Activity 2.6 Alternative energies to produce electricity

Marking Rubric

Criterion	Mark*				Total
	0	1	2	3	
Content accuracy & depth	Content was inaccurate and lacked depth	Contained some accurate content but it was superficial and/or inaccurate in several places	Content throughout was good but lacked some accuracy or depth	Content throughout was accurate and thorough	
Written expression	Written work was very poorly expressed with poor sentence structure	Written work was satisfactory, but contained some poor expression and poor sentence structure.	Written work was very clear and well expressed with good sentence structure		
Use of scientific language	No scientific language was used.	Very little correct scientific language was used.	Scientific language was used correctly in most instances	Scientific language was used correctly and effectively	
Use of graphics	Graphics were not used.	Graphics used were minimal and did not greatly enhance the pres.	Graphics were used effectively to enhance the presentation		
Group presentation	The group did not appear to have coordinated its presentation at all	The group had communicated and worked together but each person's presentation was disconnected from the story as a whole.	The group was well coordinated but one speaker did not flow well to the next to get the overall story across in a fully coherent way.	The group was very well coordinated and presented in a seamless way.	
Individual contribution	This individual made a minimal contribution to the whole group.	This individual made a lesser contribution to the presentation of the whole group.	This individual clearly made a valuable contribution to the group and presented very well.		
TOTAL (out of 15)					

*Half marks can be used if a student appears to fall between two standards.

Displacement (motion problems)

Equations of motion	Variables
$v_{av} = s/t$	v = final velocity (ms^{-1})
$v = u + at$	v_{av} = average velocity (ms^{-1})
$s = ½ at^2$	u = initial velocity (ms^{-1})
$s = ut + ½ at^2$	t = time (s)
$v^2 – u^2 = 2as$	a = acceleration (ms^{-2})
	s = displacement (m)
	Assume g (acceleration due to gravity) = 10 ms^{-2}

Question 1

A boy jumps off the 10 m tower at the swimming pool. What is his acceleration?

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Question 2:

How fast would he be travelling after falling for 1.0 s?

Question 3

What would his average speed be during the first second?

(Hint: this is the average of his speed at the start of the fall and at the end of 1 s.)

Question 4

How far would he fall during the first second?

(Calculate this using the two equations below and check that these provide the same answer.)

a) $v_{av} = s/t$

b) $s = ½ at^2$

Question 5

How much time would it take for him to reach the water (i.e. fall 10 m)?

Question 6

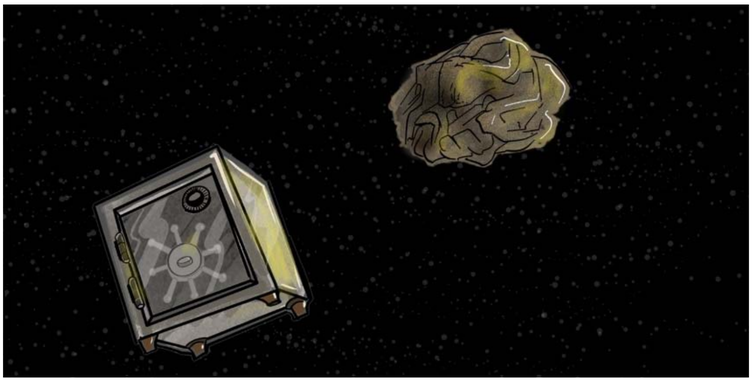
How fast would he be travelling as he hit the water?

Question 7

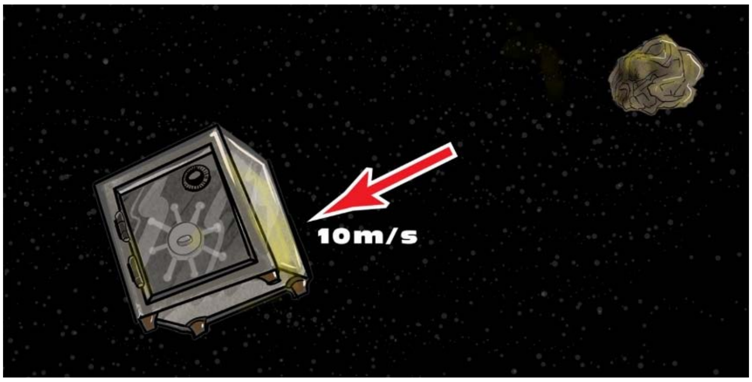
The boy says that for a brief time he was in orbit. Explain his reasoning.

