- When a vehicle travels at a **steady speed**, the **resistive forces** (mainly due to **air resistance**) balance the **driving force**.

- The **greater the speed** of a vehicle, the **greater the braking force** needed to stop it in a certain distance.

- For a given braking force, the **greater the speed** of a vehicle, the **greater the stopping distance**.

- The **stopping distance** of a vehicle is the sum of the distance the vehicle travels during the driver's reaction time (**thinking distance**) and the distance it travels under the braking force (**braking distance**).

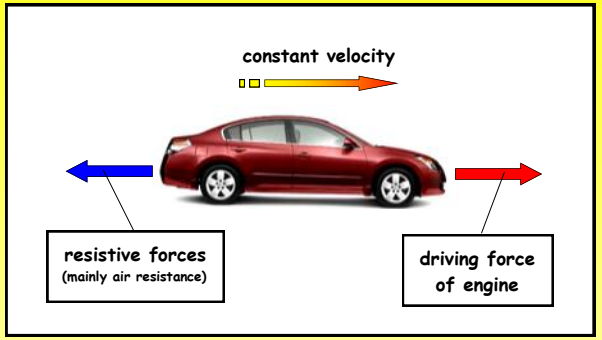
- A driver's **reaction time** can be affected by **tiredness, drugs** and **alcohol** (as well as by **distractions**).

- When the brakes of a vehicle are applied, **work done by the friction force** between the brakes and the wheel **reduces the kinetic energy** of the vehicle and causes the **temperature of the brakes to increase**.

- A vehicle's **braking distance** can be affected by **adverse road and weather conditions** and **poor condition of the vehicle**.

  Adverse road conditions includes **wet or icy conditions**.
  Poor condition of the car is limited to the **car's brakes or tyres**.

VEHICLE MOVING AT A STEADY (CONSTANT) SPEED



A car moves at **constant velocity** when the **resultant force** acting on it is **zero**. This happens when :

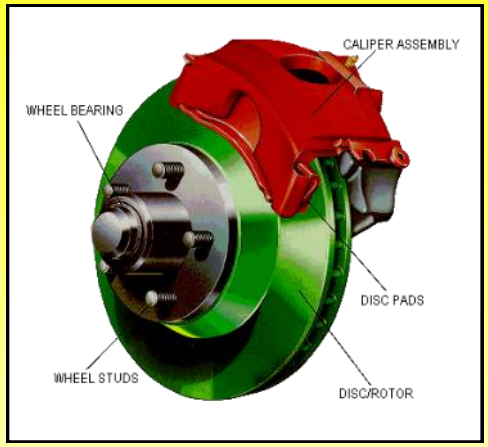
resistive force due to air resistance + road friction	=	**driving force** provided by the engine

- **Friction** is a force that occurs when an object moves through a medium (e.g. air or water), or when surfaces slide past each other (e.g. a car's Tyres as it travels along the road surface). Friction **opposes the object's motion.**

- It should be noted that although **friction between the tyres and the road surface** forms part of the **total resistive force** acting on a moving vehicle, the main component is **air resistance**.

BRAKING FORCE

- All vehicles are equipped with brakes which use friction between brake pads and the wheel discs to slow down the moving vehicle and bring it to rest.



- When the brakes of a vehicle are applied, **work done by the friction force*** between the brakes pads and the wheel discs **reduces the kinetic energy** of the moving vehicle and causes the **temperature of the brakes to increase.**

Friction is a force that occurs when an object moves through a medium (e.g. air or water), or when surfaces (e.g. the brake pads and the wheel discs) slide over each other. The friction force **always opposes motion.**

- The **braking force** needed to bring a moving vehicle to rest **increases** with :
  - The **speed of the car.**

    The **faster** a car is moving, the **greater** is the deceleration and therefore the **braking force** needed to stop it in a certain distance
  - The **mass of the car + contents.**

    Since **force = mass x acceleration,** the **greater the mass**, the **greater is the braking force** needed to produce a given deceleration.
- For a given braking force, the **greater the speed** of a vehicle, the **greater is the stopping distance.**

STOPPING DISTANCE is the shortest distance a vehicle can safely stop in.

