: Exploring Newton's second law – the solar system

vhat your weight (mass × acceleration) would be on other planets in our solar system.

, using this formula:

ass = Weight

ne nearest whole number. If you don't know your mass or you don't want to write that is the average mass for a 12-year-old. The first row on the table shows an

on planet (ms^{-2})	Mass (kg)	Weight (N)
9.81	40	9.81 × 40 = 392.4, rounded to 392 N
3.61		
8.83		
9.81		
3.75		
26		
11.2		
10.5		
13.3		

ou weigh the most during your visit? ______________________

ou weigh the least during your visit? ______________________

celeration due to gravity on another object in space such as a star or moon. Use this

Worksheet 2.2 *extension*: Units and numbers

The symbols in the top column of the tables in Worksheet 2.2 are the standard units for each measurement:

- Acceleration is measured in metres per second per second (ms^{-2}).
- Mass is measured in kilograms (kg).
- Weight and other forces are measured in Newtons (N).

Some units are made up of other units; for example, 1 Newton = 1 (kg ms^{-2}). Units can also use prefixes to specify a different scale; for example, 1 kilogram is 1 000 grams.

1. Can you find the units for the motion-related quantities listed in the table below? If possible, record both the standard unit for each quantity and other units that can be used to measure it.

Quantity	Standard unit	Other possible units
Time		
Distance		
Speed		
Length		
Energy		
Force		
Acceleration		

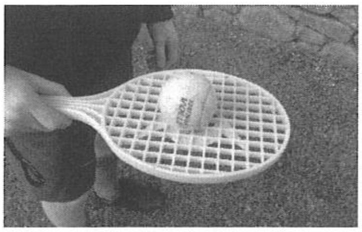
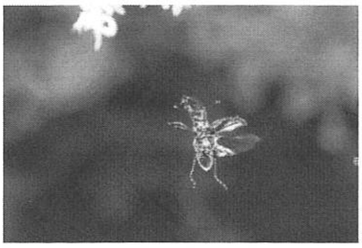
2. Can you find any other physics quantities and units? Record them in the next table.

Quantity	Standard unit	Other possible units

Worksheet 2.3: Exploring Newton's third law – pairs of forces

To every force and action, there is an equal and opposite reaction. This is Newton's third law. For an old but still relevant and cool song about this law, go to: www.youtube.com/watch?v=xfkdnnWrR94

1. Now you have it stuck in your head that "to every force and action, there is an equal and opposite reaction", complete the table below about each pair of forces. The first one has been done for you.

	Ball hits racket at 50 N left; bat hits ball at 50 N right.
	(a) 500 N boy stands on ground; ground pushes on boy with ____ N.
	(b) Rower uses oar to push on water with ____ N; water pushes on oar with 100 N.
	(c) Otto the superbug runs into a truck. The force of Otto on the truck is 5 N; the force of the truck on Otto is ____ N.
	(d) Keegan pulls on a rope weed with ____ N; the weed pulls on Keegan with 800 N.
	(e) The shoe hits the window with 40 N; the window hits the shoe with ____ N.

Worksheet 2.4: Reviewing Newton's three laws of motion – riding the lift

John and Ranui are working on a science experiment about the forces acting on a person riding a lift. They know Newton's three laws of motion:

1. An object at rest will stay at rest; an object at a constant speed will stay at a constant speed unless an unbalanced force acts.
2. Force = Mass × Acceleration
3. For every force, there is an equal and opposite force.

Ranui gets into the lift with a scale and John attempts to predict what will happen.

Newton's first law

1. When Ranui is in the lift, after the initial acceleration, the lift moves at a constant speed. What is the net force on the lift when it is moving at a constant speed? ____________________

   Why? ____________________

   ____

2. What is the net force on Ranui when the lift is stopped? ____________________

   Why? ____________________

   ____

Newton's second law

Acceleration due to gravity is 10 ms^{-2}. Ranui is 40 kg.
If the lift is moving upwards at 2 ms^{-2}, the unbalanced force on Ranui is:

$40 \times 2 = 80$ N

When Ranui stands on the scale, she will see that her weight has increased because of this acceleration.

Likewise, if the lift is moving downwards at 2 ms^{-2} then Ranui will look down at the scale and see that her weight appears to have decreased because the lift is accelerating downwards and the unbalanced force on her is now 80 N in the opposite direction.

1. Using the formula $F = ma$, calculate the unbalanced force on Ranui in each of the situations listed in the table below. Record your answers in the final column.

Ranui's mass (kg)	Acceleration (ms^{-2})	Unbalanced force (N)
40	2	
40	5	
40	6	
40	0	

2. If Ranui's dad, who is 80 kg, was in the lift instead of Ranui, what would be the unbalanced force in each of the situations listed in the table below? Record your answers in the final column.

Dad's mass (kg)	Acceleration (ms^{-2})	Unbalanced force (N)
80	2	
80	5	
80	6	
80	0	

3. Write a sentence that explains what happened to the unbalanced force when we doubled the mass.

4. Where was the unbalanced force coming from?

Newton's third law

1. When Ranui is standing in the lift and it is not moving, what is the force of Ranui on the lift?

2. What is the force of the lift on Ranui?

3. Ranui gets out of the lift and presses on John's hands with a force of 50 N. What is the force of John's hands on Ranui?

4. John begins to walk backwards while still holding his hands against Ranui's with a force of 50 N. What is the force from Ranui's hands on John's hands now?

5. John leans on the wall. Is the wall exerting a force on John?