

**MASSACHUSETTS MATHEMATICS LEAGUE
CONTEST 2 - NOVEMBER 2016 SOLUTION KEY**

Round 2

A) $A - 7 = R + 7 \Rightarrow A = R + 14$

$$A + 5 = 7(R - 5) \Leftrightarrow R + 19 = 7R - 35 \Rightarrow 6R = 54 \Rightarrow R = 9 \Rightarrow \underline{(23, 9)}.$$

B) Given: $x \blacklozenge y = x^2 + y^2 + xy$

$$2 \blacklozenge x = 4 + x^2 + 2x = 12 \Leftrightarrow x^2 + 2x - 8 = (x + 4)(x - 2) = 0 \Rightarrow x = -4, 2$$

$$3 \blacklozenge (-4) = 9 + 16 - 12 = \underline{13}.$$

$$3 \blacklozenge 2 = 9 + 4 + 6 = \underline{19}.$$

C) Given: $F = 1200$, when $(m_1, m_2, d) = (5, 20, 8)$

$$F = k \frac{m_1 m_2}{d^2} \Rightarrow 1200 = \frac{100k}{64} \Rightarrow k = 12(64) \text{ Then:}$$

$$2208 = 12(64) \frac{(5+n)(20+n)}{64} \Rightarrow 100 + 25n + n^2 = \frac{2208}{12} = 184$$

$$\Rightarrow n^2 + 25n - 84 = (n - 3)(n + 28) = 0 \Rightarrow n = \underline{3}.$$