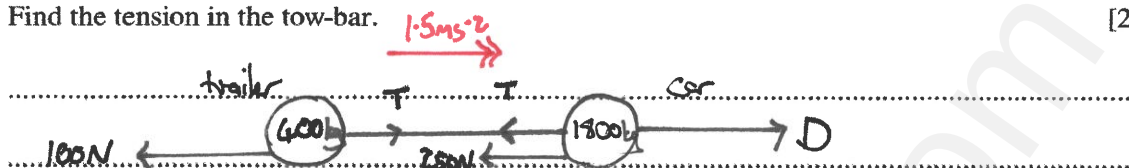


- 2 A car of mass 1800 kg is towing a trailer of mass 400 kg along a straight horizontal road. The car and trailer are connected by a light rigid tow-bar. The car is accelerating at 1.5 m s^{-2} . There are constant resistance forces of 250 N on the car and 100 N on the trailer.

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

[2]



Trailer:

$$R(\rightarrow): F = ma$$

$$T - 100 = 400 \times 1.5$$

$$T - 100 = 600$$

$$T = \underline{\underline{700 \text{ N}}}$$

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

[3]

Car:

$$R(\rightarrow): F = ma$$

$$D - T - 250 = 1800 \times 1.5$$

$$D - 700 - 250 = 2700$$

$$D - 950 = 2700$$

$$D = \underline{\underline{3650 \text{ N}}}$$

$$\text{Power} = D \times v$$

$$= 3650 \times 20$$

$$= \underline{\underline{73\,000 \text{ W}}}$$

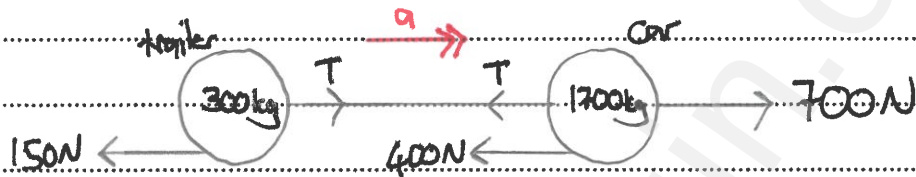
- 4 A car of mass 1700 kg is pulling a trailer of mass 300 kg along a straight horizontal road. The car and trailer are connected by a light inextensible cable which is parallel to the road. There are constant resistances to motion of 400 N on the car and 150 N on the trailer. The power of the car's engine is 14 000 W.

Find the acceleration of the car and the tension in the cable when the speed is 20 ms^{-1} . [6]

$$\text{Power} = D \times v$$

$$14000 = D \times 20$$

$$D = 700 \text{ N}$$



Car:

$$R(\rightarrow): F = ma$$

$$700 - 400 - T = 1700a$$

$$300 - T = 1700a \quad (1)$$

Trailer:

$$R(\rightarrow): F = ma$$

$$T - 150 = 300a \quad (2)$$

(1) + (2):

$$300 - 150 = 2000a$$

$$150 = 2000a$$

$$a = \underline{\underline{0.075 \text{ ms}^{-2}}}$$

$$\rightarrow (2): T - 150 = 300 \times 0.075$$

$$T - 150 = 22.5$$

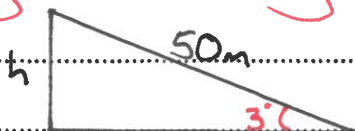
$$T = \underline{\underline{172.5 \text{ N}}}$$

- 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]

Change in height when travelling 50m:



$$\sin 3 = \frac{h}{50}$$

$$h = 50 \sin 3$$

$$\text{Work}_w + KE_{\text{init}} + PE_{\text{init}} = KE_{\text{fin}} + PE_{\text{fin}} + \text{Work}_{\text{out}}$$

$$0 + \frac{1}{2}(m+300)v^2 + 0 = \frac{1}{2}(m+300)v^2 + (m+300) \times 10 \times -50 \sin 3 + 40\,000$$

$$\frac{1}{2}(m+300)v^2 = \frac{1}{2}(m+300)v^2 + (m+300) \times -50 \sin 3 + 40\,000$$

