On Newton's laws

A.C. Norman
anorman@bishopheber.cheshire.sch.uk

Warm-up problems

1. State Newton's three laws of motion.

2. Give an everyday example of Newton's second law, and explain how it relates to the following equation which is on the GCSE formula sheet:

$$a = \frac{F}{m},$$

   where F is the resultant (overall) force on an object, m is the object's mass and a is the acceleration.

3. Draw three diagrams of a bouncing rubber ball: the first just before it hits the floor, one when it is in contact with the floor (and its speed is—just for an instant—zero), and finally to show it just after it has rebounded from the floor. Show the forces acting on the ball in all three diagrams, and write a brief sentence about each diagram to explain the force arrows you have drawn.

Regular problems

4. In a collision between two motor vehicles, the passengers are frequently injured when they hit the windscreen. Explain this fact and the advantage of a seat belt using Newton's laws.

5. A heavy goods vehicle has an engine which can provide a maximum driving force of 2.8 kN. What is the maximum acceleration of the vehicle:

   (a) if the truck is unladen, and its mass is 1300 kg?

   (b) if the truck is carrying 350 kg of potatoes?

   (c) if the truck is at its maximum laden mass of 3200 kg?

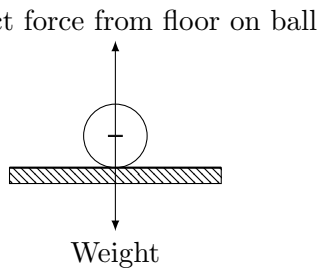
6. Estimate the size of the acceleration of the bouncing ball in the second diagram you drew in question 3, showing and explaining how you work out your answer.

7. Explain how Newton's third law applies to the situation of a bullet being fired from a gun. Where is the force pair here (draw a diagram)? Why don't the bullet and the gun end up going at the same speed?

8. Create your own problem using either Newton's 2nd or 3rd law.

Extension problems

9. When two forces are equal, e.g. on the ball which is resting on the floor in the diagram below, how can you tell whether they are equal owing to Newton's second law $F = ma$, with $a = 0$, or Newton's third law?



10. Apply Newton's 2nd and 3rd laws (draw diagrams with the forces on and explain clearly how you know those forces arise using Newton's laws) to show that if I stand on a bathroom scales holding a puppy, the total weight recorded on the scales will be the sum of my weight and the weight of the puppy.