Lesson 1

Topic: Investigating forces and motion

Exploring the First and Third Laws of Motion

Lesson concepts:

- The motion of objects can be described and predicted using the laws of physics
- Formulated hypotheses can be investigated scientifically
- Conducting investigations requires appropriate methods, assessing risk and collecting reliable data
- Data can be collected and recorded systematically and accurately using appropriate equipment
- Data can be analysed, including describing relationships between variables
- Knowledge of scientific concepts can be used to draw conclusions that are consistent with evidence
- Scientific ideas and information can be communicated using scientific language, conventions and representations

Learning alerts

Be aware of:

- Students thinking that an object at rest has no forces acting on it.
- Students thinking that objects stop moving when the force used to make them move has run out

Suggested next steps for learning

- Explain that when an object is at rest, the forces acting on it are balanced.
- Explain that moving objects remain in motion until an external force such as gravity, drag, friction, or that exerted by an obstacle, opposes the motion.

Prior knowledge notes

A review of inertia and Newton's First Law of Motion sets the scene for exploring another law of motion — the third law.

Lesson notes

Students will apply their understanding of Newton's First Law of Motion while completing **Sheet 1**. Their model person should not be too sticky, otherwise the test dummy may adhere to the car and not move as expected under the first law of motion.

The examples of the third law show the action–reaction directions clearly and are everyday examples. Students need to relate to the examples provided and realise that the forces are equal in size but opposite in direction. The ball thrown has an action force acting on it that produces a reaction force that acts on the person in the blow-up raft. The demonstration of the third law is well worth performing to show students this concept in action.

Prior knowledge answers

1. Students are required to give three original examples of motion where a force is used to change an object's state of motion — to start or stop moving, change velocity or change direction.

   For example: A ball thrown into a net slows down quickly and stops, because the force exerted by the net changes its velocity to 0 ms-1; a truck starts to move because the engine drove the wheels to exert a force that overcame the inertia of the (truck) body at rest; a stack of books slides off an office chair that has been rolling. The base of the chair runs up against an obstacle and the books continue to move in the same direction because the force exerted by the obstacle was mainly exerted on the chair.

2. a) Mass, speed, tyre selection, road surface, weather.
   b) For example: The best conditions to stop a vehicle are tyres with good tread on bitumen in dry conditions.
   c) These conditions allow for maximum frictional force to be applied to the vehicle. This force makes the inertia change, the larger the force the greater and faster the change.

Lesson answers

3. Please refer to **Sheet 1** answers.

4. a) The reaction motion occurs because as a force is applied to something, its inertia is changed. All objects have the tendency not to change their inertia, so they exert a force back on the object that is making them change their inertia.
   b) For example:
      - Sitting in a chair (action): gravity pulling you down to Earth, reaction: chair pushing you up.
      - Driving (action): tyres push on the road, reaction: the road pushes back on the tyres
      - Propeller on a boat's outboard motor (action): propeller blades push against the water, reaction: water pushes back, propelling the boat forward.

5. In this demonstration you can change some variables to observe the effect, for example: change the slope of the ramp, alter the mass of water in the bottle.

Topic: Motion calculations

Introducing the Second Law of Motion

Lesson concepts:

- The motion of objects can be described and predicted using the laws of physics
- Data can be collected and recorded systematically and accurately using appropriate equipment
- Data can be analysed, including describing relationships between variables and identifying inconsistencies
- Knowledge of scientific concepts can be used to draw conclusions that are consistent with evidence
- Conclusions can be evaluated, sources of uncertainty identified, and ways to improve the quality of data can be described
- Scientific ideas and information can be communicated using scientific language, conventions and representations

Learning alerts

Be aware of students thinking acceleration is the same as rapidity of motion.

Suggested next steps for learning

- Explain that acceleration is the change in velocity over time.

Prior knowledge notes

The start-up to this lesson is to give the student practise at interpreting Newton's Second Law of Motion by seeing how it explains situations where force, mass or acceleration are changed. It shows that mass is an important aspect of the effect of forces.

Lesson notes

The first part of the lesson is to introduce what is involved in the Second Law of Motion: $F = ma$.

Some data is collected to allow students to identify the relationship among the three factors.

The second activity (**Sheet 2**) requires students to use a freewheeling object to which more mass can be added. The mass of the freewheeling object and the added masses need to be the same or similar. If the object you have available has a mass of 200g, then you need three 200g masses that can be added to this object to complete the activity in the easiest and best way. It may be easiest to weigh the object before the lesson starts.

