

Newton's three laws of motion

Grade 8 science (Year 9 · Class 8) · Lab answers

Model answers use the sample table. Your own times will differ, but the product of total mass and acceleration should stay roughly constant and a little below the weight of the hanger because of friction.

Level: Grade 8 science (Year 9 · Class 8) · **Curriculum:** MS-PS2-1, MS-PS2-2

Question 1 Acceleration values

$$0.60 \text{ kg: } 2 \div 1.18^2 = 1.44 \text{ m/s}^2$$

$$1.10 \text{ kg: } 2 \div 1.58^2 = 0.80 \text{ m/s}^2$$

$$1.60 \text{ kg: } 2 \div 1.93^2 = 0.54 \text{ m/s}^2$$

$$2.10 \text{ kg: } 2 \div 2.22^2 = \mathbf{0.41 \text{ m/s}^2}$$

Question 2 Mass multiplied by acceleration

$0.60 \times 1.44 = 0.86$; $1.10 \times 0.80 = 0.88$; $1.60 \times 0.54 = 0.86$; $2.10 \times 0.41 = 0.86$. The product is **about 0.86 N each time**, so the acceleration is inversely proportional to the mass.

Question 3 Graph

The graph is a **falling curve**: acceleration decreases as mass increases. Plotting acceleration against $1 \div \text{mass}$ gives a straight line through the origin whose gradient is the force.

Question 4 Compare with the weight

Difference = $0.98 - 0.86 = 0.12 \text{ N}$. $0.12 \div 0.98 \times 100 = \mathbf{12 \%}$. The missing force is the friction in the wheels and pulley, which opposes the pull.

Question 5 Control variables

Independent: **total mass moving**. Dependent: **acceleration** (from the time). Keep the same pulling force (hanger mass), the same distance and the same starting position.

Question 6 Timing uncertainty

Time: $0.1 \div 1.18 = 8.5 \%$. Because a depends on t^2 , the percentage uncertainty doubles: **about 17 %**.

Question 7 Improvements

Use light gates or video analysis to time the motion, and tilt the runway slightly so gravity cancels friction. **Any two sensible improvements** earn full credit.