SCIENCE·3D

CROCODILE COUNTRY

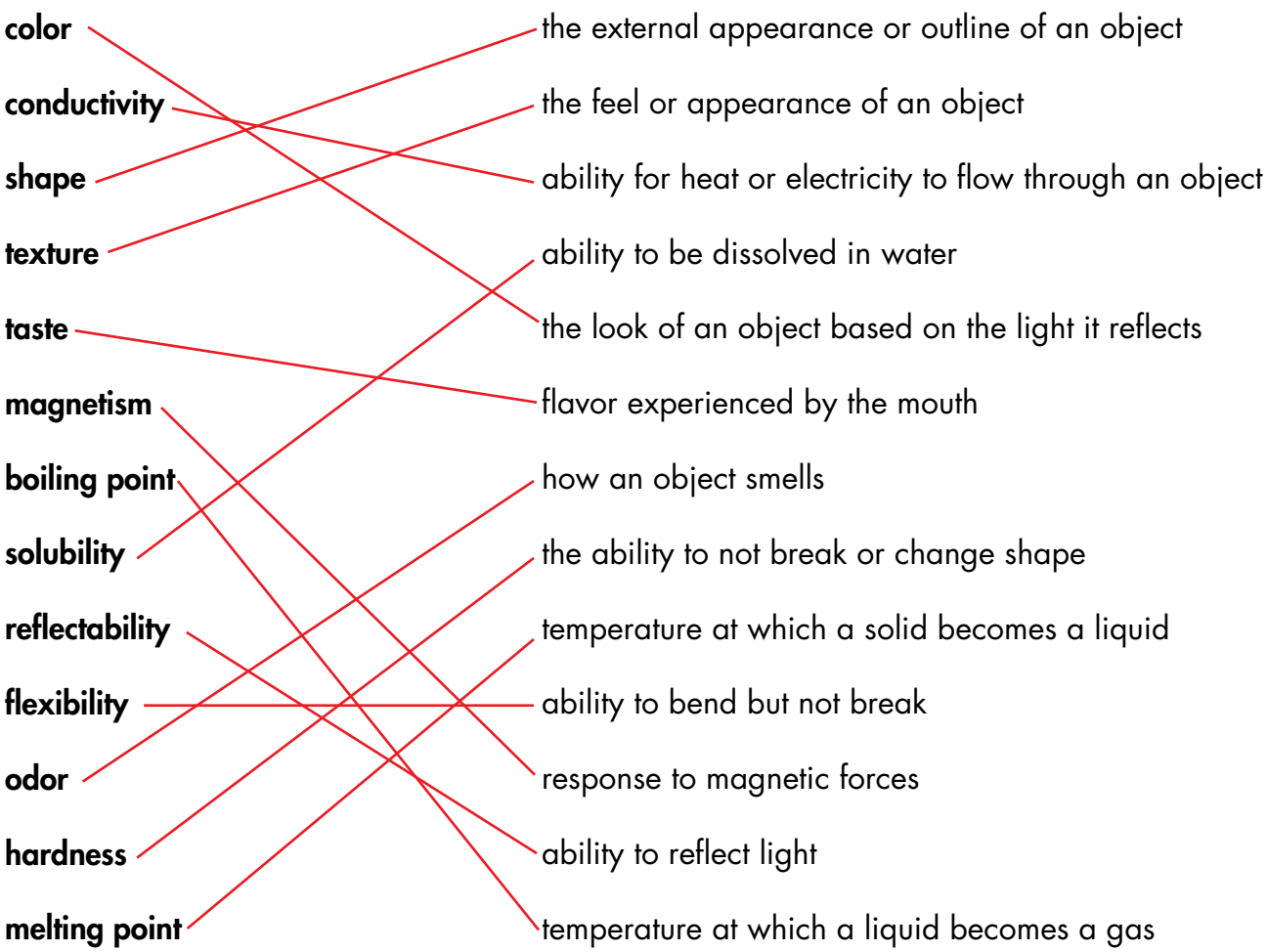
In this packet, sample student answers are provided in red and notes to teachers are in blue.

During this **Mission Research**, students will enhance their knowledge of the properties of matter and explore the mathematical relationship between force, mass, and acceleration. Then, they will explore the force of gravity and balanced and unbalanced forces. They will make calculations, draw graphs, and make conclusions based on these data.

In this mission, we are going to help figure out how to keep people safe from crocodiles while keeping crocodiles safe from people. To do that, scientists may have to catch crocodiles. And to catch crocodiles, they need to understand force and matter. Scientists need to know about the properties of different materials that could be used to build a croc trap. And, they need to know how much force the trap might have to withstand to survive an angry crocodile. The operation of the trap also involves forces!

