

Physics: Velocity–Time Graph and Engine Cooling

Worked answers based on the graph and the data shown in the photographs.

(a) Why was the businessman advised to use water?

Water has a high specific heat capacity ($4200 \text{ J kg}^{-1} \text{ K}^{-1}$). This means that it can absorb a large amount of heat for a given mass without its temperature rising too quickly. It is therefore effective for removing heat from an overheated engine.

(b) How far is the car from town A when it stops?

The area under a velocity–time graph gives the distance travelled. Reading the graph gives the following sections: 0–300 s (velocity increases from 0 to 20 m/s), 300–600 s (velocity = 20 m/s), 600–1080 s (velocity increases from 20 to 30 m/s), and 1080–1200 s (velocity decreases from 30 m/s to 0).

Section	Calculation	Distance
0–300 s	$\frac{1}{2} \times 300 \times 20$	3,000 m
300–600 s	300×20	6,000 m
600–1080 s	$\frac{1}{2}(20 + 30) \times 480$	12,000 m
1080–1200 s	$\frac{1}{2} \times 120 \times 30$	1,800 m
Total	$3,000 + 6,000 + 12,000 + 1,800$	22,800 m

Answer: The car is approximately **22,800 m = 22.8 km** from town A when it stops.

(c) Should he add 20 litres of water or call the rescue team?

Assume 20 litres of water has a mass of about 20 kg because the density of water is approximately 1 kg/L. The heat absorbed is $Q = mc\Delta T$.

$$Q = 20 \times 4200 \times (120 - 70) = 4,200,000 \text{ J} = \mathbf{4200 \text{ kJ}}.$$

The engine must lose 4500 kJ to reach 70 °C. The 20 litres of water can remove only 4200 kJ, leaving a shortfall of 300 kJ.

Conclusion: The 20 litres of water are not sufficient to cool the engine to 70 °C. It is therefore safer to **call the rescue team** rather than continue the journey.

(d) If water is not available, which liquid would you recommend?

I would recommend a proper **engine coolant/antifreeze (such as an ethylene-glycol-based coolant)**. It is formulated for engine cooling and can withstand high temperatures and help protect the cooling system. However, the exact coolant should be used according to the vehicle manufacturer's instructions.

Note: The graph values have been read from the photographed graph as 300 s, 600 s, 1080 s and 1200 s. If the printed axis labels differ on the original sheet, the numerical distance in part (b) should be recalculated using those exact values.