$$(m+300) \times 500 \sin 3 = 40\,000$$

$$m + 300 = 1528.59$$

$$m = 1228.59$$

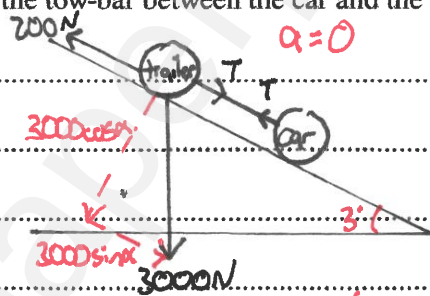
$$= \underline{\underline{1230 \text{ kg}}}$$

The resistance force on the trailer is 200 N.

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

[2]

Trailer:



$$R(\downarrow): F = ma \quad \leftarrow a=0 \text{ (constant speed)}$$

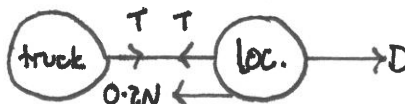
$$T + 3000 \sin 3 - 200 = 0$$

$$T + 157.0 - 200 = 0$$

$$T - 43.0 = 0$$

$$T = \underline{\underline{43.0 \text{ N}}}$$

- 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 ms^{-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]

Truck: $R(\rightarrow): F = ma \leftarrow a = 0 \text{ (constant speed)}$
 $T = 0\text{ N}$

- (b) Find the power produced by the locomotive's engine.

[1]

Locomotive: $R(\rightarrow): F = ma$
 $D - T - 0.2 = 0$
 $D - 0 - 0.2 = 0$
 $D = 0.2\text{ N}$

$\text{Power} = D \times v$
 $= 0.2 \times 2$
 $= 0.4\text{ W}$

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]

$\text{Power} = D \times v$
 $1.2 = D \times 2$
 $D = 0.6\text{ N}$

Locomotive:

$R(\rightarrow): F = ma$
 $0.6 - T - 0.2 = 0.8a$
 $0.4 - T = 0.8a \quad \textcircled{1}$

Truck:

$R(\rightarrow): F = ma$
 $T = 0.4a \quad \textcircled{2}$

$\textcircled{2}: T = 0.4 \times \frac{1}{3}$
 $= 0.133\text{ N}$

$\textcircled{1} + \textcircled{2}: 0.4 = 1.2a$
 $a = \frac{1}{3}$

- 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.

[2]

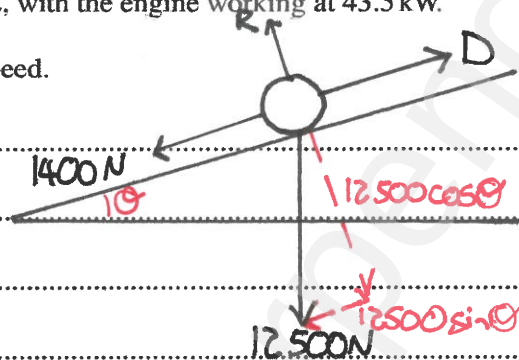
Constant speed, so $a = 0$ and driving force = resistance = 1400 N

$$\begin{aligned} \text{Power} &= D \times v \\ &= 1400 \times 28 \\ &= \underline{\underline{39200 \text{ W}}} \end{aligned}$$

- (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.

[3]



$$R(\uparrow): D - 1400 - 12500 \sin \theta = ma$$

$$D - 1400 - 12500 \times 0.12 = 0$$

$$D - 1400 - 1500 = 0$$

$$D = 2900 \text{ N}$$

$$\text{Power} = D \times v$$

$$43500 = 2900v$$

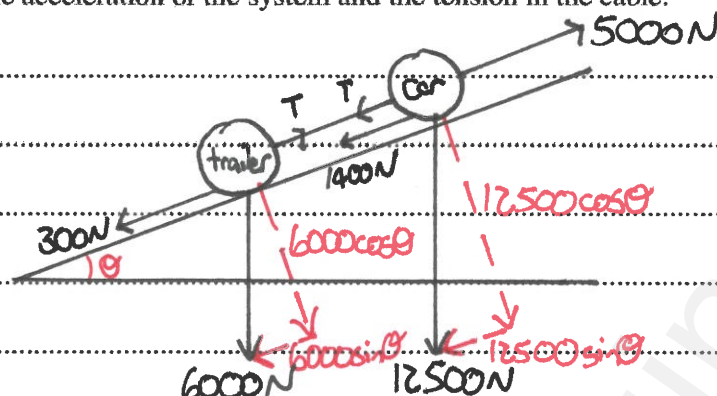
$$v = \underline{\underline{15 \text{ m s}^{-1}}}$$

