

IBSMO

International British Science & Mathematics Olympiad

Science — Sample Questions

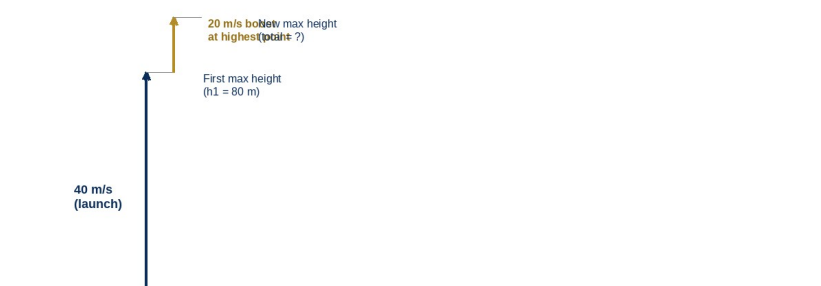
Elite Level

Grade 11–12

Question 1 — Physics — Kinematics

A probe is launched straight upward from a planet's surface at 40 m/s. The planet's gravitational acceleration is 10 m/s², and air resistance is negligible.

At the exact moment the probe reaches its highest point, its engine fires instantaneously, giving it an additional 20 m/s of upward velocity.



What is the maximum height, in metres, the probe reaches above its launch point?

- A) 90 m
- B) 95 m
- C) 100 m ✓
- D) 105 m

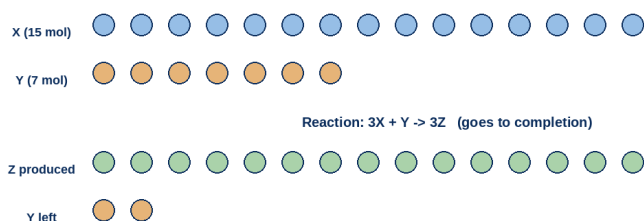
Answer: C. First stage: $h_1 = 40^2 / (2 \times 10) = 80$ m. Second stage (from rest, boosted to 20 m/s): $h_2 = 20^2 / (2 \times 10) = 20$ m. Total height = 80 + 20 = 100 m.

Question 2 — Chemistry — Limiting Reagent (Two Stages)

In a sealed vessel, the reaction $3X + Y \rightarrow 3Z$ proceeds to completion.

Initially: X = 15 mol, Y = 7 mol.

After the reaction completes, 6 more mol of X is added, and the reaction is allowed to complete again.



Then 6 more mol of X is added — reaction completes again.
Final Z + leftover Y = ?

What is the total amount of Z produced plus the leftover Y, at the end of both stages?

- A) 15 mol
- B) 18 mol
- C) 21 mol ✓

D) 24 mol

Answer: C. Stage 1: X is limiting (needs only 5 mol Y for 15 mol X), so all 15 mol X reacts, producing 15 mol Z and leaving 2 mol Y. Stage 2: 6 mol X is added; it needs exactly 2 mol Y (available) to fully react, producing 6 more mol Z and leaving 0 mol Y. Total Z = 21 mol; leftover Y = 0. Sum = 21.

Question 3 — Biology — Genetics Probability

In a certain species, allele B is dominant and b is recessive.

Two individuals with the dominant phenotype are crossed, and one offspring has the recessive phenotype.

This couple then has four more offspring.

	B	b
B	BB	Bb
b	Bb	bb

$Bb \times Bb \rightarrow 3/4$ dominant phenotype, $1/4$ recessive per child
Probability that exactly 3 of 4 more children are dominant?

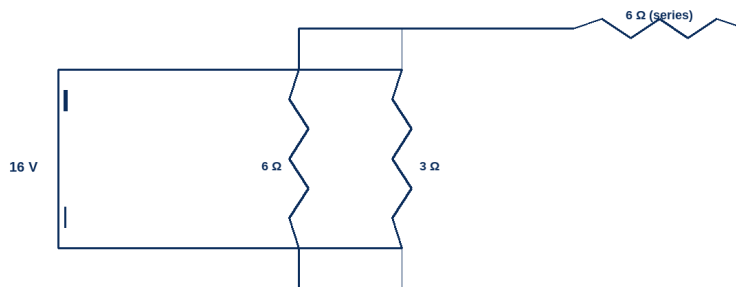
What is the probability that exactly three of these four offspring have the dominant phenotype?

- A) $9/64$
- B) $27/64$ ✓**
- C) $27/32$
- D) $81/256$

Answer: B. The recessive offspring confirms both parents are heterozygous ($Bb \times Bb$), giving each child a $3/4$ chance of the dominant phenotype. $P(\text{exactly 3 of 4}) = C(4,3) \times (3/4)^3 \times (1/4)^1 = 4 \times 27/64 \times 1/4 = 27/64$.

Question 4 — Physics — Circuit Analysis

A circuit has an ideal 16 V source. A $6\ \Omega$ resistor and a $3\ \Omega$ resistor are connected in parallel; this combination is connected in series with a $6\ \Omega$ resistor.



Find the current through the $6\ \Omega$ parallel branch

What is the current through the $6\ \Omega$ resistor in the parallel branch?

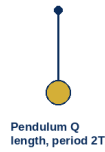
- A) $1/3\ \text{A}$
- B) $2/3\ \text{A}$ ✓**
- C) $4/3\ \text{A}$
- D) $2\ \text{A}$

Answer: B. Parallel resistance: $1/R = 1/6 + 1/3 = 1/2$, so $R = 2\ \Omega$. Total resistance = $2 + 6 = 8\ \Omega$. Total current = $16/8 = 2\ \text{A}$. Voltage across the parallel section = $2 \times 2 = 4\ \text{V}$. Current through the $6\ \Omega$ branch = $4/6 = 2/3\ \text{A}$.

Question 5 — Physics — Pendulum & Gravity

On an unfamiliar planet, researchers test simple pendulums from the same small angle, finding that the period is proportional to the square root of the pendulum's length ($T \propto \sqrt{\text{length}}$).

The planet's gravitational acceleration is 9 times that of Earth's. A pendulum of the same length is brought to Earth. A pendulum's period is inversely proportional to the square root of gravitational acceleration.



On an unknown planet: $g_{\text{planet}} = 9 \times g_{\text{Earth}}$
Same pendulum's period on the planet = 2 s. Period on Earth?

If the pendulum's period on the unknown planet is 2 seconds, what is its period on Earth?

- A) $\frac{2}{3}$ s
- B) 2 s
- C) 6 s ✓**
- D) 18 s

Answer: C. $T \propto 1/\sqrt{g}$. $T(\text{planet})/T(\text{Earth}) = \sqrt{(g(\text{Earth})/g(\text{planet}))} = \sqrt{(1/9)} = 1/3$, so $T(\text{planet}) = (1/3) \times T(\text{Earth})$. Since $T(\text{planet}) = 2$ s, $T(\text{Earth}) = 3 \times 2 = 6$ s.