Prior knowledge answers

1. a) **Both ice skaters would accelerate backwards; however, the lighter ice skater would accelerate more and travel further as they have less mass. The heavier ice skater has a greater mass so would accelerate less and wouldn't travel as far as the other ice skater. The effect of a force on an object is affected by the mass of that object.**

   b) **The person and raft had greater mass than the ball so the same force accelerated the person less. (The student might also comment that the boat would experience more drag than the ball, because it is larger and is in water rather than air.)**

Lesson answers

2. **Sheet 2 — Exploring Newton's Second Law of Motion (see pages 7 - 10).**

3. **See table below:**

Law of motion	Explanation	Example
First	Objects will not change their motion (inertia) until a force is applied. This includes objects at rest or in motion in a straight line at constant velocity.	An object travelling in a car will be thrown forward when the car suddenly applies the brakes.
Second	When a force acts on an object, it will make the object accelerate at a rate depending on the mass of the object present. F, m and a are all related by F = ma.	When playing with a football, the harder I kick the ball (larger force) the greater it will accelerate. If I apply the same force to a medicine ball it will accelerate less than the football due to having a greater mass.
Third	To every action there is an equal and opposite reaction.	A bird flying in the sky pushes down on the air with its wings, while the air is pushing up on it.

Lesson 3

Topic: Motion calculations

Calculating with the Second Law of Motion

Lesson concepts:

- The motion of objects can be described and predicted using the laws of physics
- Formulated hypotheses can be investigated scientifically
- Data can be analysed, including describing relationships between variables
- Knowledge of scientific concepts can be used to draw conclusions that are consistent with evidence
- Scientific ideas and information can be communicated using scientific language and representations

Learning alerts

Be aware of:

- Students thinking that objects stop moving when the force used to make them move has run out.
- Students thinking that Aboriginal peoples and Torres Strait Islander peoples had little understanding of the forces involved in spear usage.

Suggested next steps for learning

- Explain that moving objects remain in motion until an external force, such as gravity, drag, friction, or that exerted by an obstacle acts against the motion.
- Explain that Aboriginal peoples and Torres Strait Islander peoples have a deep understanding of the forces involved in spear use, which they use to design devices to change the size of the forces involved as well as adapting devices to exert different forces for differing purposes.

Prior knowledge notes

The start-up exercise provides an opportunity to review Newton's laws of motion.

Lesson notes

In this lesson students will consider the knowledge of force, mass and acceleration applied to the design and use of spears for hunting. This illustrates Newton's second law in a real-world setting.

The second part of the lesson further develops the understanding of Newton's Second Law of Motion. This provides practice with the use of the formula F = ma.

Prior knowledge answers

1. a) If no force acts on an object, then its motion will **remain unchanged**.
   b) The force required to move an object with greater mass from rest is **greater** than the force needed to move an object with less mass from rest. If you double the mass of an object, then the force needed to move that object with the same acceleration must be **doubled**.
   c) If you have two objects of the same mass, twice the force will cause **twice** the acceleration.
   d) When a constant force acts, the acceleration will **decrease** as the mass increases.
   e) When a person applies a force to an object, that object will apply an **equal** and **opposite** force back on the person.

Lesson answers

2. **No answer required.**

3. **Please refer to Sheet 3 — Motion knowledge applied to spears (see pages 11 - 13).**

4. **Please refer to Sheet 4 — Second law calculations (see pages 14 - 16).**

Exploring Newton's First Law of Motion

Materials

- Modelling clay (fist-sized amount)
- Freewheel vehicle (for example, skateboard, scooter, toy car)
- Pack of toothpicks

Method

1. Make a crash-test dummy using the modelling clay and toothpicks. Sit your dummy on top of the freewheel vehicle.
2. Predict the motion of the dummy for each of the events described in the table below.

Event	Predicted motion	Actual motion
Vehicle starts suddenly from rest.	**Student answers will vary.**	**The dummy will seem to move backwards and come off the vehicle.**
Vehicle stops suddenly (for example: collides with wall).	**Student answers will vary.**	**The dummy will continue to move forward and crash into the wall.**
Vehicle suddenly turns right.	**Student answers will vary.**	**The dummy will continue forwards in the original direction and seem to slide sideways off the vehicle.**
Vehicle goes over a speed bump.	**Student answers will vary.**	**The dummy will bounce up off the vehicle.**

3. Conduct an experiment to test your predictions. Record the results of your experiment in the 'Actual motion' column.
4. Use Newton's first law to explain the observed motion of the crash-test dummy in each event.