$a = 0$ (constant speed)

- (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]



Car:

$$R(\nearrow): 5000 - 1400 - 12500 \sin \theta - T = 1250a$$

$$3600 - 12500 \times 0.12 - T = 1250a$$

$$2100 - T = 1250a \quad (1)$$

Trailer:

$$R(\nearrow): T - 300 - 6000 \sin \theta = 600a$$

$$T - 300 - 6000 \times 0.12 = 600a$$

$$T - 1020 = 600a \quad (2)$$

$$(1) + (2): 2100 - 1020 = 1850a$$

$$1080 = 1850a$$

$$a = 0.584 \text{ ms}^{-2} \text{ STO}$$

$$\rightarrow (2): T - 1020 = 600 \times 0.584$$

$$T = 350.27 + 1020$$

$$= 1370 \text{ N}$$

- 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]

Constant speed, so $a=0$. Consider whole system:

$$R(\rightarrow): D - 400 - 250 = 0$$

$$D = 650 \text{ N}$$

$$\text{Power} = D \times v$$

$$= 650 \times 25$$

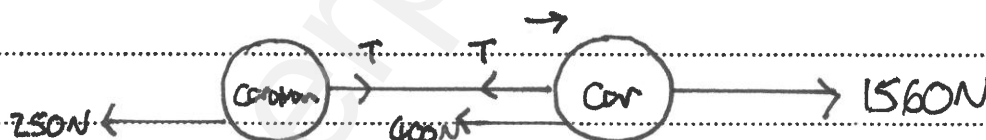
$$= \underline{16250 \text{ W}}$$

- (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]

$$\text{Power} = D \times v$$

$$39000 = D \times 25$$

$$D = 1560 \text{ N}$$



Car:

$$R(\rightarrow): F = ma$$

$$1560 - 400 - T = 1600a$$

$$1160 - T = 1600a \quad (1)$$

Caravan:

$$R(\rightarrow): F = ma$$

$$T - 250 = 800a \quad (2)$$

cont.

$$\textcircled{1} + \textcircled{2}: 1160 - 250 = 2400a$$

$$910 = 2400a$$

$$a = 0.379 \text{ ms}^{-2} \quad \text{STO}$$

$$\rightarrow \textcircled{2}: T - 250 = 800 \times 0.379$$

$$T - 250 = 303.3$$

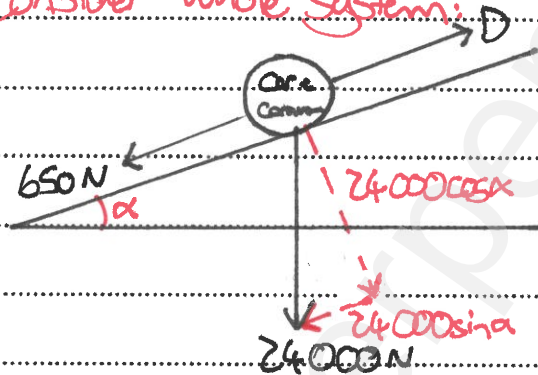
$$T = 553 \text{ N}$$

- (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 $v \text{ ms}^{-1}$. The car's engine is working at 32.5 kW. $\uparrow \sin \alpha = 0.05$

Find v .

