# Impulse & Force–Time Graphs – IGCSE Physics Worksheet

## Reading Comprehension: Impulse & Force–Time Graphs

When a force acts on an object for a certain amount of time, it changes the object's momentum. This change in momentum is called impulse. Impulse is defined as the product of force and time, and it is measured in newton-seconds (N s). The equation is:

Impulse = Force × Time

Impulse is also equal to the change in momentum:

Impulse = Δp = m v_final - m v_initial

This means that applying a larger force or applying a force for a longer time will produce a greater change in momentum.

A force–time graph shows how the force acting on an object varies over time. The area under the graph represents the impulse. If the force is constant, the graph is a rectangle. If the force changes, the graph may be triangular or irregular, but the area still gives the impulse.



Force–time graphs are especially useful in analysing collisions. During a collision, the force may rise sharply and then fall again within a very short time. Even though the force is large, the collision time is small. Car safety features such as airbags and crumple zones work by increasing the collision time, which reduces the force on the passengers while keeping the impulse (change in momentum) the same.

Understanding impulse and force–time graphs helps scientists and engineers design safer vehicles, analyse sports performance, and study how objects interact during collisions.

## Section A: Multiple-Choice Questions

1. Impulse is equal to: [1 mark]

A. Force ÷ time

B. Force × time

C. Mass × acceleration

D. Mass ÷ time

2. The unit of impulse is: [1 mark]

A. J

B. N

C. N s

D. $kg/m^3$

3. On a force–time graph, the impulse is represented by: [1 mark]

A. The gradient of the graph

B. The area under the graph

C. The maximum force

D. The time axis

### Section B: Short-Answer Questions

4. A force of 10 N acts on an object for 0.5 s.
Calculate the impulse. [2 marks]

5. Explain why increasing the collision time reduces the force on an object. [2 marks]

6. A 0.20 kg ball changes velocity from 5.0 m/s to –3.0 m/s.
Calculate the impulse acting on the ball. [3 marks]



### Section C: Force–Time Graph Application

7. A force–time graph shows a triangular shape with a maximum force of 12 N and a base of 0.4 s.
Calculate the impulse. [3 marks]

### Section D: Longer-Answer Question

8. Explain how airbags reduce injuries during a collision.
Refer to impulse and force–time graphs in your answer. [4 marks]

## Answer Key

### Section A

1. B

2. C

3. B

## Section B

4.

Impulse = F × t = 10 × 0.5 = 5 N s

5.

Impulse is fixed for a given change in momentum.

If collision time increases, the force must decrease because:

Impulse = F × t

6.

Δp = m(v_f - v_i) = 0.20(-3 - 5) = 0.20(-8) = -1.6 kg m/s

Impulse = –1.6 N s (negative = opposite direction)

## Section C

7.

Impulse = area of triangle = ½ × 12 × 0.4 = 2.4 N s



## Section D

8. (Model answer)

Airbags increase the time over which the passenger's momentum changes.

Since impulse is equal to the change in momentum, the impulse stays the same.

However, increasing the collision time reduces the force because:

Impulse = F × t

On a force–time graph, the area (impulse) stays constant, but the peak force becomes much smaller.

This reduces injuries.