Newton's Laws

(Take $g = 9.8$ ms^{-2} where necessary in these problems)

1. A car of mass 1000 kg is acted on by a net force of 2500 N. What is the resulting acceleration?

2. A car of mass 1000 kg pulls a caravan of mass 800 kg; the driving wheels of the car exert a force of 8000 N on the road. The total resistance to motion is 3000 N.

(a) what is the net accelerating force?
(b) what is the acceleration?
(c) what is the force of the car on the caravan?

3. An engine of mass 5000 kg pulls a train of ten trucks each of mass 2000 kg along a horizontal track. Assume that the frictional forces to be 5000 N and that the engine exerts a force of 50 000 N on the rails. If the trucks are numbered from 1 to 10 starting with the one next to the engine calculate:

(a) the net total accelerating force
(b) the acceleration of the train
(c) the force of truck 6 on truck 7
(d) the force of truck 9 on truck 8

4. A stone of mass 500 g is thrown with a velocity of 15 ms^{-1} across a frozen surface of a lake and comes to rest in 40 m. Calculate:
(a) the acceleration
(b) the frictional force between the stone and the ice

5. At the start of a 100 m the rear foot of a sprinter can exert a force of some 1150 N on the starting blocks and the front foot an additional 800 N. If the sprinter is a man of mass 83 kg what is his initial acceleration?

6. A rescue helicopter lifts a stretcher case off a hillside. The injured climber and stretcher have a mass of 180 kg and the rope supporting them has a breaking force of 2000 N. Calculate:
(a) the tension in the rope when the stretcher and climber are suspended from the rope at rest
(b) the maximum vertical acceleration possible before the rope breaks

7. A 60 kg woman is a passenger in a car that is involved in a crash. She is wearing a seat belt that stops her in 0.1 s. If the car had been travelling at 12 ms^{-1} before the crash calculate:
(a) the deceleration
(b) the force on her breastbone due to the seat belt

8. A rocket of take off mass 50 000kg lifts off from a launch pad. If the engines burn 100 kg of fuel per second and the engines give a thrust of 480 000 N calculate:
(a) the time before the rocket moves
(b) the accelerating force when the mass has fallen to 45 000 kg
(c) the acceleration when the mass has fallen to 45 000 kg

9. A man of mass 80 kg and a bucket of bricks of mass 120 kg are tied to opposite ends of a piece of rope that passes over a frictionless pulley so that they hang vertically downwards. Calculate:

(a) the tension in the section of the rope supporting the man
(b) the tension in the section of the rope supporting the bucket of bricks
(c) the acceleration of the mans

(d) the acceleration of the bricks
(e) the tension in the two sections of the rope if the rope is held stationary on the pulley

10. A girl of mass 53 kg stands on a weighing machine on the floor of a lift of mass 400 kg. Four seconds after starting from rest the lift has risen 5 m and has reached its maximum speed. Calculate:

(a) the acceleration of the lift
(b) the reading on the balance during the acceleration
(c) how can you tell if the acceleration was uniform?

11. A dummy is used in a test crash to test a safety belt. The dummy has a mass of 65 kg and is brought to rest in a distance of 65 cm from a velocity of 12.5 ms^{-1} Find:
(a) the mean deceleration
(b) the average force on the dummy
Comment on your answers.

12. An astronaut is a sealed box in deep space. She then begins to realise that there is a steadily increasing force between her feet and one side of the box.
How can she tell what is causing this? Suggest some possibilities.

13. A man of 75 kg stands on a gantry of mass 40 kg. The gantry is attached to a rope which passes over a pulley and the man holds the other end. When he pulls the rope he exerts a force of 340 N on the floor of the gantry.

 Calculate the acceleration of the gantry.

14. A force of 12 N pushes a 2.5 kg trolley and is just sufficient to keep it moving at a constant velocity across a level horizontal surface.
(a) what is the force of friction on the trolley
(b) what is the acceleration of the trolley if the force pushing the trolley is doubled?

15. A lump of putty falls from rest onto the floor from a height of 5 m. If the mass of the putty is 60 g and it stops in 0.05 s calculate:

(a) the acceleration of the putty while it is stopping
(b) the force on the putty