Event	Explanation
Vehicle starts suddenly from rest.	**The force is applied to the vehicle and not the dummy. Consequently, due to the dummy's inertia it remains stationary and appears to fall backwards in comparison to the vehicle movement.**
Vehicle stops suddenly (for example: collides with wall).	**The force is applied to the vehicle and not the dummy. Consequently, due to the dummy's inertia it continues to move forward.**
Vehicle suddenly turns right.	**The force is applied to the vehicle and not the dummy. Consequently, due to the dummy's inertia it continues to move forward. Because the dummy is continuing to move forward as the vehicle turns right, the dummy appears to slip off the side.**
Vehicle goes over a speed bump.	**The shape of the bump will affect vertical forces imparted to the dummy, and also any horizontal forces imparted across the original direction of motion. These forces will change the state of vertical motion of the dummy, as well as any motion across the original motion path. For the time that the dummy is airborne, inertia keeps it moving forward in addition to whichever other motions occur.**

Exploring Newton's Second Law of Motion

Activity A: Revising Newton's First and Third Laws of Motion

1. Use the double arrow tab to set the Applied Force scale to 50 N. What two forces are working in opposition to each other in controlling the motion of the crate?

   The applied force from the robot pushing the crate and the friction force caused by the crate rubbing against the surface.

2. Explain why the crate is stationary.

   When the two oppositional forces (applied force and friction force) are balanced (both 50N), Newton's first law dictates that the crate will continue to be stationary until the applied force is greater than the friction force, causing the crate to move in the direction of the applied force.

3. Use the double arrow button to increase the Applied Force up to 300 N. Observe the robot and the speed of the crate as the applied force increases.

   a) How does the robot's movement change as the applied force increases?

      Explain reasons for the change.

      The robot bends more towards the crate and pushes its legs further back into the ground. By doing this, the robot is demonstrating a larger effort in applying a force to the crate. This greater effort is in response to the friction force pushing against the robot.

   b) How does the motion of the crate change as the applied force increases?

      The crate begins to move forward, increasing in speed.

4. Reset the simulation, tick the check boxes and set the Applied Force to 50 N. Slide the Friction scale all the way to the left to reduce the friction to none. Observe the movement and speed of the crate. Describe the motion of the crate with 50 N applied force.

   The crate begins to move instantly, increasing in speed rapidly until it reaches maximum speed.

5. Continue to observe the motion of the crate until the value on the Applied Force scale returns to 0 N. Describe the motion of the crate with 0 N applied force.

   The crate continues to move forward at the maximum speed without slowing or stopping.

6. Slide the Friction scale to the half-way point (roughly 100 N). Describe the motion of the crate with 0 N applied force and 100 N friction force.

   The crate begins to slow down, until it stops.

7. Newton's first law (inertia) states that an object in motion will travel at a constant speed unless acted upon by an unbalanced force. How was Newton's first law demonstrated in this simulation?

   Once the crate reached maximum speed, the applied force was 0 N, and the friction force was also 0 N. Because the two forces were balanced, the crate kept moving in the same direction at the same speed. It was only when the friction force was increased above 0 N that the crate began to slow down and stop.

8. Predict what changes you would notice in the motion of the crate, if the applied force in step 4 had been increased to 150 N.

   Personal response required. For example:

   The crate would have accelerated more rapidly and gained maximum speed in a shorter amount of time.

9. Reset the simulation, tick the check boxes and follow step 4 again to test your prediction.

   How did the observed results compare with our prediction?

   Personal response required. Students should refer to data collected from the simulation that either supports or refutes their prediction.

Activity B: Newton's Second Law of Motion

1. Imagine a horse pulling a cart. What would happen to the speed of the cart if several bags of cement were added to the cart?

   The greater mass would slow down or decelerate the cart because the pulling force has remained the same.

2. Suppose several more horses were hitched up to the same cart. How would this affect the speed of the cart?

   The extra horses will increase the pulling force applied to the cart, so the speed will increase.

3. Use the double arrow button to set the *Applied Force* scale to 50 N. What was the acceleration rate (m/s2) with 50 N applied force?

