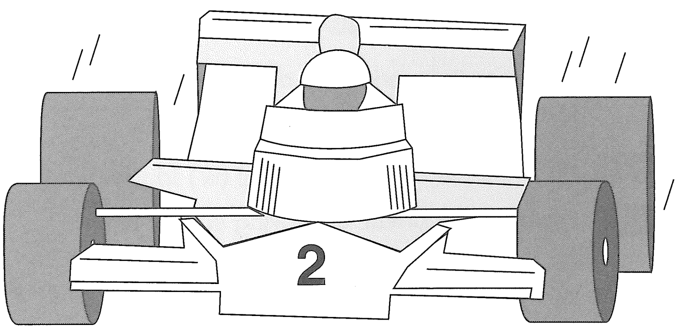
Investigating pit stop induced collisions

Racing authorities have been concerned with a series of tail-end collisions that have occurred near the pits between cars pulling out of the pits and cars travelling at speed down the straight. Although these accidents do not occur often, it is felt that the drivers could be protected if the physics of the collisions was investigated and better headrests designed. It has also been suggested that the momentum of the vehicles stuck together and careering out of control be taken into consideration in building new barricades and pit stop facilities. Five accidents were investigated.

	1	2	3	4	5
m_1	1489	1224	1370	1442	1310
u_1	55	51	58	53	57
m_1u_1					
m_2	1318	1510	1427	1377	1424
u_2	11	9	8	10	12
m_2u_2					
$m_1 + m_2$					
v					
p					

where m_1 = mass of the car travelling at speed down the straight (kg),
u_1 = velocity of the car (m s^{-1}),
m_2 = mass of the slower car coming out of the pits (kg),
u_2 = velocity of the car (m s^{-1}),
$v = \dfrac{m_1u_1 + m_2u_2}{m_1 + m_2}$ [final velocity],
$p = v(m_1 + m_2)$ [momentum].



1 Complete the table (*Note*: m_1u_1 is $m_1 \times u_1$).

2 Draw a bar graph showing the three velocities in each collision.

3 Giving reasons why, state the collisions that generated:

a the most risk to the slower driver,
b the most risk to the faster driver,
c the most risk to the people in the pits.

4 When a collision occurs, it is the deceleration or acceleration that creates the most dangerous situations. Apply the formula $a = \dfrac{v - u}{t}$ and find:

a the acceleration for whiplash in the worst case for the driver in the slower car coming out of the pits (assume t = 0.4 s),
b the deceleration in the worst case for the fast driver coming down the straight (assume t = 0.4s).

5 What factors would you bear in mind in designing a new headrest?

6 What factors would you bear in mind in constructing new crash barriers?