STOPPING DISTANCE = THINKING DISTANCE + BRAKING DISTANCE

The distance travelled by the vehicle during the driver's reaction time.

Increases with :

- **Increased speed.**
- **Decreased alertness** as a result of all the following factors which **increase a driver's reaction time :**
  - Taking **drugs or alcohol.**
  - **Tiredness.**
  - **Old age.**
  - **Careless attitude.**
- **Poor visibility** due to **rain, fog** etc, which makes it more difficult to spot a hazard.

The distance travelled by the vehicle during its deceleration while the brakes are being applied.

Increases with :

- **Increased speed.**
- **Increased vehicle weight** due to Passengers and luggage.
- **Worn or faulty brakes.**
- **Poor road grip** resulting from :
  - **Worn/bald tyres** (the minimum legal tyre tread depth is **1.6 mm**).
  - **Slippery road surface** (due to **rain, ice** or **oil spills**).

- **PRACTICE QUESTIONS**

1 Complete the following sentences using the words shown below :

greater than **less than** **equal to**

A vehicle starts from rest and accelerates along a straight, flat road.

(a) The force of air resistance on it is ..... the driving force provided by its engine.

(b) The resultant force acting on it is ..... zero.

(c) The downward force of the vehicle's weight on the road is ..... the support force exerted by the road on the vehicle.

2 Each of the factors in the sentences below affects the **thinking distance** or the **braking distance** of a vehicle. Which of these two distances is affected in each case?

(a) The road surface condition affects the ..... distance.

(b) The tiredness of a driver affects his or her ..... distance.

(c) Badly worn tyres affects the ..... distance.

3 **(a)** Explain what is meant by **thinking distance** and **braking distance**.

(b) Use the words shown below to complete the following word equations :

braking **speed** **reaction time** **thinking**

(i) Thinking distance = ... x .....

(ii) Stopping distance = ... Distance + ... Distance.

4 The table below shows the **stopping distance** for cars at different speeds.

SPEED m/s	SPEED mph	thinking distance (m)	braking distance (m)	stopping distance (m)
15	34	9	19	
20	45	12	30	
25	56	15	48	
30	67	18	70	

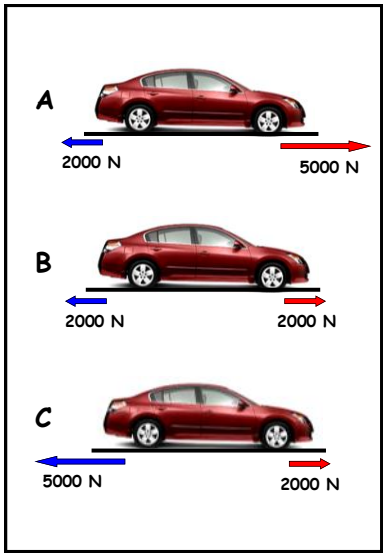
(a) Copy the table and complete the **'stopping distance (m)'** column.

(b) Explain why the driver's **thinking distance** increases with increasing speed even though the reaction time (approximately = **0.70 s**) stays the same.

(c) A drunk driver's reaction time has increased to **2.0 s**. Calculate :

(i) His **thinking distance** at a speed of **45 mph (20 m/s).**
(ii) His **stopping distance** at a speed of **45 mph (20 m/s).**

5 A car travels on a straight, flat road. The diagrams show the car at three stages, **A, B** and **C** of its journey. The arrows show the forward and backwards forces acting on the car.



(a) What is happening to the car at :

(i) Stage **A**, **(ii)** Stage **B** and **(iii)** Stage **C**?

(b) The driver sees some traffic lights ahead change to red and he applies the brakes. Between seeing the lights change and applying the brakes, there is a time delay called the **reaction time**.

(i) Suggest **two** things that would **increase** the driver's **reaction time**.

(ii) Suggest **two** things that would **increase** the **braking distance** of the car.