   For example: 1.00m/s^2

4. Predict what will happen to the acceleration rate if the applied force is increased.

   For example: The acceleration rate should increase.

5. Reset the simulation as per the above instructions.

6. Repeat step 3 for each of the applied forces in Table 1 below. Record the acceleration rate for each trial.

Table 1

Trial	Mass (kg)	Applied force (N)	Acceleration (m/s^2)
1	50	50	**1**
2	50	100	**2**
3	50	150	**3**
4	50	200	**4**
5	50	250	**5**
6	50	300	**6**
7	50	350	**7**
8	50	400	**8**
9	50	450	**9**
10	50	500	**10**

7. Predict how the force needed to accelerate the crate from stationary to moving, will change if the mass of the crate is increased.

   For example: The applied force will need to be increased.

8. Reset the simulation as above. Use the double arrow button to set the *Applied Force* scale to 400 N. Record the acceleration for trial 1 in Table 2.

Table 2

Trial	Mass (kg)	Applied force (N)	Acceleration (m/s²)
1	50	400	**8**
2	50	400	**4**
3	50	400	**2**
4	50	400	**1**

9. Reset the simulation as above. Use the cursor to move the extra 50 kg crate on top of the existing crate.

10. Use the double arrow to increase the applied force until the crate begins to move forward.

    Record the acceleration rate for trial 2.

11. Reset the simulation as above. Use the cursor to move the extra 50 kg crate and the 100 kg bucket on top of the existing crate.

12. Predict what the acceleration rate would be if the mass of the crate was increased to 400 kg.

    Record your predicted value for trial 4 in Table 2.

Interpretation of results:

Refer to **Table 1** results.

13. How did increasing the applied force affect the acceleration rate of the crate?

    Increasing the applied force increases the acceleration rate.

14. Compare the results for trials 1, 2, 4 and 8. How did doubling the applied force affect the acceleration rate of the crate?

    Doubling the applied force also double the acceleration rate.

15. Compare the results of trial 1 with trial 3 as well as trial 2 with trial 6. How does tripling the applied force affect the acceleration rate of the crate?

    Tripling the applied force also triples the acceleration rate.

Refer to **Table 2** results.

16. As the mass of the crate increased, what happened to the acceleration rate?

    As the mass increased, the acceleration rate decreased.

17. What effect does doubling the mass of the object have on the acceleration rate?

    Doubling the mass, halves the acceleration rate.

18. Describe relationships between mass, force and acceleration that you can identify in the results.

For example: Acceleration rate is affected by mass and applied force. To maximise acceleration, a greater force needs to be applied to a smaller mass. If the mass of an object is large, then the force required to accelerate it also needs to be large.

19. Newton's second law states that force (F) is equal to mass (m) times acceleration (a): $F = ma$

This law can be rearranged as $a = F \div m$, or $m = F \div a$

Explain how your results from the website simulation demonstrate Newton's second law.

For example:

In Table 1 trial 2 of the simulation, a 50 kg crate, with an applied force of 100 N, accelerated at a rate of 2 m/s/s. Rearranging Newton's law to:

$a = F \div m$

a **= 100 N ÷ 50 = 2 m/s/s**

Motion knowledge applied to spears

This is about applying knowledge of force, mass and acceleration to designing tools.

Part A

1. In many cultures, spears have been or are used to hunt game animals or fish.
   a) Children are taught the skills for using spears, but may be disadvantaged by their age and size. How would these factors impact the force applied to a spear when it is thrown?

   Bigger children are more likely to provide a greater force.

   b) When would a greater force be an advantage in spear hunting?

   Student responses may vary.

   Examples may **include:**

   - **A greater force would achieve greater acceleration with a spear of the same mass.**
     With greater acceleration, the spear can reach a faster speed quicker thus reaching its target faster before the target has a change to escape.
   - **A greater force would enable a spear to pierce the skin of a fish more easily.**

   c) What would be the advantage of a child holding the spear and jabbing it into the water to catch a fish, rather than throwing the spear?

   By adding their mass to the spear the total mass increases, making the spear force better at penetrating the target and ensuring it is captured. This is an advantage but you would need to get a lot closer, which is a drawback.

   d) How might the ideas shown in the ball-throwing video be applied to spear hunting?

   The ball thrower adds more force to the ball, so it travels further. If a similar tool could add more force to a spear it could travel further and hit the target with more force.

