(b)

Simple Force Problems – Newton's First and Second Laws

1. State Newton's First law. Describe **2 situations** that would demonstrate this law.

An object at rest will stay at rest and an object in motion will stay in motion unless acted upon by an external force.

- box flying forwards off back seat of car when car brakes.
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2. State Newton's Second Law. Describe **1 situation** that would demonstrate this law.

The acceleration of an object is directly proportional to the force acting on the object and indirectly proportional to an objects mass.

- loaded car accelerates slower than unloaded car
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3. A 0.025 kg bullet is shot out of a 0.45 m rifle barrel. The force on the bullet is 3600 N. What is the muzzle speed (the speed that the bullet leaves the gun barrel) of the bullet?

$F = 3600\ N$

$m = 0.025\ kg$

$a = ?$

$u = 0\ ms^{-1}$

$s = 0.45\ m$

$v = ?$

$F = ma$

$3600 = 0.025 \times a$

$a = \frac{3600}{0.025}$

$= 144000\ ms^{-2}$

$v^2 = u^2 + 2as$

$= 0^2 + 2 \cdot 144000 \cdot 0.45$

$= 129600$

$v = \sqrt{129600} = 360\ ms^{-1}$

The clay exerts a force of 0.99 N on the bullet.

4. A 0.012 g bullet travelling at 230 m/s enters a block of clay. The bullet is stopped in a distance of 0.32 m. What force was applied to the bullet by the clay?

$m = 0.012\,g = 1.2 \times 10^{-5}\,kg$ $\quad a = ?$ $\quad F = ?$

$u = 230\,ms^{-1}$

$v = 0\,ms^{-1}$

$s = 0.32\,m$

$v^2 = u^2 + 2as$

$0^2 = 230^2 + 2 \cdot a \cdot 0.32$

$\frac{-52900}{0.64} = a$

$a = -82656\,ms^{-2}$

$F = ma = 1.2 \times 10^{-5} \times -82656 = -0.99\,N$

5. A 36000 kg cement truck accelerates from rest to a speed of 28 m/s in a time of 18.7 s.

   a. What is the acceleration of the truck?

$m = 36000\,kg$

$u = 0\,ms^{-1}$

$v = 28\,ms^{-1}$

$t = 18.7\,s$

$a = \frac{v-u}{t} = \frac{28-0}{18.7} = 1.50\,ms^{-2}$

   b. What is the net force that causes this acceleration?

$F = ma$

$= 36000 \times 1.50$ (use actual value!)

$= 5.39 \times 10^4\,N$

6. An F-1 race has a mass of only 850 kg. It is able to generate a total force of 8500 N against a frictional force of 1100 N.

   a. What is the acceleration of this F-1 car?

$m = 850\,kg$

$\Sigma F = 8500 - 1100 = 7400\,N$

$a = ?$

$F = ma$

$7400 = 850 \times a$

$a = \frac{7400}{850} = 8.71\,ms^{-2}$

   b. How far starting from rest will this car travel in 3.2 s?

$u = 0$

$t = 3.2\,s$

$a = 8.71\,ms^{-2}$

$s = ?$

$s = ut + \frac{1}{2}at^2$

$= 0 \cdot 3.2 + \frac{1}{2} \cdot 8.71 \cdot 3.2^2$

$= 44.6\,m$

   c. What would the speed of this car be at 3.2 s?

$v = ?$

$v = u + at$

$= 0 + 8.71 \cdot 3.2$

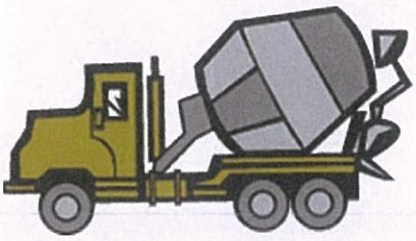
$= 27.9\,ms^{-1}$

7. Repeat #6 a – c for an ordinary car of mass 2300 kg and able to generate only 5500 N of force against the 1100 N of frictional Force.

$m = 2300\,kg$

$\Sigma F = 5500 - 1100$

$= 4400\,N$



a) $F = ma$

$4400 = 2300 \times a$

$a = 1.91\ ms^{-2}$

b) $u = 0$

$t = 3.2$

$a = 1.91$

$s = ?$

$s = ut + \frac{1}{2}at^2$

$= 0.3.2 + \frac{1}{2}\,1.91 . 3.2^2$

$= 9.79\,m$

c) $v = u + at$

$= 0 + 1.91 . 3.2$

$= 6.12\ ms^{-1}$