calculate the acceleration during the first 10 s.
2. Calculate the total distance travelled.
3. State the acceleration during the last 5 s.

Problem 7 Stopping distance (medium)

A car travels at 20 m/s. The driver's reaction time is 0.70 s. After that the brakes give a constant deceleration of 6.5 m/s^2 .

1. Calculate the distance travelled during the reaction time.
2. Calculate the braking distance.
3. Calculate the total stopping distance.

Problem 8 Sprint start (medium)

Diego in Texas covers the first 10.0 m of a sprint in 2.20 s from rest, accelerating uniformly.

1. Calculate his acceleration.
2. Calculate his speed after 2.20 s.

Problem 9 Well depth (medium)

Bilal in Lahore drops a pebble into a well and sees the splash after 2.4 s. Ignore the travel

time of sound.

1. Calculate the depth of the water surface.
2. Calculate the speed of the pebble as it hits the water.

Problem 10 Ball thrown down (medium)

Mei throws a ball downwards at 5.0 m/s from a balcony 12 m above the pavement.

1. Calculate its speed when it hits the pavement.
2. Calculate the time of flight.

Problem 11 Tennis ball thrown up (medium)

Aarav in Pune throws a tennis ball vertically upwards at 18 m/s and catches it at the same height.

1. Calculate the maximum height above the release point.
2. Calculate the time to reach the top.
3. Calculate the total time in the air.

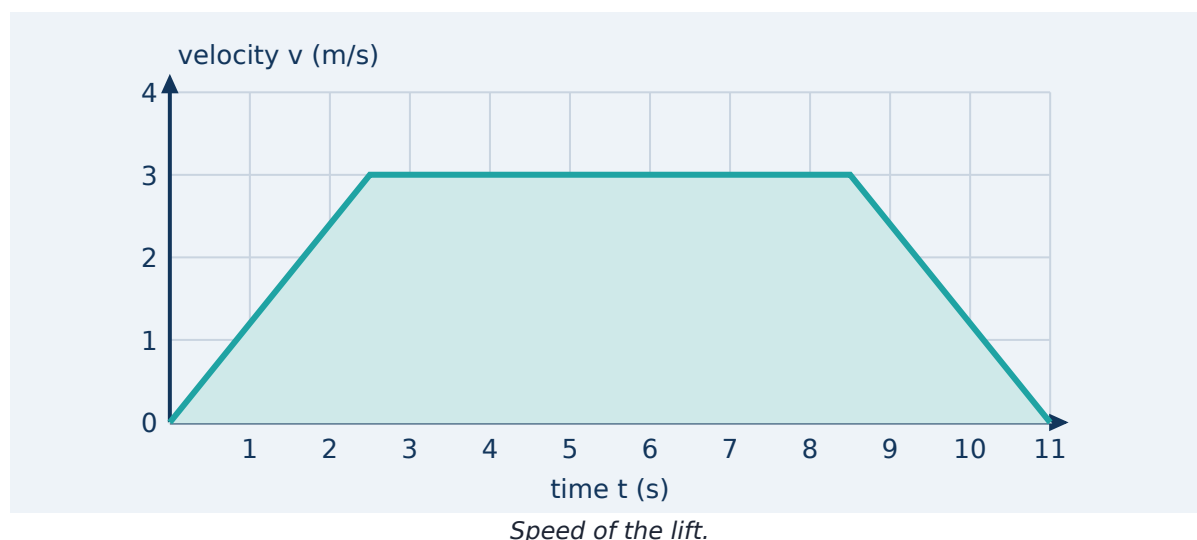
Problem 12 Ruler reaction test (medium)

Chiamaka drops a ruler without warning and Emma catches it after it has fallen 18.0 cm.

1. Convert 18.0 cm to metres.
2. Calculate the time of fall, which is Emma's reaction time.

Problem 13 Lift motion (medium)

A lift in a Kenyan office block moves as shown in the graph.



1. Calculate the acceleration in the first 2.5 s.
2. Calculate the total distance travelled.
3. Calculate the average speed over the whole journey.

Problem 14 Spot the sign error (medium)

A student throws a ball upwards at 10 m/s. To find the velocity after 0.50 s she writes $v = u + at = 10 + 9.81 \times 0.50 = 14.9$ m/s.

