

# IBSMO

International British Science & Mathematics Olympiad

## Science — Sample Questions

### Senior Level

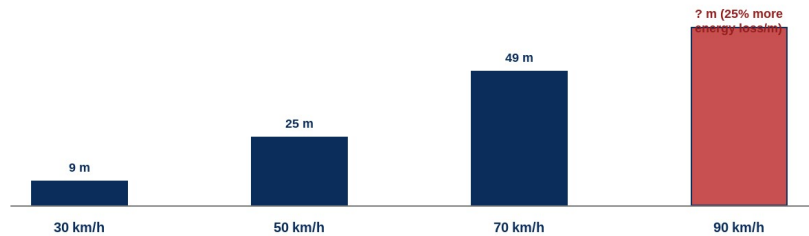
Grade 9–10

#### Question 1 — Physics — Quadratic Relationships

A vehicle brakes under identical road conditions from different speeds:

30 km/h → 9 m    50 km/h → 25 m    70 km/h → 49 m

The same vehicle now brakes from 90 km/h, but this time the energy lost per metre of braking distance is 25% greater than in the original experiments.



What is the vehicle's approximate new braking distance?

- A) 55 m
- B) 60 m
- C) 65 m ✓
- D) 70 m

**Answer: C.** The data fits  $d = 0.01v^2$ . At 90 km/h, the unadjusted distance would be  $0.01 \times 90^2 = 81$  m. Since 25% more energy is lost per metre, the actual distance is shorter:  $81 \div 1.25 \approx 65$  m.

#### Question 2 — Chemistry — Atomic Structure

Three initially neutral atoms are described:

P has 3 more protons than Q. Q has 11 electrons. R has the same number of protons as P, but 3 more neutrons than P.

Afterwards, atom P gains 3 electrons, and atom Q loses 2 electrons.



11 protons  
(neutral: 11 e<sup>-</sup>)



protons = Q + 3  
(14, neutral: 14 e<sup>-</sup>)



same protons as P  
+ 3 neutrons

After: P gains 3 electrons, Q loses 2 electrons

What is the sum of the electron counts of P and Q in their final state?

- A) 22
- B) 24

C) 26 ✓

D) 28

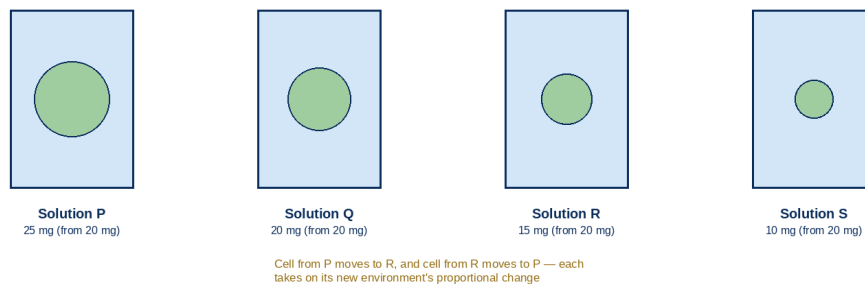
**Answer: C.** Q has 11 protons (neutral, so 11 electrons). P has  $11 + 3 = 14$  protons (and 14 electrons neutrally). After the changes:  $P = 14 + 3 = 17$ ,  $Q = 11 - 2 = 9$ . Sum =  $17 + 9 = 26$ .

### Question 3 — Biology — Osmosis and Proportional Change

Identical cells are placed in four solutions, each starting at 20 mg. After 40 minutes:

Solution P: 25 mg    Solution Q: 20 mg    Solution R: 15 mg    Solution S: 10 mg

A cell from Solution P is then moved to Solution R, and a cell from Solution R is moved to Solution P. Each cell shows the same proportional change characteristic of its new environment, applied to its current mass at the moment of transfer.



**What is the sum of the two cells' masses in the final state?**

A) 35.0 mg

B) 36.5 mg

C) 37.5 mg ✓

D) 38.0 mg

**Answer: C.** Solution P's ratio is  $25/20 = 1.25$ ; Solution R's ratio is  $15/20 = 0.75$ . The cell moving from P (currently 25 mg) into R becomes  $25 \times 0.75 = 18.75$  mg. The cell moving from R (currently 15 mg) into P becomes  $15 \times 1.25 = 18.75$  mg. Sum = 37.5 mg.

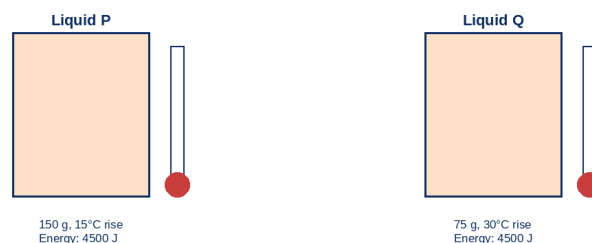
### Question 4 — Physics — Specific Heat

At the same starting temperature:

150 g of liquid P needs 4,500 J to rise 15 °C.

75 g of liquid Q needs 4,500 J to rise 30 °C.

Assume no heat loss.



**If equal masses of P and Q are given equal amounts of energy, how do their temperature changes compare?**

A) P's change is twice Q's

B) Q's change is twice P's

C) The changes are equal ✓

D) Q's change is four times P's

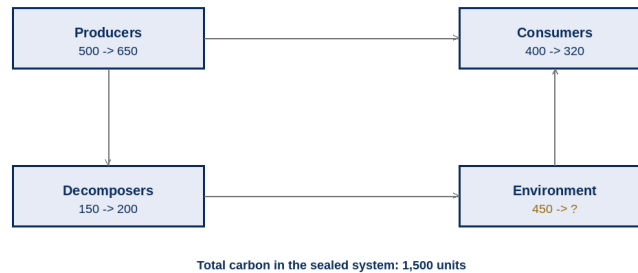
**Answer: C.** Specific heat capacity:  $c_P = 4500/(150 \times 15) = 2 \text{ J/(g} \cdot ^\circ\text{C)}$ ;  $c_Q = 4500/(75 \times 30) = 2 \text{ J/(g} \cdot ^\circ\text{C)}$ . Since the specific heats are equal, equal mass and equal energy produce equal temperature change.

**Question 5** — Biology / Earth Science — Closed-System Balance

A sealed but light-permitting container holds producers, consumers and decomposers, with 1,500 units of carbon in total at the start.

After some time: Producers 500  $\rightarrow$  650. Consumers 400  $\rightarrow$  320. Decomposers 150  $\rightarrow$  200. Environmental carbon ( $\text{CO}_2$  etc.): 450  $\rightarrow$  ?

The container is fully sealed, with no carbon exchange with the outside.



**How many units of carbon should be in the environment in the final state?**

- A) 300
- B) 330 ✓**
- C) 360
- D) 390

**Answer: B.** The three living compartments changed by +150, -80, and +50 — a net gain of +120. Since the total carbon (1,500) is fixed, the environment must lose exactly 120:  $450 - 120 = 330$ .