Activity 5.1 Newton's second law

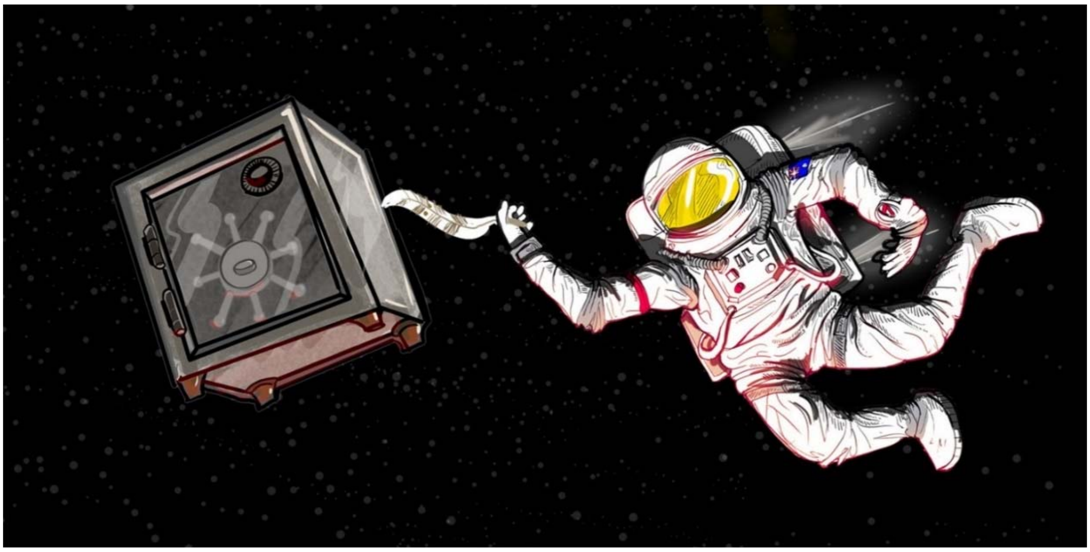
F = ma	**where F = force (N),**	**m = mass (kg),**	**a = acceleration (ms^{-2})**



1. A 1000 kg safe is motionless in space. What is its acceleration?



2. If the safe is moving in one direction at 10 m/s, what is its acceleration?



3. A 1000 kg safe is motionless in space. What will happen to the safe if an astronaut continually applies the same light pressure to one side of the safe with a feather? Will the safe:
    a. Speed up?
    b. Stay still?
    c. Increase its acceleration?
    d. Maintain a constant acceleration?
    e. Reduce its acceleration?

   Note – More than one of these answers is correct.

4. A car has a mass of 1500 kg. It is accelerating at a rate of 2.5 m/s^2. What force is being applied to the road by the tyres?

5. In space, a rocket is accelerating at a rate of 3 m/s^2. Its rockets are applying a force of 6000 N. What is the mass of the rocket?

6. A girl and her father jump off a diving board. The girl has a mass of 40 kg. Her father has a mass of 80 kg.

   a) What are the weights of the:

      i. girl?

      ii. father?

   b) What is the force of gravity on the:-

      i. girl?

      ii. father?

   c) Use Newton’s second law to calculate the acceleration of each and show both are equal.

7. If an object experiences a force of zero, what will be its acceleration?

Activity 5.2 Forces in balance

1. A bowling ball slows as it rolls down an alley. Is any horizontal force acting on the ball? How do you know?

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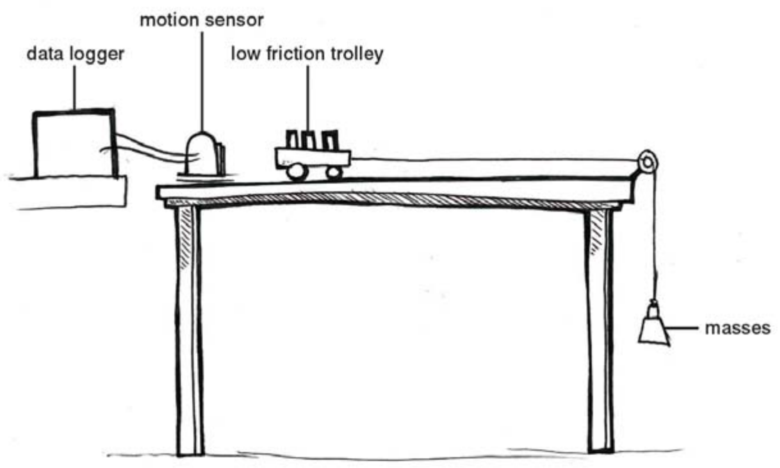

2. This diagram shows a low-friction trolley set up as in the experiment in **Activity 5.1**. The mass of the trolley is 1.0 kg. The mass loaded onto the hanging mass is 100 g.

   a) What is the total mass of the trolley system?

   [Hint: remember to include everything that will be accelerating]

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b) What forces are acting on the trolley in a vertical direction? Use arrows to indicate these on the diagram. Are these forces contributing to the acceleration of the trolley?

c) Ignoring friction (since it is a low-friction trolley) what forces are acting on the trolley in a horizontal direction?

d) What is the net force acting on the trolley system?

e) What would be the acceleration of the trolley?

3. a) A grocery bag can withstand 400 N of force before it tears. How many kilograms of apples can it safely hold?

b) If the apples break through the bag, what will their acceleration be as they fall towards the floor?

4. A student drops two pieces of paper. One is a flat sheet and the other has been tightly scrunched up. Explain, using the idea of balanced forces and Newton's second law, why the scrunched up piece accelerates downwards, while the flat piece floats down at a constant speed.

5. A car travelling at 10 m/s (36 km/h) brakes suddenly, stopping in just 2.0 s.

a) What was its acceleration?

b) In which direction was it accelerating?

