a place of mind

FACULTY OF EDUCATION

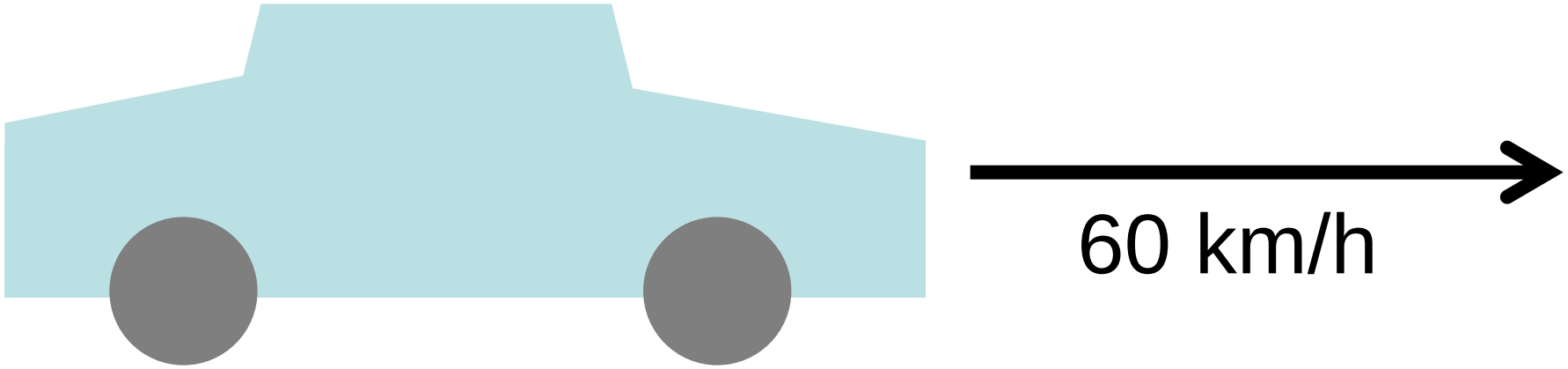
Department of
Curriculum and Pedagogy

Physics
Dynamics: Forces

Science and Mathematics Education Research Group

Supported by UBC Teaching and Learning Enhancement Fund 2012-2013

Cruising Car



Cruising Car I

A 2 ton car has activated cruise control and is travelling at a stable 60 km/h on the highway. What is the net force acting on the car?

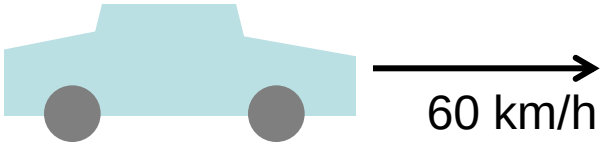
A. 120 kN

B. 0 N

C. 10 N

D. 196 kN

E. Not enough information



Solution

Answer: B

Justification: Since the car is travelling at a constant velocity, there is no net force on the car. Some might have answered D because they accounted for the gravitational force on the car. However, the gravitational force is negated by the normal force, which is what keeps the car from sinking into the earth's core.

Cruising Car II

The 2 ton car approaches a residential area and slows from 60 km/h to 30 km/h in 20 seconds. What is the net force applied on the car to slow it down?

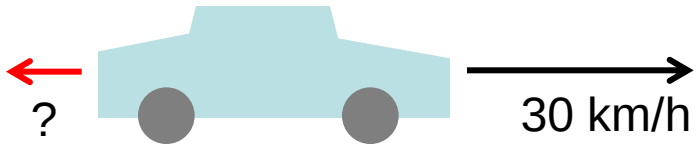
A. 833 N

B. -833 N

C. 0 N

D. 3 kN

E. -3 kN



Solution

Answer: B

Justification: In 20 s, the car slows from 60 km/h (16.67 m/s) to 30 km/h (8.33 m/s). This means the acceleration of the car is:

$$\frac{8.33m/s - 16.67m/s}{20s} = -0.417m/s^2$$

Newton's second law tells us $\sum \vec{F} = m\vec{a}$

By multiplying the acceleration of the car by its mass we get:

$$F = (-0.417m/s^2)(2000kg) = -833N$$

Cruising Car III

The driver of the 2 ton car sees a stop sign 25 m ahead and responsibly slows from 30 km/h to a stop in front of the sign. What is the average acceleration of the car?

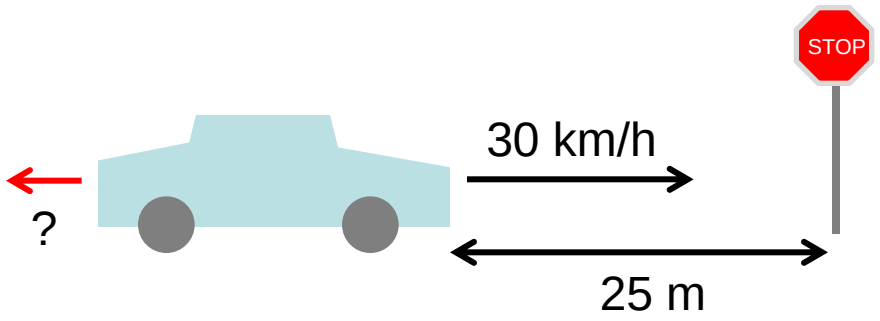
A. -18 m/s^2

B. 18 m/s^2

C. -1.39 m/s^2

D. 1.39 m/s^2

E. -2.78 m/s^2



Solution

Answer: C

Justification: First of all, we should convert km/h into m/s:

$$30\ km/h = \frac{30,000\ \text{m}}{3,600\ \text{s}} = 8.33\ m/s$$

One of the basic kinematics equations state that:

$$v^2 = v_0^2 + 2ad$$

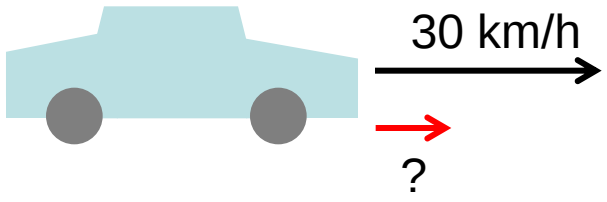
Since the final velocity is zero:

$$a = \frac{v^2 - v_0^2}{2d} = \frac{0 - v_0^2}{2d} = \frac{-(8.33\ \text{m/s})^2}{50\ \text{m}} = -1.39\ \text{m/s}^2$$

Cruising Car IV

After waiting to cross the intersection, the car accelerates from 0 km/h back to 30 km/h in 20 seconds. How does the net force on the car compare to when the car was slowing from 60 km/h to 30 km/h in question 2?

	Magnitude	**Direction**
A	Equal	Opposite
B	Less than	Opposite
C	More than	Opposite
D	Equal	Same
E	Less than	Opposite



Solution

Answer: A

Justification: This question is simply a reverse of question 2, except that it is speeding up. The initial velocity does not matter as the two questions have the same change in velocity. As the car is speeding up, the force acting on the car is in the same direction as it is travelling and is therefore opposite to the direction of the force in question 2.