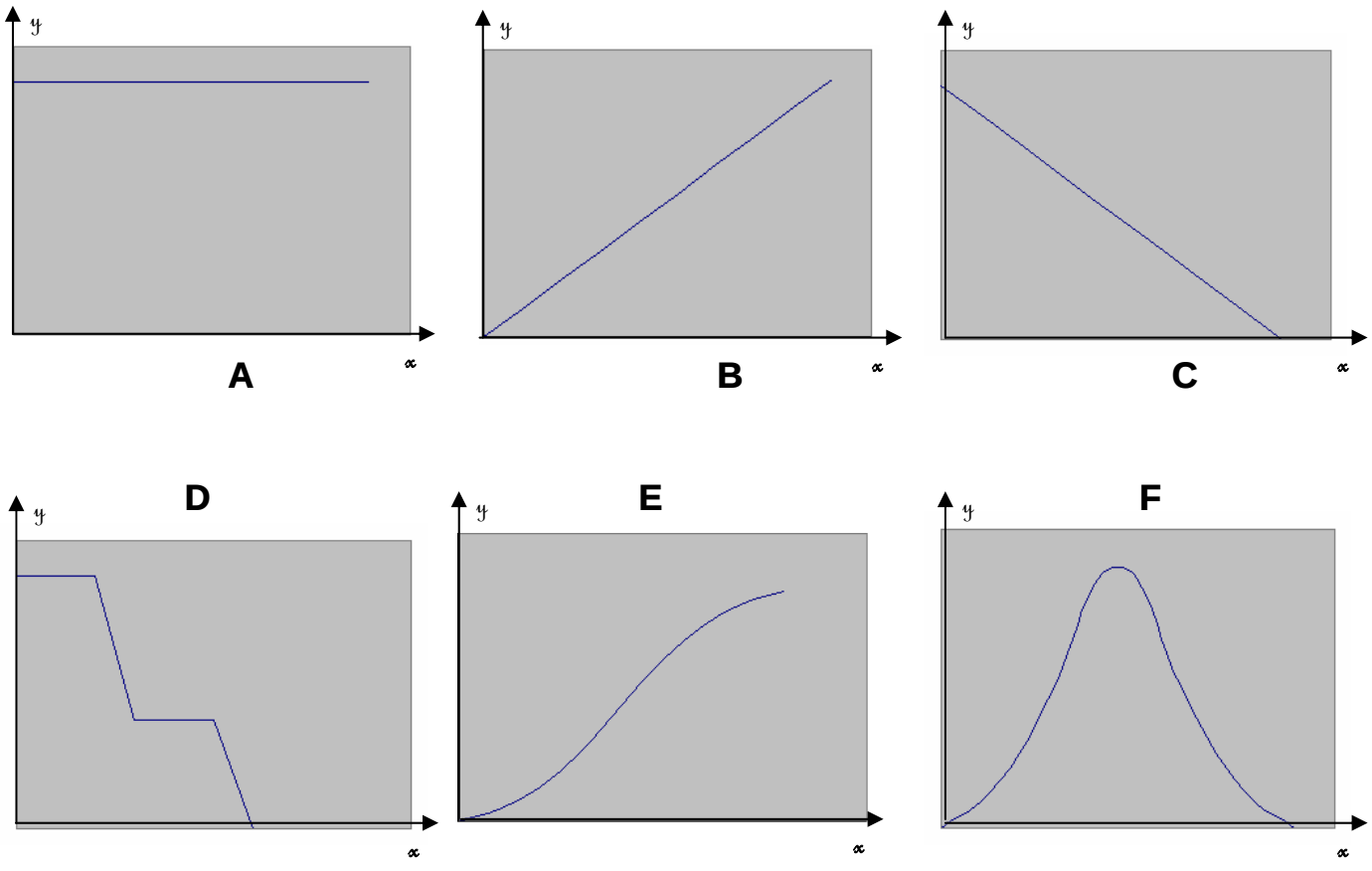
Lesson 18: Car crash safety

Crumple zones

Lesson structure. (may be spread over 2 lessons)

Starter:
Reading graphs (5 – 10 mins)
Given some simple graphs (see attached graph sheet) ask the students to describe what the graphs show.

For lower ability students the teacher could add some X and Y axis labels (e.g. distance and time, or comedy ones like number of drinks and visits to the toilet). The teacher could lead a group discussion.
For higher ability students the teacher could ask them to apply their own labels for the X and Y axes and decide what the graph is saying.



Extra points to be drawn from the graphs could include what the gradient of the line could mean, and what the difference in gradient could imply.

Looking at collisions (10 – 15 mins)

$$F = m \times a$$

Students are reminded of the equation. The teacher could explain the effects of an object's mass and acceleration on the forces it experiences; (e.g. Large masses lead to lower accelerations. The object requires a larger force to maintain its acceleration. Large accelerations require large forces, etc...)

The main point from this part of the lesson is for the students to understand the idea that large accelerations or decelerations lead to large forces.

This can be illustrated by imagining an F1 racing car and the forces the driver experiences as he accelerates, or by using the case of a fighter pilot. (Large G-forces caused by large accelerations.)

Questions on F = m x a, to help consolidate?

1) **A force of 1000N is applied to push a mass of 500kg. How quickly does it accelerate?**
2) **A force of 3000N acts on a car to make it accelerate by 1.5m/s^2. How heavy is the car?**
3) **A car accelerates at a rate of 5m/s^2. If it weighs 500kg how much driving force is the engine applying?**
4) **A force of 10N is applied by a boy while lifting a 20kg mass. How much does it accelerate by?**

CRUMPLE ZONES

Plot both graphs on the same axes

Data from a collision involving a car **without** a crumple zone.

Time (s)	Velocity (m/s)
0.00	16
0.05	16
0.10	16
0.15	16
0.20	16
0.25	0
0.30	0
0.35	0
0.40	0
0.45	0

Data from a collision involving a car **with** a crumple zone.

Time (s)	Velocity (m/s)
0.00	16
0.05	16
0.10	16
0.15	16
0.20	16
0.25	12
0.30	8
0.35	4
0.40	0
0.45	0

Questions:

The graphs you have plotted show the velocity of two cars that have a mass of 750 kg. One car has a crumple zone and the other doesn't.

1. Use the graphs to answer the following questions:
    a. Which of the two cars had the highest deceleration?

    b. How can you tell this from just looking at the graphs?

2. Using the graphs:
    a. Calculate the deceleration of the two cars.

    b. Calculate the distance travelled by the two cars during the collisions.

3. Using your calculated values for the accelerations of the car and the given mass to work out the forces acting on the car.
    a. Which car experiences the biggest forces?

    b. Which car do you think would cause the most damage to its passengers?