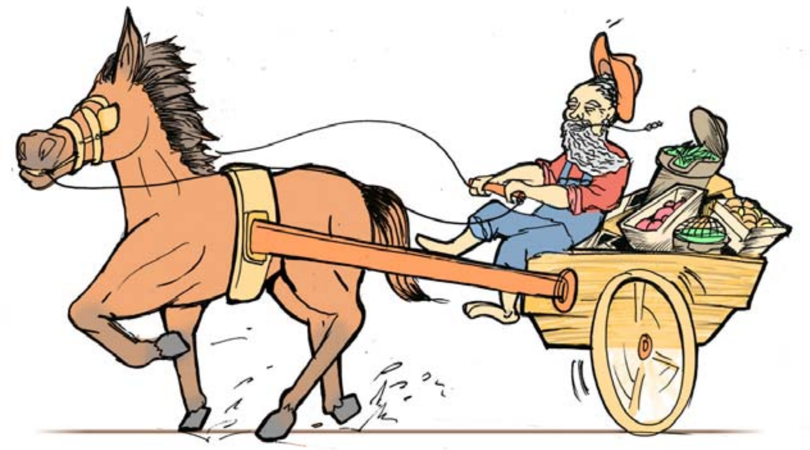
c) If the car had a mass of 1500 kg, how much frictional force was applied to the car by the road surface?

6. A skydiver jumps from a plane. After a few seconds, but before he opens his parachute, he is free falling. His mass, including the parachute, is 100 kg. At that point, air resistance is applying a force of 600 N on his body.

a) What would be the net force acting on his body? (Hint: remember force also has direction.)

b) What would be his acceleration at that point? (Hint: remember acceleration also has direction.)

The horse and cart problem



Bessie, the horse, has studied a little physics. Her driver wants her to pull the cart forward, but Bessie thinks this would be futile because of Newton's third law of motion.

Her reasoning goes like this. "It doesn't matter how hard I pull the cart forward, the cart will apply a force backwards of equal magnitude, leading to no net force. Therefore I cannot pull the cart forward."

On the diagram above, draw force arrows indicating all the forces you can identify acting on the horse and cart system. Use a different colour for each action/reaction pair of forces (i.e. according to Newton's third law).

HINTS

a) Have you drawn a force arrow that causes the cart to move forward?
b) Have you drawn a force arrow that causes the horse to move forward?

Activity 5.3 Newton's third law

1. Identify the force acting on the horse/cart system, pushing it forward.

2. Explain to Bessie why her reasoning is incorrect.

Activity 5.5 Car crash analysis

This analysis is based on a Jaguar sports car which left 290 m of skid marks on the M1 Freeway (near London) in 1960. The car had a mass of 1300 kg. How fast was it travelling before it skidded to a stop?

You have already determined the coefficient of friction, μ_f, for a tyre on a bitumen surface. We can use this value to analyse the motion of the car:

μ_f = Force of friction/Weight

We can rearrange this to find the frictional force that was stopping the car:

Force of friction = Weight x μ_f

Step 1: Use Newton's second law to find the weight of the car. Then use the equation above to determine the force of friction between the car tyres and the road.

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Step 2: Use Newton's second law and the force of friction to determine the acceleration of the car during the skid.

(In this case it will be a deceleration, or a negative acceleration, but this does not affect the calculations.)

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Step 3: If the car slowed down in 290 m to a final velocity (v) of zero, use the acceleration you have calculated to determine its initial velocity (u).

Extend your understanding: alternative method using energy.

Step 1: Use the weight of the car (in Newtons) and the coefficient of friction μ_f to determine the frictional force between the car tyres and the road.

Step 2: Work is defined as W = F x d

Use this equation to determine how much work was done on the car. Use your calculation of the force of friction on the car for F.

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Step 3: In this case sufficient work was done to transform all the original kinetic energy into heat.

W = KE

Write down the kinetic energy equation and rearrange it so that v^2 is the subject. Substitute all the other values into this equation to find v^2 and then v.

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Activity 6.1 Air resistance

Parachute Jump

Summarise the different forces acting at different stages of the skydiver's fall. Use the diagrams provided. Draw force arrows to indicate the direction of each force acting on the skydiver. Adjust the length of each arrow to indicate whether the force is stronger or weaker, relative to other forces in your diagrams.

Also draw an arrow on each diagram to indicate the acceleration of the skydiver. (Use a different colour.)

[*Hint: remember that deceleration is equivalent to acceleration in a direction opposite to the motion.*]

1. The skydiver has just stepped out of the plane.

2. **The skydiver is at terminal velocity.**

3. **The parachute has just opened.**

4. **The skydiver is floating down with parachute.**

5. **The skydiver lands.**

Questions

1. At what stages of the fall is the skydiver actually accelerating upwards?

2. What force is causing this upwards acceleration in each case, and why does it occur?

3. What can alter the force of air resistance on the skydiver?

4. At what stage of the fall did the skydiver have the greatest velocity?

5. At what stage of the fall did the skydiver have the greatest acceleration?

(There are two points where she experienced quite large accelerations.)