[3]

Consider whole system:



$$R(\uparrow): D - 650 - 24000 \sin \alpha = ma$$

$$D - 650 - 24000 \times 0.05 = 0$$

$$D - 650 - 1200 = 0$$

$$D = 1850 \text{ N}$$

$$\text{Power} = D \times v$$

$$32500 = 1850v$$

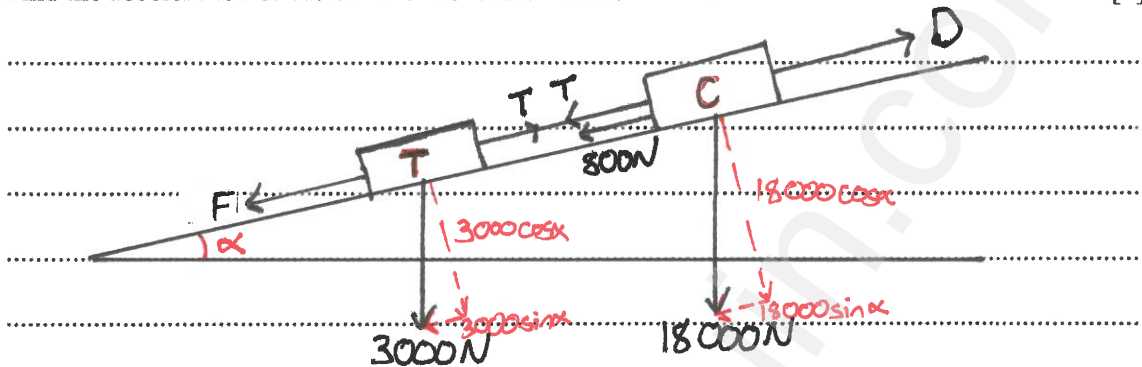
$$v = 17.6 \text{ ms}^{-1}$$

- 6 A car of mass 1800 kg is towing a trailer of mass 300 kg up a straight road inclined at an angle α to the horizontal, where $\sin \alpha = 0.05$. The car and trailer are connected by a tow-bar which is light and rigid and is parallel to the road. There is a resistance force of 800 N acting on the car and a resistance force of F N acting on the trailer. The driving force of the car's engine is 3000 N.

(a) It is given that $F = 100$.

Find the acceleration of the car and the tension in the tow-bar.

[5]



Car:

$$R(\nearrow): F = ma$$

$$D - 18000 \sin \alpha - 800 - T = 1800a$$

$$3000 - 18000(0.05) - 800 - T = 1800a$$

$$1300 - T = 1800a \quad (1)$$

Trailer:

$$R(\nearrow): F = ma$$

$$T - 3000 \sin \alpha - F = 300a$$

$$T - 3000(0.05) - 100 = 300a$$

$$T - 250 = 300a \quad (2)$$

(1) + (2):

$$1300 - 250 = 2100a$$

$$1050 = 2100a$$

$$a = 0.5 \text{ m s}^{-2}$$

→ (2):

$$T - 250 = 300(0.5)$$

$$T - 250 = 150$$

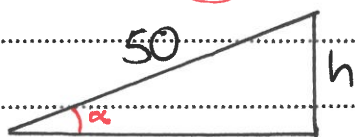
$$T = 400 \text{ N}$$

- (b) It is given instead that the total work done against F in moving a distance of 50 m up the road is 6000 J. The speed of the car at the start of the 50 m is 20 m s^{-1} .

Use an energy method to find the speed of the car at the end of the 50 m.

[5]

Find change in height when moving a distance of 50 m:



$$\sin \alpha = \frac{h}{50}$$

$$\begin{aligned} h &= 50 \sin \alpha \\ &= 50 \times 0.05 \\ &= \underline{2.5 \text{ m}} \end{aligned}$$

$$\begin{aligned} \text{Work done against friction} &= \text{work done against } F + \text{work done against } 800 \text{ N} \\ &= 6000 + 800 \times 50 \\ &= \underline{46000 \text{ J}} \end{aligned}$$

