Bonfire Night maths activities for IGCSE and GCSE: Beyond school: answers

IGCSE Math Revision · Beyond school: for adults and maths fans · 5 November · Teacher answers and notes

No calculator needed. Every answer works out exactly. Take $g = 10$ m/s^2.

Teacher notes

- A stretch set for anyone past school maths: adults, maths clubs and keen sixth-formers. Competition style, no calculator, every answer exact.
- Task B's last part has a neat symmetry argument; ask solvers to explain it before checking with a sum.

Starter

1. **10**
   - Choose the 2 places for the Roman candles out of 5: ${}^5C_2 = 10$
2. **1/10 (per metre)**
   - $4\pi r^2 \div (4\pi r^3/3) = 3/r = 3/30 = 1/10$
3. **144**
   - 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144
4. **3**
   - 5^6 leaves remainder 1, so 5^{11} leaves the same as 5^5.
   - $5^2 \to 4$, $5^4 \to 2$, $5^5 \to 10 \to 3$

Task A: The best launch angle

a. **45°**
- sin 2θ is greatest (1) when 2θ = 90°.

b. **40 m**
- 400 × 1 ÷ 10 = 40

c. **15° and 75°**
- sin 2θ = 20 × 10 ÷ 400 = 1/2
- 2θ = 30° or 150°, so θ = 15° or 75°

Task B: Sparkler probability

a. **7/15**
- ${}^8C_3 \div {}^{10}C_3 = 56/120 = 7/15$

b. **1/5**
- The duds take 2 of the 10 places: ${}^{10}C_2 = 45$ choices, 9 of them next to each other.
- 9/45 = 1/5

c. **8/3**
- Each good sparkler comes before both duds with probability 1/3 (it is equally likely to be first, second or third of the three).
- 8 × 1/3 = 8/3

Extension

1. **3 different distances; the squares add to 48**
   - Distances: 1 (12 edges), √2 (12 face diagonals), √3 (4 space diagonals).
   - 12 × 1 + 12 × 2 + 4 × 3 = 48

Every question is original and every answer was checked before publishing.