

MATHEMATICS ENRICHMENT CLUB.
 Problem Sheet 11, August 2, 2012

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1. Solve $\frac{x + 3y}{2x + 5y} = \frac{4}{7}$.
2. Find a number less than 100 which is increased by 20% when the digits are reversed.
3. (a) Verify that

$$\begin{aligned} x^{15} - 1 &= (x^3 - 1)(x^{12} + x^9 + x^6 + x^3 + 1) \\ &= (x^5 - 1)(x^{10} + x^5 + 1): \end{aligned}$$

- (b) Hence factor $2^5 - 1$ as a product of prime factors.
- (c) Can you factorise $2^5 + 1$ as a product of prime factors?
4. Suppose that P is a point inside a rectangle ABCD with AB = 15cm, and AD = 10cm. If PA = 14cm and PB = 11cm, find PD in surd form.
5. Find all positive integers m and n such that $3m - 1$ is a multiple of n and $3n - 1$ is a multiple of m.
 (Hint: Suppose $m = n$, then n divides $3m - 1 < 3m - 3n$.)

6. (a) Let M be the midpoint of the side BC of the triangle ABC and let N be the midpoint of AC. Suppose that AM and BN meet at S. Show that

$$AS : SM = BS : SN = 2 : 1:$$

- (b) Hence show that the medians of a triangle are concurrent.
7. (a) Let M be the midpoint of the side AB in the triangle ABC. If CM has length h, prove that

$$2(a^2 + b^2) = c^2 + 4h^2:$$

This is known as Apollonius' theorem.

- (b) Show how to draw a triangle knowing only the lengths of the three medians k and l. (You can either use (i), or find a better way.)

¹Some of the problems here come from T. Gagen, Uni. of Syd. and from E. Szekeres, Macquarie Uni.