

- 2 A car of mass 1800 kg is towing a trailer of mass 400 kg along a straight horizontal road. The car and trailer are connected by a light rigid tow-bar. The car is accelerating at 1.5 m s^{-2} . There are constant resistance forces of 250 N on the car and 100 N on the trailer.

(a) Find the tension in the tow-bar.

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(b) Find the power of the engine of the car at the instant when the speed is 20 m s^{-1} .

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- 3 A car of mass m kg is towing a trailer of mass 300 kg down a straight hill inclined at 3° to the horizontal at a constant speed. There are resistance forces on the car and on the trailer, and the total work done against the resistance forces in a distance of 50 m is 40 000 J. The engine of the car is doing no work and the tow-bar is light and rigid.

(a) Find the value of m . [3]

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The resistance force on the trailer is 200 N.

(b) Find the tension in the tow-bar between the car and the trailer. [2]

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- 4 A toy railway locomotive of mass 0.8 kg is towing a truck of mass 0.4 kg on a straight horizontal track at a constant speed of 2 m s^{-1} . There is a constant resistance force of magnitude 0.2 N on the locomotive, but no resistance force on the truck. There is a light rigid horizontal coupling connecting the locomotive and the truck.

(a) State the tension in the coupling. [1]

(b) Find the power produced by the locomotive's engine. [1]

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The power produced by the locomotive's engine is now changed to 1.2 W.

(c) Find the magnitude of the tension in the coupling at the instant that the locomotive begins to accelerate. [5]

[illegible]

3 A constant resistance of magnitude 1400 N acts on a car of mass 1250 kg.

- (a) The car is moving along a straight level road at a constant speed of 28 m s^{-1} .

Find, in kW, the rate at which the engine of the car is working.

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- (b) The car now travels at a constant speed up a hill inclined at an angle of θ to the horizontal, where $\sin \theta = 0.12$, with the engine working at 43.5 kW.

Find this speed.

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- (c) On another occasion, the car pulls a trailer of mass 600 kg up the same hill. The system of the car and the trailer is modelled as particles connected by a light inextensible cable. The car's engine produces a driving force of 5000 N and the resistance to the motion of the trailer is 300 N. The resistance to the motion of the car remains 1400 N.

Find the acceleration of the system and the tension in the cable.

[4]

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- 6 A car of mass 1600 kg is pulling a caravan of mass 800 kg. The car and the caravan are connected by a light rigid tow-bar. The resistances to the motion of the car and caravan are 400 N and 250 N respectively.

(a) The car and caravan are travelling along a straight horizontal road.

- (i) Given that the car and caravan have a constant speed of 25 m s^{-1} , find the power of the car's engine. [2]

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- (ii) The engine's power is now suddenly increased to 39 kW. Find the instantaneous acceleration of the car and caravan and find the tension in the tow-bar. [5]

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- (b) The car and caravan now travel up a straight hill, inclined at an angle of $\sin^{-1} 0.05$ to the horizontal, at a constant speed of $v \text{ m s}^{-1}$. The car's engine is working at 32.5 kW.

Find v .

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- 6** A car of mass 1750 kg is pulling a caravan of mass 500 kg. The car and the caravan are connected by a light rigid tow-bar. The resistances to the motion of the car and caravan are 650 N and 150 N respectively.

(a) The car and caravan are moving along a straight horizontal road at a constant speed of 24 m s^{-1} .

- (i)** Find the power of the car's engine. [2]

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- (ii)** The engine's power is now suddenly increased to 40 kW.

Find the instantaneous acceleration of the car and caravan and find the tension in the tow-bar. [5]

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- (b) The car and caravan now travel up a straight hill, inclined at an angle $\sin^{-1} 0.14$ to the horizontal, at a constant speed of $v \text{ m s}^{-1}$. The car's engine is working at 31 kW. The resistances to the motion of the car and caravan are unchanged.

Find v .

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- 6 A car of mass 1500 kg is pulling a trailer of mass 750 kg up a straight hill of length 800 m inclined at an angle of $\sin^{-1} 0.08$ to the horizontal. The resistances to the motion of the car and trailer are 400 N and 200 N respectively. The car and trailer are connected by a light rigid tow-bar. The car and trailer have speed 30 m s^{-1} at the bottom of the hill and 20 m s^{-1} at the top of the hill.

(a) Use an energy method to find the constant driving force as the car and trailer travel up the hill.

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After reaching the top of the hill the system consisting of the car and trailer travels along a straight level road. The driving force of the car's engine is 2400 N and the resistances to motion are unchanged.

(b) Find the acceleration of the system and the tension in the tow-bar. [4]

[illegible]

- 5** A car of mass 1250 kg is pulling a caravan of mass 800 kg along a straight road. The resistances to the motion of the car and caravan are 440 N and 280 N respectively. The car and caravan are connected by a light rigid tow-bar.

(a) The car and caravan move along a horizontal part of the road at a constant speed of 30 m s^{-1} .

- (i)** Calculate, in kW, the power developed by the engine of the car. [2]

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- (ii)** Given that this power is suddenly decreased by 8 kW, find the instantaneous deceleration of the car and caravan and the tension in the tow-bar. [4]

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- (b) The car and caravan now travel along a part of the road inclined at $\sin^{-1} 0.06$ to the horizontal. The car and caravan travel up the incline at constant speed with the engine of the car working at 28 kW.

(i) Find this constant speed. [3]

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(ii) Find the increase in the potential energy of the caravan in one minute. [2]

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- (a) It is given that as the car and trailer descend the hill, the engine of the car does 150 000 J of work, and there are no resistance forces.

Find the length of the hill.

[5]

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- (b)** It is given instead that there is a resistance force of 100 N on the trailer, the length of the hill is 200 m, and the acceleration of the car and trailer is constant.

Find the tension in the tow-bar between the car and trailer.

[4]

[illegible]