Force and Motion

Forces and braking

1. Friction and air resistance oppose the driving force of a vehicle.
2. Stopping distance = thinking distance + braking distance
3. Braking distance can be increased by high speed, poor weather conditions and poor vehicle maintenance.
4. Thinking distance can be increased by high speed or poor reaction times (due to tiredness, alcohol, drugs or using a mobile phone).
5. **F = ma** gives the braking force of a vehicle.
6. When a force is applied to the brakes of a vehicle, work done by the friction force between the brakes and the wheel reduces the kinetic energy of the vehicle and increases the temperature of the brakes.
7. The greater the speed of a vehicle the greater the braking force needed to stop the vehicle in a certain distance.
8. The greater the braking force the greater the deceleration of the vehicle. Large decelerations may lead to brakes overheating and/or loss of control.

Momentum

9. The momentum of a moving object is $\boldsymbol{p = m\,v}$.
10. The unit of momentum is kg m/s.
11. A closed system is a system in which the total momentum before an event is the same as the total momentum after the event. This is called **conservation of momentum**.

Conservation of momentum – PHYSICS ONLY

12. Momentum is defined as **mass x velocity** and has both size and direction (a vector quantity).
13. When two objects push each other apart, they move with different speeds if they have unequal masses, and with equal and opposite momentum, so their total momentum is zero.
14. Use the equation $\boldsymbol{m_A v_A + m_B v_B} = 0$ when two objects, A and B, recoil from each other.
15. Conservation of momentum can be used to find the speed of a car before an impact.

Impact forces – PHYSICS ONLY

16. When vehicles collide, the force of the impact depends on mass, change of velocity, and the length of the impact time.
17. **Impact force = change of momentum ÷ impact time**.
18. The shorter the impact time, the greater the impact force.
19. The longer the impact time, the more the impact force is reduced.
20. When two vehicles collide; they exert equal and opposite forces on each other, their total momentum is unchanged.

Safety first – PHYSICS ONLY

21. Cycle helmets and cushioned surfaces reduce impact forces by increasing the impact time.
22. Seat belts and air bags spread the force across the chest and increase the impact time.
23. Side impact bars and crumple zones give way in an impact, and so increase the impact time.