# Our Dynamic Universe
Kinematic Equations

1. A car accelerates at 5 ms⁻² from an initial velocity of 13 ms⁻¹ over a distance of 100 m.
   Calculate the velocity at the end of the 100 m.   [34.2ms⁻¹]

2. A Boeing 747 lands with a velocity of 180 ms⁻¹ and decelerates at 6 ms⁻² coming to a halt in 30 seconds.
   Calculate the distance it took for the aircraft to come to a halt.   [2,700m]

3. A cyclist traveling at 8 ms⁻¹ applies her brakes and comes to a stop in a distance of 5 meters.
   Calculate the acceleration of the cyclist.   [-6.4 ms⁻²]

4. A bus accelerates from rest to 20 ms⁻¹ in six seconds. Calculate the distance the bus traveled in this time.   [60.6m]

5. By considering the velocity time graph below show that the displacement, s is given by the equation   s = ut + ½at²
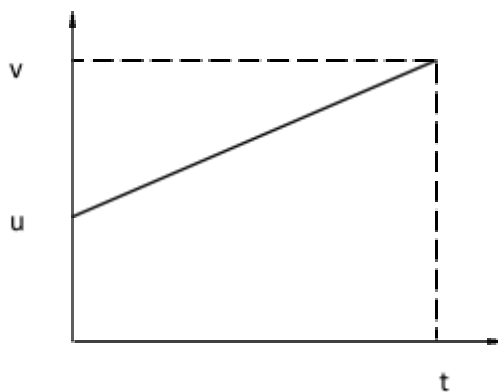
6. Calculate the height that a ball would rise to if it is thrown vertically into the air with a velocity of 5 ms⁻¹   [1.3m]

7. A helicopter hovers above a boat in trouble. A first aid parcel is dropped from the helicopter. The parcel takes 1.5 seconds to land on the boat.
   Calculate the height of the helicopter above the boat.   [11m]

8. A stuntman drops off a high building 20m tall and lands onto cardboard boxes.
   What would be the velocity of the stuntman just as he hits the cardboard boxes?   [19.8ms⁻¹]

9. An angry scaffolder throws her spanner down to the ground with a velocity of 2 ms^{-1} the spanner takes 2 seconds to strike the ground.
   Calculate the height the scaffolder was at when she threw down the spanner.   [23.6m]

10. A helicopter releases a package at a height of 20 m while moving upwards with a velocity of 4 ms^{-1}.
    a. Find the velocity of the package as it hits the ground.   [20.2ms^{-1}]
    b. Calculate the time it took the package to hit the ground.   [1.7s]

11. A hot air balloon is descending with a constant velocity of 3.5 ms^{-1}.
    A sandbag is dropped from the basket and strikes the ground 5 seconds later.
    Find the height at which the sandbag was dropped.   [140m]

12. An experimental rocket is launched vertically with a velocity of 5ms^{-1}
    At a certain height the tail falls off and strikes the ground after 4 seconds.
    Assuming the tail falls off while the rocket is travelling at 5 ms^{-1} ,calculate the height at which it fell off.   [58.4m]

13. A ball is thrown vertically into the air with a speed of 5.0 ms^{-1}.
    Calculate the maximum height reached by the ball.   [1.3 m]

14. A one pound coin is dropped 20.0 m from a bridge over a river. Determine the time it takes for the splash to be heard from the moment the coin is dropped.   [2.0 s]

15. A test rocket is launched horizontally on a rail with an initial speed of 150 ms^{-1}. The rocket comes to a stop 100m after launch. Calculate the deceleration of the rocket
                                                                        [112.5 ms^{-2}]

16. A test car traveling at 18 ms^{-1} (about 40 mph) comes to a complete rest in a distance of 0.5 m after crashing into a wall.
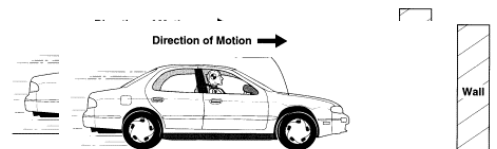
    a. Calculate the magnitude of the acceleration experienced by the driver.
    b. State the assumption you have made in the above calculation.
    c. A similar test car traveling at the same speed crashed into the wall and with extra safety features came to a stop at a distance of 1.0 m.
       Calculate the size of the acceleration experienced by the driver in this test.
                            [a) 324 ms^{-2}, c) 162 ms^{-2}]

17. A lead ball is dropped from a height of 2.0 m
    a. Calculate the speed of the ball just as it hits the ground. [6.3 ms^{-1}]
    b. Sketch a velocity time graph of the ball's motion.

18. A small rocket is launched and reaches a maximum height of 30 m.
    a. Calculate the launch velocity. [24 ms^{-1}]
   b. Find the time the rocket took to reach this height [2.4 s]

19. A car approaches traffic lights with a speed of 30 m s^{-1}. The car decelerates at 8 m s^{-2}. Determine the distance it takes for the car to come to a stop. [56.3m]

20. A test rocket accelerates from rest to 150 m s^{-1} in a time of 5 seconds. Determine the acceleration of the rocket and the distance it travels from its launch in the 5 seconds.

21. During a pub argument it is stated that if a stone is dropped down a 400 m well, the splash would be heard before Usain Bolt finished his world record 100 meters final.
    Usain Bolt`s record for the 100 meters is 9.63 seconds. Use your kinematics equations to settle the argument.

22. Determine the initial vertical velocity an athlete must attain in order to match the world record high jump of 2.45 metres.
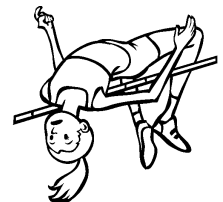
23. The high jump competition in the above question is held on the Moon. The acceleration of falling objects on the Moon is 6.7 m s^{-1}.
    Determine the initial vertical velocity the same athlete would need to obtain to break the same record.

24. The maximum acceleration of a jet aircraft is 5 m s^{-2}. The minimum take off speed is 80 m s^{-1}. Determine the minimum length of runway that this jet aircraft could use to safely take off.