

Work & Energy – Q2 [11 marks](19/6/21)

Exam Boards

OCR : Mechanics (Year 1)

MEI: Mechanics a

AQA: Mechanics (Year 1)

Edx: Mechanics 1 (Year 1)

A car of mass 1200kg pulls a trailer of mass 400kg . There are resistances of 400N and 100N on the car and trailer, respectively.

(i) If an acceleration of 0.2ms^{-2} is possible when travelling at 20ms^{-1} , find the maximum speed of the car. [6 marks]

(ii) If the trailer is connected to the car by means of a rope, what is the maximum deceleration that is possible? [5 marks]

Solution

(i) Considering the car and trailer combined, if X is the driving force of the car's engine:

$$N2L \Rightarrow X - (400 + 100) = (1200 + 400)(0.2)$$

$$\Rightarrow X = 820N \quad [3 \text{ marks}]$$

The (maximum) power of the car's engine is therefore

$$820(20) = 16400 \quad [1 \text{ mark}]$$

At maximum speed, the driving force is equal to the total resistance, $500N$, and the maximum speed, v_{max} is given by

$$16400 = 500v_{max} ,$$

$$\text{so that } v_{max} = 32.8ms^{-1} \quad [2 \text{ marks}]$$

(ii) Considering the trailer,

$$N2L \Rightarrow T - 100 = 400a ,$$

where T is the tension, and a is the acceleration [1 mark]

The rope cannot be in compression, so $T > 0$.

$$\text{Hence } T = 400a + 100 > 0 \quad [2 \text{ marks}]$$

$$\Rightarrow a > -0.25$$

ie the maximum possible deceleration is $0.25ms^{-2}$ [2 marks]