$\uparrow \text{ work done} = F \times d$

Whole System:

$$\text{Work}_{\text{in}} + KE_{\text{init}} + PE_{\text{init}} = KE_{\text{fin}} + PE_{\text{fin}} + \text{Work}_{\text{car}}$$

$$3000 \times 50 + \frac{1}{2} \times 2100 \times 20^2 + 0 = \frac{1}{2} \times 2100 \times v^2 + 2100 \times 10 \times 2.5 + 46000$$

$$150000 + 420000 = 1050v^2 + 52500 + 46000$$

$$570000 = 1050v^2 + 98500$$

$$1050v^2 = 471500$$

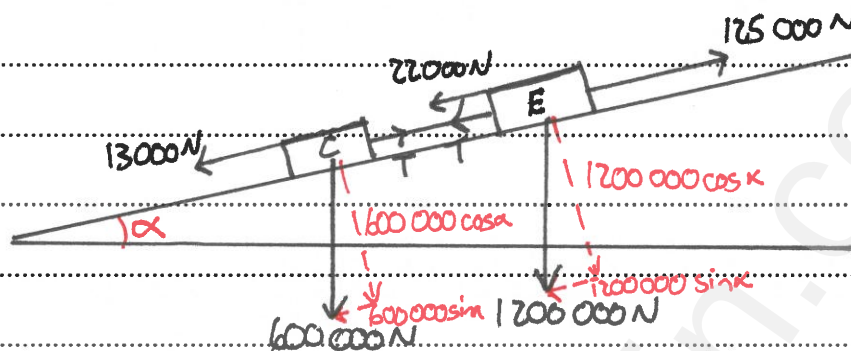
$$v^2 = 449.05$$

$$\underline{v = 21.2 \text{ m s}^{-1}}$$

- 6 A railway engine of mass 120 000 kg is towing a coach of mass 60 000 kg up a straight track inclined at an angle of α to the horizontal where $\sin \alpha = 0.02$. There is a light rigid coupling, parallel to the track, connecting the engine and coach. The driving force produced by the engine is 125 000 N and there are constant resistances to motion of 22 000 N on the engine and 13 000 N on the coach.

(a) Find the acceleration of the engine and find the tension in the coupling.

[5]



Engine:

$$R(\rightarrow): F = ma$$

$$125\,000 - 1\,200\,000 \sin \alpha - 22\,000 - T = 120\,000a$$

$$125\,000 - 1\,200\,000(0.02) - 22\,000 - T = 120\,000a$$

$$79\,000 - T = 120\,000a \quad (1)$$

Coach:

$$R(\rightarrow): F = ma$$

$$T - 600\,000 \sin \alpha - 13\,000 = 60\,000a$$

$$T - 600\,000(0.02) - 13\,000 = 60\,000a$$

$$T - 25\,000 = 60\,000a \quad (2)$$

(1) + (2):

$$79\,000 - 25\,000 = 180\,000a$$

$$54\,000 = 180\,000a$$

$$a = 0.3 \text{ ms}^{-2}$$

→ (2):

$$T - 25\,000 = 60\,000(0.3)$$

$$T - 25\,000 = 18\,000$$

$$T = 43\,000 \text{ N}$$

At an instant when the engine is travelling at 30 m s^{-1} , it comes to a section of track inclined upwards at an angle β to the horizontal. The power produced by the engine is now $4\,500\,000 \text{ W}$ and, as a result, the engine maintains a constant speed.

- (b) Assuming that the resistance forces remain unchanged, find the value of β .

[4]

$$\text{Power} = D \times v$$

$$4\,500\,000 = D \times 30$$

$$D = 150\,000 \text{ N}$$

Whole system: (We don't need to find T , so quicker to do whole thing)

$$R(\uparrow): F = ma$$

$$150\,000 - 1\,800\,000 \sin \beta - 22\,000 - 13\,000 = ma$$

$\uparrow$ weight of engine and coach

$a = 0$
(constant speed)

$$115\,000 - 1\,800\,000 \sin \beta = 0$$

$$1\,800\,000 \sin \beta = 115\,000$$

$$\sin \beta = \frac{23}{360}$$

$$\beta = \underline{\underline{3.7^\circ}}$$

$\uparrow$ angles to 1 dp
when in degrees

- 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]

Constant speed, so $a=0$ and Driving Force = Resistive Forces.