1. Explain the mistake.
2. Calculate the correct velocity.

Problem 15 Speeding up over a distance (medium)

A van accelerates uniformly from 8.0 m/s to 20 m/s over a distance of 150 m.

1. Calculate the acceleration.
2. Calculate the time taken.

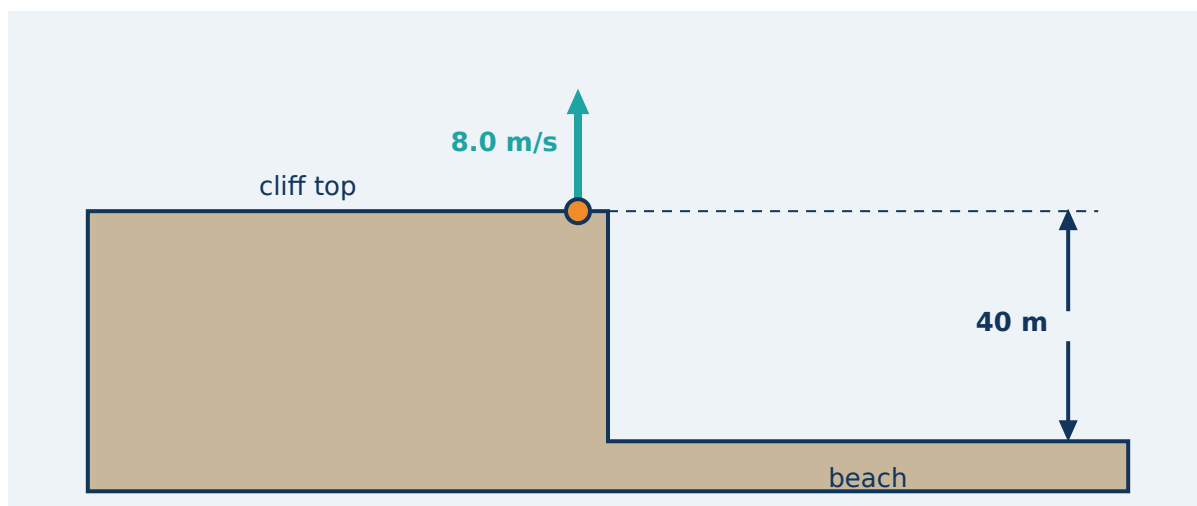
Problem 16 Overtaking (hard)

A car A travels at a constant 18 m/s and passes a stationary car B at a junction. At that moment B accelerates from rest at 3.0 m/s^2 .

1. Write an equation for the displacement of each car after time t .
2. Calculate the time at which B catches A.
3. Calculate the distance from the junction and B's speed at that moment.

Problem 17 Stone from a cliff (hard)

A stone is thrown vertically upwards at 8.0 m/s from the edge of a cliff 40 m above a beach.



Stone thrown up from the cliff edge.

1. Calculate the greatest height above the cliff top.
2. Calculate its speed when it reaches the beach.
3. Calculate the total time of flight.

Problem 18 Trolley data (hard)

Kofi in Accra records the displacement s of a trolley from rest at five times: $t = 0.20, 0.40, 0.60, 0.80$ and 1.00 s give $s = 0.05, 0.20, 0.45, 0.80$ and 1.25 m.

1. Show that s is proportional to t^2 .
2. State what the gradient of a graph of s against t^2 represents.
3. Calculate the acceleration.
4. Predict the displacement at 1.40 s.

Problem 19 Late braking (hard)

A car travels at 30 m/s towards a fallen tree 100 m ahead. The brakes give a constant deceleration of 8.0 m/s².

1. Calculate the braking distance once the brakes are applied.
2. The driver reacts after 0.50 s. State whether the car stops before the tree.
3. The driver reacts after 1.5 s. Calculate the speed at which the car hits the tree.

Problem 20 Chasing stones (hard)

A stone is dropped from a high bridge. Exactly 1.0 s later a second stone is thrown straight down at 15 m/s from the same point.

1. Write equations for the distance fallen by each stone, measured from the release time of the first.
2. Calculate the time after the first release when the second catches up.
3. Calculate how far below the bridge this happens.