Let's start with some properties of matter:

1. **Match** the definitions with the property of matter.



A force is a push or a pull. There are two major types of forces. One is the force from contact. That is when one object is touching another. The other types of force act at a distance. Gravitational and magnetic forces are examples of the latter! The force of an object is measured with a mathematical equation

$F = m \bullet a$

In this equation, ***F*** is force; ***m*** is the mass of an object and ***a*** is the acceleration of the object. Force is measured in units called Newtons (N).

2. Use this equation to **complete** the tables below:

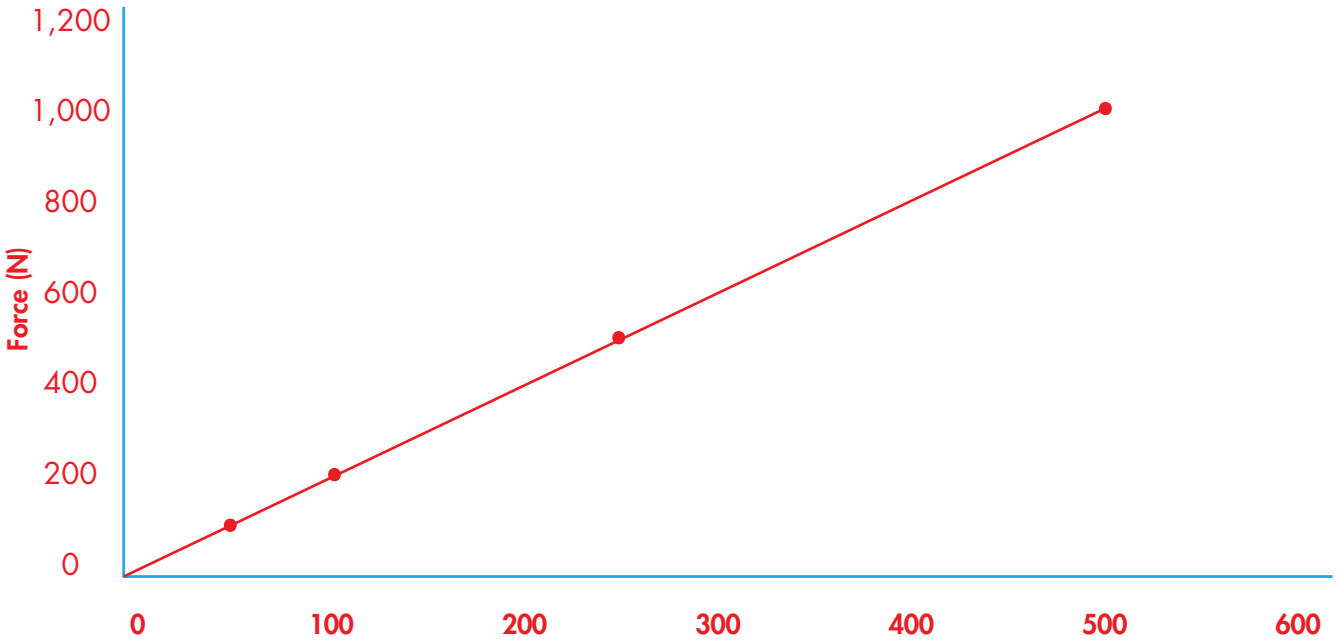
Table 1. Force of different sized objects with the same acceleration

Mass (kg)	Acceleration (m/sec)	Force (N)
50	2	100
100	2	200
250	2	500
500	2	1000

Table 2. Force of an object with different accelerations

Mass (kg)	Acceleration (m/sec)	Force (N)
50	0.5	25
50	1	50
50	1.5	75
50	2	100

3. **Draw** a graph to show the relationship between mass and force from Table 1. Label the axes and write a figure caption.

