5 A new high-speed train is being installed in China. The total mass of a high-speed train is 500 000 kg.

Fig. 5.1 shows how the speed of a high-speed train on a horizontal straight track varies with time.

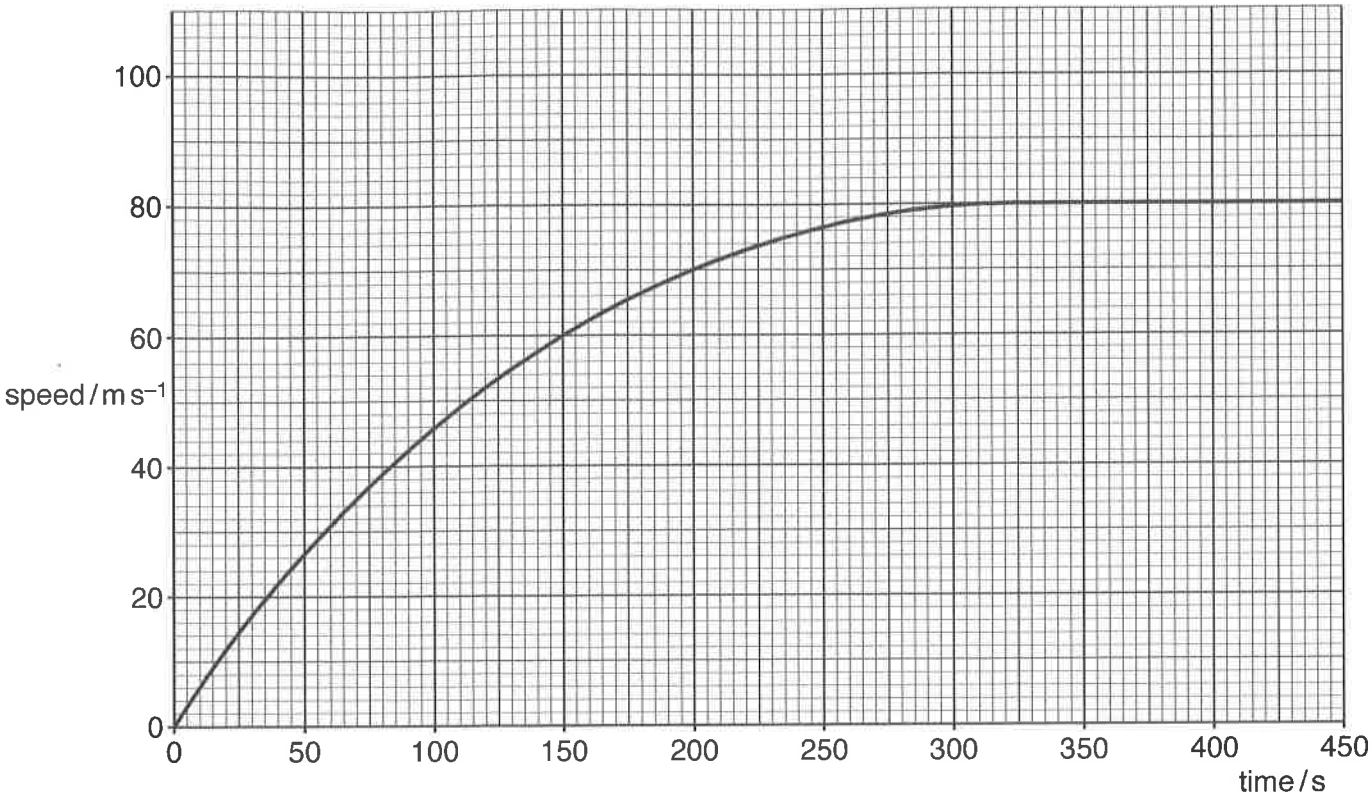

Fig. 5.1

(a) (i) Using the graph in Fig. 5.1, estimate the initial resultant force on the train as it starts moving.

force = ... N [2]

(ii) Calculate the kinetic energy of the train at its maximum speed.

kinetic energy = ... J [1]

(b) High-speed trains travel with a top speed of at least 200 km h^{-1}.

The trains are provided with electrical power from overhead lines.

The graph in Fig. 5.2 shows the energy transferred per unit distance of a high-speed train as a function of its average speed, over inter-city journeys of about 600 km.

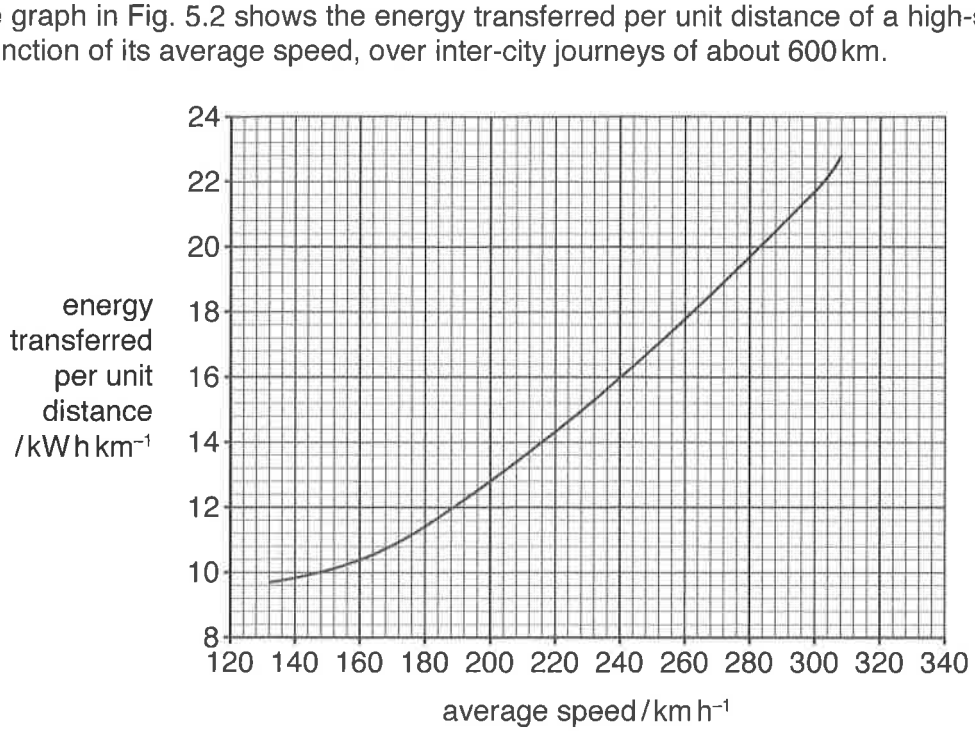

Fig. 5.2

(i) Using data from the graph in Fig. 5.2, calculate the total energy, in joules, transferred to the train for a 600 km journey at an average speed of 200 km h^{-1}.

energy = ... J [2]

(ii) Suggest why the transferred energy per unit distance is higher at an average speed of 300 km h^{-1}.

.....

.....

.....

.....[1]

(iii) A student states that travelling by high-speed trains between cities needs more energy than cars and so new high-speed trains should not be introduced into China.

By considering the energy needed per passenger per kilometre, state whether you agree with the student and justify your conclusion. You may need to estimate some numbers used in any calculations.

A typical car will use 40 dm^3 of petrol to travel 600 km and carries 2–6 people. A typical train will carry 100–500 people.

1 dm^3 of petrol supplies approximately 2.9×10^7 J.

.....

.....[2]