Whole system:

$$R(\rightarrow): D - 650 - 150 = ma \quad a=0$$

$$D - 800 = 0$$

$$D = 800 \text{ N}$$

$$\text{Power} = D \times V$$

$$= 800 \times 24$$

$$= \underline{19200 \text{ W}}$$

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

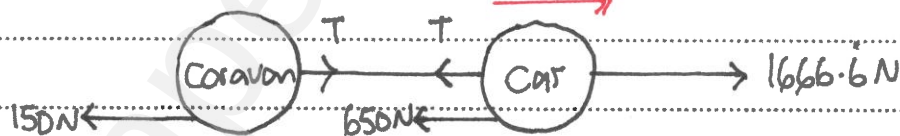
Find the instantaneous acceleration of the car and caravan and find the tension in the tow-bar.

[5]

$$\text{Power} = D \times V$$

$$40000 = D \times 24$$

$$D = 1666.6 \text{ N}$$



Car:

$$R(\rightarrow): F = ma$$

$$1666.6 - 650 - T = 1750a$$

$$1016.6 - T = 1750a \quad (1)$$

Caravan:

$$R(\rightarrow): F = ma$$

$$T - 150 = 500a \quad (2)$$

cont

$$\textcircled{1} + \textcircled{2}: 1016.6 - 150 = 2250a$$

$$866.6 = 2250a$$

$$a = \underline{0.385 \text{ ms}^{-2}}$$

→ $\textcircled{2}$:

$$T - 150 = 500 \times 0.385$$

$$T - 150 = 192.6$$

$$T = 342.6$$

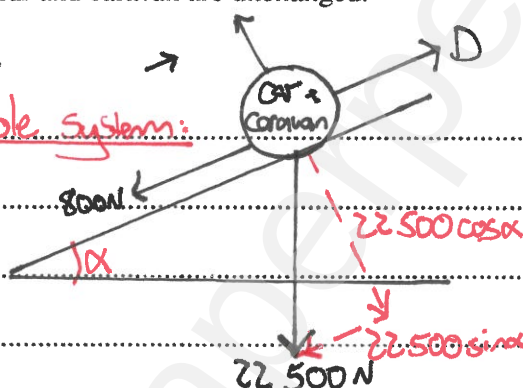
$$= \underline{343 \text{ N}}$$

- (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 $v \text{ ms}^{-1}$. The car's engine is working at 31 kW. The resistances to the motion of the car and caravan are unchanged.

Find v .

[3]

Whole System:



$$R(\uparrow): F = ma \quad \leftarrow a = 0 \text{ (constant velocity)}$$

$$D - 800 - 22500 \sin x = 0$$

$$D - 800 - 22500 \times 0.14 = 0$$

$$D = \underline{3950 \text{ N}}$$

$$\text{Power} = D \times v$$

$$31000 = 3950v$$

$$v = \underline{7.85 \text{ ms}^{-1}}$$

$$\sin \alpha = 0.08$$

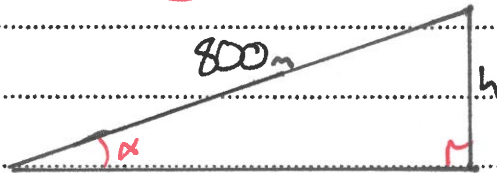
8

- 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.

[5]

Change in height when travelling 800m:



$$\sin \alpha = \frac{h}{800}$$

$$\begin{aligned} h &= 800 \sin \alpha \\ &= 800 \times 0.08 \\ &= 64 \text{ m} \end{aligned}$$

$$\text{Work}_{\text{in}} + \text{KE}_{\text{init}} + \text{PE}_{\text{init}} = \text{KE}_{\text{fin}} + \text{PE}_{\text{fin}} + \text{Work}_{\text{out}}$$

$$800D + \frac{1}{2} \times 2250 \times 30^2 + 0 = \frac{1}{2} \times 2250 \times 20^2 + 2250 \times 10 \times 64 + 600 \times 800$$