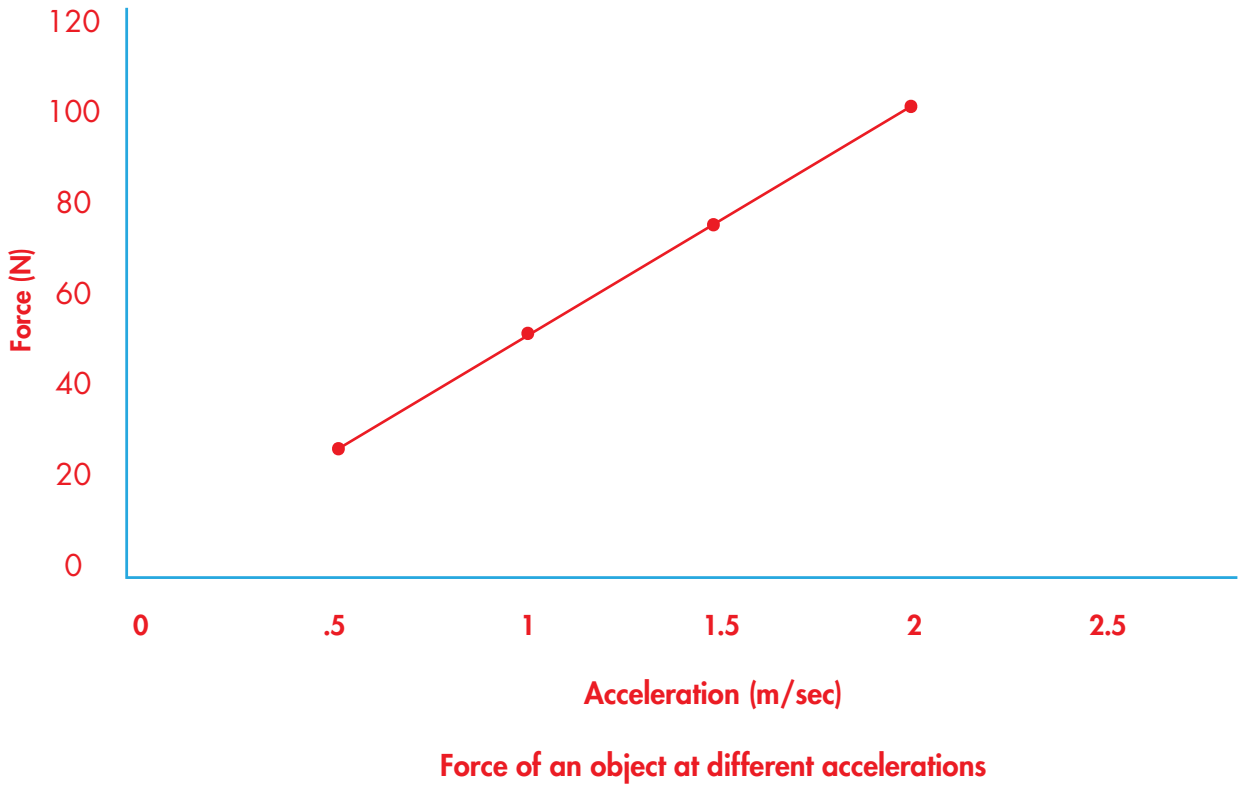


Force of objects of different masses accelerating at 2 m/sec

4. **Describe** the relationship between force and the mass of an object.

As the mass of an object increases, it exerts more force if it is moving with the same acceleration.

5. **Draw** a graph to show the relationship between acceleration and force from Table 2. Label the axes and write a figure caption.



Force of an object at different accelerations

6. **Describe** the relationship between force and the acceleration of an object.

The faster an object accelerates, the more force it has.

Extend the lesson: This is an area where you could make links to lessons about levers. Have students use what they learned about force to investigate and explain how levers work.

The acceleration on Earth due to gravity is 9.8 meters per second.

7. **Write** an equation to determine the force of gravity working on an object. Use *F* to represent force and *m* to represent mass.

   $F = m \bullet 9.8$

8. What is the one variable that matters the most in calculating the force of gravity acting on an object sitting on Earth?

   Mass
   In a discussion, ask students to describe why this is the case. They should recognize that the acceleration would be the same for all objects on Earth.

Objects often have multiple forces working on them at the same time. You can use math to figure out which way an object will move if there are multiple forces pushing or pulling on it.

If there are two forces working on an object, they can be *unbalanced* or *balanced*. If one force is stronger than another force, then they are **unbalanced forces**. If the forces are the same strength, then they are **balanced**. The object will not move.

If forces are working in opposite directions, we can determine if they are balanced or unbalanced by subtracting one force from the other. The result is the net force. If the net force is 0, the object does not move. They are balanced forces. If the net force is not 0 the object will move in the direction of the bigger force.

Let's say we have an object that is 1 kilogram. Let's find how much force it will take to lift it off the ground.

9. What is the force of gravity pulling the object down? Show your work!

   $F = 1 \text{ kg} \bullet 9.8 \text{ m/sec} = 9.8 \text{ N}$

10. What does the force have to be to lift the object up?
Write an inequality (for example: *Force* > *x*) to answer the question. **Describe** your reasoning.

F > 9.8 N. The force pulling up has to be greater than the force pulling down to lift the object.

11. To lift the object, will the forces be balanced or unbalanced?

Unbalanced

12. Engineers often try to reduce the mass of airplanes. Why do you think they do this? Express your answer in terms of the force needed to fly.

By reducing the mass of the airplane, it needs less force to overcome the force of gravity.