The Scottish Mathematical Council

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MATHEMATICAL CHALLENGE 2006–2007

Entries must be the unaided efforts of individual pupils. Solutions must include explanations.

Answers without explanation will be given no credit.

CURRENT AND RECENT SPONSORS OF MATHEMATICAL CHALLENGE ARE

The Edinburgh Mathematical Society, Professor L E Fraenkel,

The London Mathematical Society and The Scottish International Education Trust.

Middle Division: Problems 1

M1. Lord Snooty's park is in the shape of a perfect circle of diameter 5 miles. There are two monuments in the park. To reach the first – commemorating the Battle with the Bash Street Kids – enter the park at its most northerly point and proceed due south for a mile. To reach the second monument – erected on the occasion of the 50th Birthday of Dennis the Menace – from the first monument, go due west until the perimeter of the park is reached then turn due south and proceed for one and a half miles.

How far apart are the two monuments (as the crow flies) ?

M2. The diagram shows two wheels of the same diameter. The lower wheel is fixed and the upper wheel rotates without slipping about the lower wheel, the two wheels always being in contact. How many times does the upper wheel turn on its axis in making a complete revolution of the lower wheel?
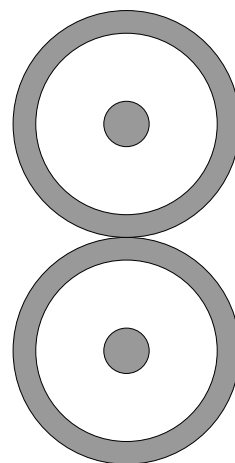
M3. Two young mountaineers were descending a mountain quickly at 6 miles per hour. They had left the hostel late in the day, had climbed to the top of the mountain and were returning by the same route. One said to the other "It was three o'clock when we left the hostel. I am not sure if we will be back before nine o'clock." His companion replied "Our pace on the level was 4 miles per hour and we climbed at 3 miles per hour. We will just make it." What is the total distance they would cover from leaving the hostel to getting back there?

M4. In a snowball 'fight', where snowballs are identical spheres, your opponents have stacked their snowballs in a square pyramid. You are about to count the snowballs along the bottom edge of the opponent's stack when one appears with another snowball. After giving him a telling off, the opposition's leader takes apart the square pyramid and builds a new, triangular pyramid using all the original snowballs and the extra one. Find two possible values for the number of snowballs that your opponents now have.

M5. Three cyclists are out for the day. Two are on a tandem and one on an ordinary cycle. Disaster struck when the ordinary cycle was stolen while they were having lunch in a café. They were left with the tandem and 20 miles to go. The tandem has to have two riders and the third person walks. Anne can walk a mile in 20 minutes, Sam in 30 minutes and Oscar in 40 minutes. The tandem travels at 20 miles per hour no matter which pair is riding it. What is the shortest time for all three to get home?

END OF PROBLEM SET 1