THE ANSWERS

CHALLENGE 1

$$\frac{\text{distance}}{\text{speed}} = \text{time} \qquad \frac{2000}{80} = 25 \text{ seconds}$$

CHALLENGE 2

(a)

120 - 20 = 100 (Finding difference in speeds)

$$\frac{1600}{100} = 16 \text{ seconds}$$

(b)

There are several ways to solve this. We'll solve it below by using our answer from (a) to figure out whether the point where the cars cross is before or after the Speed Trap. If the cars cross before the Speed Trap, then the Ferrari must reach it first, if they cross after the Speed Trap, the Ford must be first.

120 x 16 = 1920 (Distance the Ferrari travels until the cars cross)

1600 + 440 = 2040 (Distance from Ferrari to Speed Trap)

$1920 < 2040$

> Crossing point is before Speed Trap
> Ferrari reaches the Speed Trap first

(c)

$$\frac{2040}{120} = 17 \text{ seconds}$$

(Time taken for Ferrari to reach Speed Trap)

20 x 17 = 340 metres (Distance Ford travels in that time)

440 - 340 = 100 metres (Distance from the Ford to the Speed Trap)

CHALLENGE 3 - WARNING: HARD!

There are two methods to solve this. The easier method is using a SUVAT equation (aka The Equations of Motion). The harder method is by using Calculus. I'll show both.

SUVAT Method:

First list out our variables and select our equation. We have distance, initial speed and acceleration and we want to know time.

$s = 1500$
$u = 25$
$v =$
$a = 5$
$t =$ (want to know)

$s = ut + \frac{1}{2}at^2$ (This is the equation we'll use)

$\frac{1}{2}at^2 + ut - s = 0$ (rearranging to be a quadratic equation)

$2.5t^2 + 25t - 1500 = 0$ (substituting in our variables)

$t^2 + 10t - 600 = 0$ (dividing by 2.5)

$(t + 30)(t - 20) = 0$ (factorising the quadratic)

$t = -30$

or $t = 20$ seconds — We want the positive solution, so this is the answer

Calculus Method:

Observe the speed of the Dodge Viper can be written as the equation $y = 5x + 25$ where y is the speed and x is the time. The area under this curve represents the distance travelled. We want to calculate that (which we can through integration) and find what time t would give us our distance 1500m.

$y = 5x + 25$ (this is our equation of speed)

$\int_0^t 5x + 25$ (adding in our integral)

$= \left[\frac{5}{2}x^2 + 25x\right]_0^t$ (integrating)

$= \frac{5}{2}t^2 + 25t$ (calculating integral)

$1500 = \frac{5}{2}t^2 + 25t$ (setting equal to our distance)

$0 = \frac{5}{2}t^2 + 25t - 1500$ (minus 1500 from both sides)

$0 = t^2 + 10t - 600$ (dividing by 2.5)

$0 = (t + 30)(t - 20)$ (factorising as it is a quadratic)

$t = -30$

or $t = 20$ seconds — We want the positive solution so this is the answer