Work = $F \times d$

$\uparrow F \times d$

$$800D + 1012500 = 450000 + 1440000 + 480000$$

$$800D + 1012500 = 2370000$$

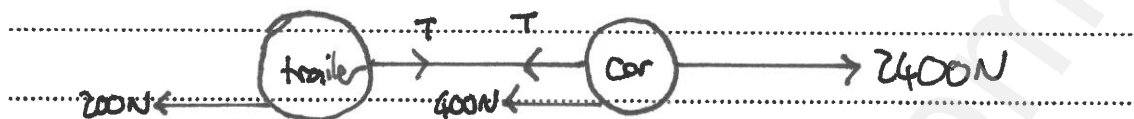
$$800D = 1357500$$

$$D = 1696.875 \text{ N}$$

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]



Car:

$$R(\rightarrow): F = ma$$

$$2400 - 400 - T = 1500a$$

$$2000 - T = 1500a \quad (1)$$

Trailer:

$$R(\rightarrow): F = ma$$

$$T - 200 = 750a \quad (2)$$

$$(1) + (2): 2000 - 200 = 2250a$$

$$1800 = 2250a$$

$$a = 0.8 \text{ ms}^{-2}$$

$$\rightarrow (2): T - 200 = 750 \times 0.8$$

$$T - 200 = 600$$

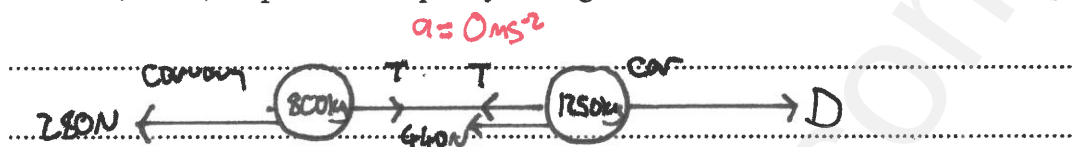
$$T = 800 \text{ N}$$

- 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]



Consider whole system:

$$R(\rightarrow): F = ma \quad a = 0$$

$$D - T + T - 440 - 280 = ma$$

$$D - 720 = 0$$

$$D = 720 \text{ N}$$

$$\begin{aligned} \text{Power} &= D \times v \\ &= 720 \times 30 \\ &= \underline{21600 \text{ W}} \end{aligned}$$

- (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]

$$\begin{aligned} \text{New Power} &= 21600 - 8000 \\ &= 13600 \text{ W} \end{aligned}$$

$$\begin{aligned} \text{Power} &= D \times v \\ 13600 &= D \times 30 \end{aligned}$$

$$D = 453.3 \text{ N}_{\text{STO}}$$

Whole system:

$$R(\rightarrow): F = ma$$

$$453.3 - 440 - 280 = 2050 a$$

$$-266.6 = 2050 a$$

$$a = \underline{-0.130 \text{ m s}^{-2}}$$

Caravan:

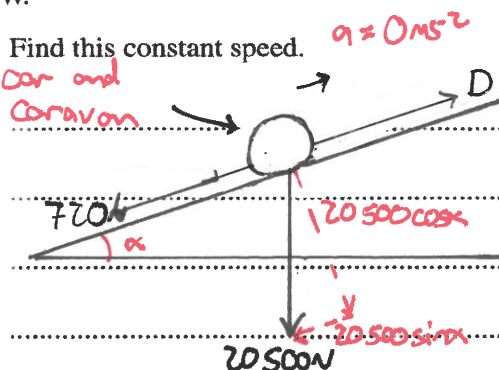
$$\begin{aligned} R(\rightarrow): T - 280 &= ma \\ T - 280 &= 800 \times (-0.130) \\ T - 280 &= -104.1 \\ T &= 175.9 \\ T &= \underline{176 \text{ N}} \end{aligned}$$

$$\sin \alpha = 0.06$$

- (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]



Whole system:

$$R(\rightarrow): F = ma = 0$$

$$D - 720 - 20500 \sin \alpha = 0$$

$$D - 720 - 20500 \times 0.06 = 0$$

$$D - 720 - 1230 = 0$$

$$D - 1950 = 0$$

$$D = 1950 \text{ N}$$

$$\text{Power} = D \times v$$

$$28000 = 1950 \times v$$

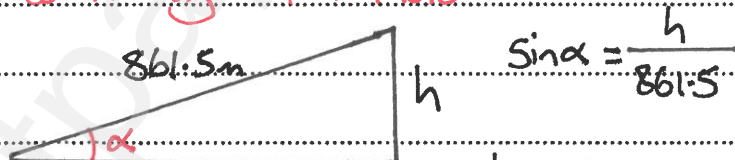
$$v = 14.4 \text{ m s}^{-1} \text{ STO}$$

- (ii) Find the increase in the potential energy of the caravan in one minute.