2. Spears used by *Homo neanderthalensis* (Neanderthal man) are thought to have been heavy so that they could deliver the force necessary to take down large game. The spears were not designed to be thrown, but were used up close with prey, using the mass and strength of *Homo neanderthalensis'* bodies to add force. *Homo sapiens* (modern humans) began to employ lighter spears for more agile game that needed to be hunted from a distance. Due to the spears lightness and the absence of the body's mass to apply a strong force directly behind the spear, a technique was needed to ensure enough force was generated to be effective. The use of a spear thrower was introduced.

   Choose the correct term:

   a) A way was needed to increase the **force** (force, mass) with which a spear of lesser mass would strike.

   b) To increase the force of the lighter spear when it hit, it was necessary to **increase** (increase, decrease) the force used to propel the spear.

   c) To do this, using a spear thrower would not only increase the force propelling the spear, it would also **increase** (increase, decrease) the acceleration.

Part B

Using a law of motion to create a testable hypothesis

3. Develop a testable hypothesis relating the mass and velocity of lighter and heavier spears to produce the same force.

   Student responses will vary. Students may choose to use the format 'If ... then ... because ...'

   Examples include:

   If mass of the spear determines the force needed to throw it, then a lighter spear will need less force to launch because it has a smaller mass.

4. Suggest how this hypothesis could be tested.

   Student responses will vary, but will ideally involve measuring or observing comparisons of force, mass and acceleration associated with an object being thrown or launched.

Part C

Using secondary data to reflect on your hypothesis

Here we use mass data from secondary sources and an accepted value for acceleration as the spear is propelled, to calculate force of propulsion for a heavy spear.

Using these, and Newton's Second Law of Motion, you can calculate what you expect to be the force to propel the spear, $F_{propulsion}$.

5. Steps to find the expected $F_{propulsion}$ for a spear with a mass of 375g and acceleration of $334ms^{-2}$

   Step 1 is to list the known information:

   - mass for a heavy spear = 375g
   - acceleration = $334ms^{-2}$.

   Step 2 is to state what you want to determine:

   We need to determine $F_{propulsion}$ on the spear.

   Step 3 is to state the rule, law or equation:

   $F = ma$

   Step 4 is to substitute and solve, checking and stating units:

   Use 0.375kg for the 375g heavy spear so that the calculation is using the correct units of measurement. F will be in newtons.

   $F = ma$

   $F_{propulsion} = 0.375kg \times 334ms^{-2}$

   $F_{propulsion} = 125.25\ N$

6. a) Calculate the force required to produce an equivalent acceleration of 334ms^{-2} in a lighter 125g spear.

Heavy spear = 0.375kg

Light spear = 0.125kg

Acceleration = 334ms^{-2}

For the heavy spear	For the light spear
1. **Select the measurements you will use from the list and record them.** **Mass of spear = 0.375 kg** **Acceleration = 334 ms^{-2}** 2. **Write the formula you will use to solve the problem.** $F = m \times a$ 3. **Substitute the measurements into the formula.** F **= 0.375 kg × 334 ms^{-2}** 4. **Calculate the force.** F **= 125.25** 5. **Include units in the final answer.** F **= 125.25 N**	1. **Select the measurements you will use from the list and record them.** **Mass of spear = 0.125 kg** **Acceleration = 334 ms^{-2}** 2. **Write the formula you will use to solve the problem.** $F = m \times a$ 3. **Substitute the measurements into the formula.** F **= 0.125 kg × 334 ms^{-2}** 4. **Calculate the force.** F **= 41.75** 5. **Include units in the final answer.** F **= 41.75 N**

b) Compare the masses and forces for the lighter and heavier spears.

Student response should summarise and compare the results of calculations:

A lighter spear with a mass of 0.125 kg requires only a force of 41.75 N to launch.

This is much smaller than for a spear with a mass of 0.375 kg, which requires a force of 125.25 N to achieve the same acceleration of 334 ms^{-2}.

c) Reflect on your hypothesis.

Student responses should refer to the data above and describe the way in which these results either support or do not support the hypothesis.

For example:

The data and calculations support the hypothesis that a smaller force will be required to accelerate the lighter spear at the same acceleration.

Second law calculations

The purpose of these examples is to practise performing calculations on force, mass and acceleration according to Newton's Second Law of Motion.

For each question, state the equation that you need to use and perform the calculation.

