Hints & Solutions

1. **(B)**
A book resting on a table

2. **(A)**
acted upon by an external force.

3. **(B)**
Frictional force

4. **(A)**
Speed increases

5. **(A)**
The forces are equal in magnitude but opposite in direction.

6. Newton's second law of motion states that the force acting on an object is equal to the mass of that object multiplied by its acceleration. Mathematically, it can be expressed as F=ma, where F is the force, m is the mass, and a is the acceleration. For example, if a 10 kg object experiences a force of 5 N, its acceleration can be calculated using a = F/m, resulting in an acceleration of 5 N/10 kg = 0.5 m/s, 25N/10kg = 0.5m/s^2.

7. Inertia is the tendency of an object to resist changes in its state of motion. An object at rest tends to stay at rest, and an object in motion tends to stay in motion with the same speed and in the same direction unless acted upon by an external force. For instance, when a car suddenly stops, the passengers lurch forward because of their inertia. They were moving with the car, and when it stops, their bodies tend to keep moving forward.

8. Friction is a force that opposes the relative motion or tendency of such motion between two surfaces in contact. It can either slow down or stop the motion of an object. For example:

- **Walking on Ice:** The low friction between shoes and icy surfaces makes it difficult to walk smoothly.
- **Braking of a Car:** Friction between the brake pads and the wheel slows down the car when brakes are applied.

9. Newton's third law states that for every action, there is an equal and opposite reaction. This means that if object A exerts a force on object B, then object B simultaneously exerts a force of the same magnitude but in the opposite direction on object A. For example, when you push a wall (action), the wall pushes back on you with an equal force in the opposite direction (reaction).

10. Using Newton's second law (F=ma), where F is the force, m is the mass, and a is the acceleration, we can rearrange the formula to find acceleration: a = F/m. In this case, a = 500N/50kg = 10m/s^2. Therefore, the acceleration of the object is 10 m/s^2.

11 Force is a push or pull that can change the state of motion or shape of an object. According to Newton's laws of motion, force is directly related to the motion of an object. Newton's first law states that an object at rest remains at rest, and an object in motion continues to move with a constant velocity unless acted upon by a net external force. This force is what causes changes in the motion of an object. For example, when you kick a football, you apply force to it, causing it to move.
Newton's second law mathematically defines the relationship between force, mass, and acceleration as F = ma, where F is the force, m is the mass of the object, and a is the acceleration produced. This means that the force applied to an object is directly proportional to the mass of the object and the acceleration it undergoes.
In summary, force is crucial for understanding how and why objects move, and Newton's laws provide a framework for explaining the relationship between force and motion.

12. Net force is the vector sum of all the individual forces acting on an object. It plays a crucial role in determining the motion of an object according to Newton's second law, which states that the acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass (F = ma). When the net force acting on an object is non-zero, it causes the object to accelerate.
Example: Consider a car moving on a straight road. If the driving force applied by the engine is greater than the frictional force and air resistance acting

against the car's motion, a net force in the direction of motion is established. This net force causes the car to accelerate. Conversely, if the frictional force and air resistance become greater than the driving force, a net force in the opposite direction is established, leading to deceleration or stopping.

13 Air resistance, also known as drag, is the force exerted by air molecules on an object moving through the air. When an object falls, it experiences gravitational force pulling it downward and air resistance pushing against its motion. The interaction between these forces influences the motion of the falling object.

Effect of Speed on Air Resistance:

- At low speeds, the force of air resistance is relatively small. The object accelerates due to the greater influence of gravity.
- As the speed increases, so does the force of air resistance. Eventually, a point is reached where the force of air resistance equals the force of gravity, creating a terminal velocity. At terminal velocity, the object falls at a constant speed with no further acceleration.

Real-world Example: Consider a skydiver in free fall. Initially, the skydiver accelerates due to the force of gravity being greater than air resistance. As the skydiver's speed increases, air resistance becomes stronger until it equals the force of gravity. At this point, the skydiver reaches terminal velocity, falling at a constant speed without further acceleration. Understanding the interplay between gravitational force and air resistance is crucial in predicting the motion of falling objects.

14. In the case of the model rocket launch, several forces come into play. Let's analyze these forces and apply Newton's laws of motion:

1. **Force of the Rocket Engine (Thrust):**
   - The force generated by the rocket engine is the thrust, which propels the rocket upward.
   - According to Newton's third law, the expulsion of gases from the rocket creates an equal and opposite reaction, resulting in the upward thrust force.
2. **Force of Gravity:**
   - Gravity acts downward on the rocket, trying to pull it back to the ground.
   - Newton's second law (F=ma) can be applied to understand how the gravitational force influences the motion. The weight of the rocket (mass times acceleration due to gravity) is the force acting downward.
3. **Air Resistance (Drag):**
   - As the rocket ascends, it encounters air resistance (drag), which opposes its motion.
   - Newton's second law is also applicable here, as the net force acting on the rocket is the difference between thrust and air resistance. If thrust is greater, the rocket continues to accelerate; if air resistance becomes equal to or greater than thrust, the rocket reaches a constant speed (terminal velocity).
4. **Role of Mass:**
   - The mass of the rocket is a crucial factor in determining its acceleration. According to Newton's second law, F=ma, a smaller mass results in greater acceleration for the same force.
   - The students need to consider the balance between the thrust force generated by the rocket engine and the mass of the rocket to achieve the desired launch performance.

In conclusion, understanding the forces acting on the model rocket and applying Newton's laws of motion allows the students to optimize their design, ensuring a successful and scientifically sound rocket launch for the science fair.

15. **(A)**

Both Assertion and Reason are true, and Reason is the correct explanation of the Assertion.