2 A car of mass 1500 kg is towing a trailer of mass m kg along a straight horizontal road. The car and the trailer are connected by a tow-bar which is horizontal, light and rigid. There is a resistance force of F N on the car and a resistance force of 200 N on the trailer. The driving force of the car's engine is 3200 N, the acceleration of the car is $1.25\,\text{m s}^{-2}$ and the tension in the tow-bar is 300 N.

Find the value of m and the value of F. [4]

6 On a straight horizontal test track, driverless vehicles (with no passengers) are being tested. A car of mass 1600 kg is towing a trailer of mass 700 kg along the track. The brakes are applied, resulting in a deceleration of $12\,m\,s^{-2}$. The braking force acts on the car only. In addition to the braking force there are constant resistance forces of 600 N on the car and of 200 N on the trailer.

(a) Find the magnitude of the force in the tow-bar. [2]

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(b) Find the braking force. [2]

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(c) At the instant when the brakes are applied, the car has speed $22\,m\,s^{-1}$. At this instant the car is 17.5 m away from a stationary van, which is directly in front of the car.

Show that the car hits the van at a speed of $8\,m\,s^{-1}$. [2]

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(d) After the collision, the van starts to move with speed $5\,m\,s^{-1}$ and the car and trailer continue moving in the same direction with speed $2\,m\,s^{-1}$.

Find the mass of the van. [3]

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2 A van of mass 3600 kg is towing a trailer of mass 1200 kg along a straight horizontal road using a light horizontal rope. There are resistance forces of 700 N on the van and 300 N on the trailer.

(a) The driving force exerted by the van is 2500 N.

Find the tension in the rope. [4]

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The driving force is now removed and the van driver applies a braking force which acts only on the van. The resistance forces remain unchanged.

(b) Find the least possible value of the braking force which will cause the rope to become slack. [2]

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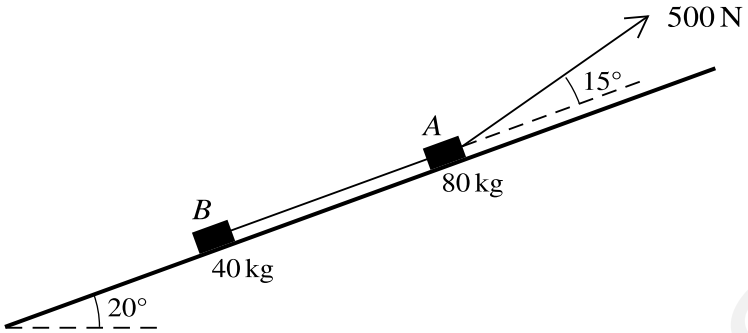

A block A of mass 80 kg is connected by a light, inextensible rope to a block B of mass 40 kg. The rope joining the two blocks is taut and is parallel to a line of greatest slope of a plane which is inclined at an angle of 20° to the horizontal. A force of magnitude 500 N inclined at an angle of 15° above the same line of greatest slope acts on A (see diagram). The blocks move up the plane and there is a resistance force of 50 N on B, but no resistance force on A.

(a) Find the acceleration of the blocks and the tension in the rope. [5]

(b) Find the time that it takes for the blocks to reach a speed of $1.2\,\text{m}\,\text{s}^{-1}$ from rest. [2]

5 A van of mass 4500 kg is towing a trailer of mass 750 kg down a straight hill inclined at an angle of θ to the horizontal where $\sin\theta = 0.05$. The van and the trailer are connected by a light rigid tow-bar which is parallel to the road. There are constant resistance forces of 2500 N on the van and 300 N on the trailer.

(a) It is given that the tension in the tow-bar is 450 N.

Find the acceleration of the trailer and the driving force of the van's engine. [4]

On another occasion, the van and trailer ascend a straight hill inclined at an angle of α to the horizontal where $\sin\alpha = 0.09$. The driving force of the van's engine is now 9100 N, and the speed of the van at the bottom of the hill is $20\,\text{m}\,\text{s}^{-1}$. The resistances to motion are unchanged.

(b) (i) Find the acceleration of the van and the tension in the tow-bar. [5]

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(ii) Find the speed of the van when it has travelled a distance of 375 m up the hill. [2]

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