The second law equations may be in the forms:

$$F = ma \qquad a = F/m \qquad m = F/a$$

For these calculations, ignore the effects of friction or drag.

Following are some steps to help with the working:

- List known information.
- If you need to, draw a diagram. You may not need this for all tasks.
- State the equation.
- Substitute and solve.
- Check and state units.

1. A water-filled balloon with an overall mass of 1kg undergoes an acceleration of 10ms^{-2}.
   What force was required to do this?

   m = 1 kg

   a = 10 ms^{-2}

   F = ma

   = 1 kg × 10 ms^{-2}

   = 10 N

2. A theme park ride carriage with a mass of 1000kg when empty needs to be accelerated at 0.5ms^{-2} along a horizontal track. What force is required to accelerate the empty ride carriage?

   m = 1 000 kg

   a = 0.5 ms^{-2}

   F = ma

   = 1 000 kg × 0.5 ms^{-2}

   = 500 N

3. When loaded, the ride carriage has a total mass of 2000kg. What force is required to accelerate the loaded carriage at 2 ms^{-2}?

   m = 2 000 kg

   a = 2 ms^{-2}

   F = ma

   = 2 000 kg × 2 ms^{-2}

   = 4 000 N

4. A skyrocket is launched with a force of 10N and accelerates horizontally at $20ms^{-2}$.

   What is the mass of this skyrocket?

   F = 10 N

   a = 20 ms^{-2}

   m = F/a

   = 10 N/20 ms^{-2}

   = 0.5 kg

5. A loaded coal wagon with a total mass of 20 tonnes (1000kg = 1 tonne) is pushed by a force of 300kN (1000N = 1 kN). What is the value of the acceleration?

   F = 300 000 N

   m = 20 000 kg

   a = F/m

   = 300 000 N/20 000 kg

   = 15 ms^{-2}

6. What force would be required to attain an acceleration of 8 ms–2 when pulling the 20 000 kg wagon?

   m = 20 000 kg

   a = 8 ms^{-2}

   F = ma

   = 20 000 kg × 8 ms^{-2}

   = 160 000 N

7. A 7.5 N force is applied to a football, generating an initial acceleration of 15 ms–2. What is the mass of this football?

   F = 7.5 N

   a = 15 ms^{-2}

   m = F/a

   = 7.5 N/15 ms^{-2}

   = 0.5 kg

8. A truck with an overall mass of 6500 kg is accelerating at 0.3 ms–2. What force does the engine need to apply in order to do this?

   m = 6 500 kg

   a = 0.3 ms^{-2}

   F = ma

   = 6 500 kg × 0.3 ms^{-2}

   = 1 950 N

9. A scale model aeroplane of 2 kg mass accelerates at 35 ms–2. What force is required to do this?

   m = 2 kg

   a = 35 ms^{-2}

   F = ma

   = 2 kg × 35 ms^{-2}

   = 70 N

10. A 600 g dynamics trolley has a 1.4 kg load added. It is launched with a force of 20 N. What is the acceleration?

F = 20 N

m = $m_{(trolley)} + m_{(load)}$ = 2 kg

a = F/m

= 20 N/2 kg

= 10 ms^{-2}

11. What would be the force required to project a 6 g mass with an acceleration of 800 ms–2?

m = 0.006 kg

a = 800 ms^{-2}

F = ma

= 0.006 kg × 800 ms^{-2}

= 4.8 N

12. A 1000 kg satellite in space needs a course correction. To achieve this, one of its rocket motors is fired to apply 100 N of force as thrust. What will be the acceleration due to this thrust?

F = 100 N

m = 1 000 kg

a = F/m

= 100 N/1 000 kg

= 0.1 ms^{-2}

13. A spring balance is used to launch a 5 g foam ball with a force of 5 N. What acceleration is produced?

F = 5 N

m = 0.005 kg

a = F/m

= 5 N/0.005 kg

= 1 000 ms^{-2}

14. A 1000 kg ride is accelerating at 9.8 ms–2. What is the force propelling this ride?

m = 1 000 kg

a = 9.8 ms^{-2}

F = ma

= 1 000 kg × 9.8 ms^{-2}

= 9 800 N

15. A cannonball accelerates at 1000 ms–2 from an applied force of 5000 N. What is the mass of the cannonball?

F = 5 000 N

a = 1 000 ms^{-2}

m = F/a

= 5 000 N/1 000 ms^{-2}

= 5 kg