[2]

Distance travelled in 1 minute: $\text{distance} = 14.4 \times 60$
 $= 861.5 \text{ m STO}$

Increase in height in 1 minute:



$$h = 861.5 \times 0.06$$

$$= 51.7 \text{ m STO}$$

Change in PE = $mg\Delta h$

$$= 800 \times 10 \times 51.7$$

$$= 413538 \text{ J}$$

$$= 414000 \text{ J}$$

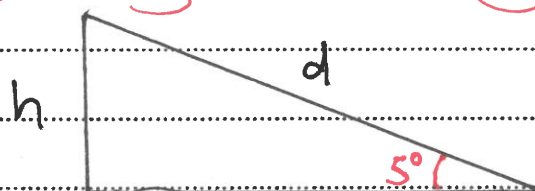
- 5 A car of mass 1400 kg is towing a trailer of mass 500 kg down a straight hill inclined at an angle of 5° to the horizontal. The car and trailer are connected by a light rigid tow-bar. At the top of the hill the speed of the car and trailer is 20 m s^{-1} and at the bottom of the hill their speed is 30 m s^{-1} .

- (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]

Change in height when travelling a distance d :



$$\sin 5 = \frac{h}{d}$$

$$h = d \sin 5$$

$$\text{Work}_{\text{in}} + \text{KE}_{\text{init}} + \text{PE}_{\text{init}} = \text{KE}_{\text{fin}} + \text{PE}_{\text{fin}} + \text{Work}_{\text{out}}$$

$$150\,000 + \frac{1}{2} \times 1900 \times 20^2 + 0 = \frac{1}{2} \times 1900 \times 30^2 + 1900 \times 10 \times -d \sin 5 + 0$$

$$150\,000 + 380\,000 = 855\,000 - 19000d \sin 5$$

$$530\,000 = 855\,000 - 19000d \sin 5$$

$$-325\,000 = -19000d \sin 5$$

$$d = \frac{-325\,000}{-19000 \sin 5}$$

$$= \underline{\underline{196 \text{ m}}}$$

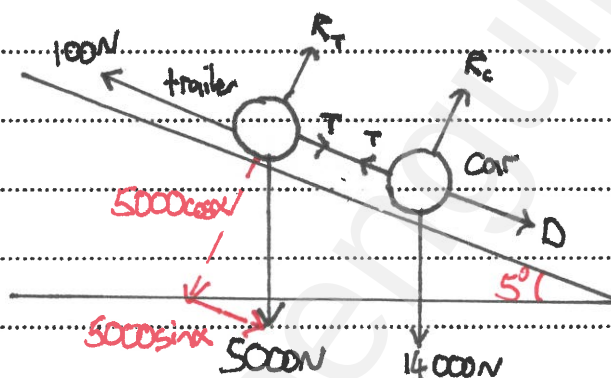
- (b) It is given instead that there is a resistance force of 100 N on the trailer, the length of the hill is 200 m, and the acceleration of the car and trailer is constant.

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

[4]

Find acceleration using SUVAT:

$$\begin{aligned}
 \downarrow s &= 200 & v^2 &= u^2 + 2as \\
 u &= 20 & 30^2 &= 20^2 + 2 \times a \times 200 \\
 v &= 30 & 900 &= 400 + 400a \\
 a &= & 500 &= 400a \\
 t &= & a &= 1.25 \text{ ms}^{-2}
 \end{aligned}$$



Consider Trailer:

$$\begin{aligned}
 R(\downarrow): \quad T + 5000\sin 5 - 100 &= ma \\
 T + 5000\sin 5 - 100 &= 500 \times 1.25 \\
 T + 5000\sin 5 - 100 &= 625 \\
 T &= 725 - 5000\sin 5 \\
 &= \underline{\underline{289 \text{ N}}}
 \end{aligned}$$