1 **(i)**	$3.5 = 10a \quad \rightarrow \quad a = 0.35\,\text{ms}^{-2}$	**B1**		Allow $a = 3.5/10$
	$[10\cos 15 - F = 2 \times 0.35]$	**M1**		For applying Newton's 2nd law to the particle
	$F = 8.96\,\text{N}$ AG	**A1**	[3]	
	Alternative to 1(i)			
	$s = \frac{1}{2}(0 + 3.5) \times 10 = 17.5\,\text{m}$	**B1**		Distanced moved in 10 secs
	$[10\cos 15 \times 17.5 = F \times 17.5 + \frac{1}{2}\,2\,(3.5)^2]$	**M1**		Work done by 10 N force = WD against F + KE gain
	$F = 8.96\,\text{N}$ AG	**A1**	[3]	
(ii)	$[R = 2g - 10\sin 15]$	**M1**		Resolving forces vertically
	$[\mu = 8.96/(2g - 10\sin 15)]$	**M1**		Using $F = \mu R$
	$\mu = 0.515$	**A1**	[3]	
2 **(i)**	$[v = 4t - 40t^{0.5}]$	**M1***		For differentiating s to find v
	$[a = 4 - 20t^{-0.5}]$	**M1***		For differentiating v to find a
	$[4 - 20t^{-0.5} = 0]$	**DM1**		For setting $a = 0$ and attempt to solve to find t
	$t = 25\,\text{s}$	**A1**	[4]	
(ii)	Substitute their t into s **or** v	**M1**		
	Displacement = –2083.3 m (= –2080 3sf) **and** Velocity = $-100\,\text{ms}^{-1}$	**A1**	[2]	or Displacement = – 6250/3

3 (i)	$[X = 60\cos25 + 50\cos15]$	**M1**		For resolving both forces in the direction of river
	$= 103\,\text{N}$	**A1**	[2]	Value of X is 102.7 N
(ii)	$Y = 60\sin25 - 50\sin15$ [= 12.4]	**B1**		Component perpendicular to the direction of the river
	$[R^2 = X^2 + Y^2]$ or $[\alpha = \arctan(Y/X)]$	**M1**		For using Pythagoras or for using arctan to find the resultant force or its direction
	Magnitude is 103 N (or $\alpha = 6.9^\circ$ with direction specified unambiguously)	**A1**		Magnitude is 103.4 N
	$\alpha = 6.9^\circ$ with direction specified unambiguously (or Magnitude = 103 N)	**B1**	[4]	
4 (i)	PE loss = $mg \times 100\sin20$	**B1**		
	$[\frac{1}{2}mv^2 - \frac{1}{2}m \times 5^2 = mg \times 100\sin20]$	**M1**		Using KE gain = PE loss
	$v = 26.6\,\text{ms}^{-1}$	**A1**	[3]	
Alternative method for 4(i)				
	$a = g \sin 20$ [= 3.42]	**B1**		
	$[v^2 = 5^2 + 2 \times a \times 100]$	**M1**		Using $v^2 = u^2 + 2as$
	$v = 26.6\,\text{ms}^{-1}$	**A1**	[3]	
(ii)	KE = $\pm(0.5m \times 441 - 0.5m \times 25)$ [$= \pm208m$]	**B1**		
	$[mg \times 100\sin20 = 8500 + 208m]$	**M1**		For using PE loss = WD against Friction + KE gain
	Mass $m = 63.4\,\text{kg}$	**A1**	[3]	

5	$F = \mu mg\cos 30$	**B1**		
	$[10 + F - mg\sin 30 = 0]$	**M1**		Resolving up, first case
	$[75 - F - mg\sin 30 = 0]$	**M1**		Resolving up, second case
	$[85 = 2mg\sin 30]$ or $[10 + \mu mg\cos 30 - mg\sin 30 = 0$ $75 - \mu mg\cos 30 - mg\sin 30 = 0]$	**M1**		Either attempt to solve for m or Solve a pair of two 3 term simultaneous equations for either m or μ
	$m = 8.5\,\text{kg}$ or $\mu = 0.442$	**A1**		
	$\mu = 0.442$ or $m = 8.5\,\text{kg}$	**B1**	[6]	
6 (i)	[Power = 400 × 25]	**M1**		For using $P = Fv$ where $F =$ resistance = 400 N
	Power = 10000 W	**A1**	[2]	Allow 10 kW
(ii)	Tension = 100 N	**B1**	[1]	Considering the trailer
(iii)	New driving force $= 25000/20 = 1250\,\text{N}$	**B1**		Driving force = P/v at the instant when $v = 20$
	$[\text{DF} - 300 - T - 3000\,g\sin 4 = 3000a]$ or $[T - 100 - 500\,g\sin 4 = 500a]$ or $[\text{DF} - 400 - 3500\,g\sin 4 = 3500a]$	**M1**		For using Newton's second law applied **either** to the van **or** to the trailer **or** to the system of van and trailer.
		M1		For using N2 applied to one of the other cases
	$[a = -0.4547$ may be seen$]$	**M1**		Solving or using substitution to find T
	$T = 221\,\text{N}$	**A1**	[5]	Allow $T = 1550/7\,\text{N}$

7 (i)	$v = 3 \times 10 = 30\,\text{ms}^{-1}$	**B1**		Velocity after 10 seconds
	[$s = ½ (30 + 40) \times 30$] or equivalent complete method	**M1**		For determining distance travelled in first 40 seconds
	Total distance = 1050 m	**A1**	[3]	
(ii)	[Distance = 450 m Time taken = 450 / 15 = 30 s]	**M1**		For finding distance covered in deceleration stage and time taken for this stage
	Total time of motion for car = 70 s	**A1**		May be implied by time for motorcycle = 50 s
	[Motorcycle takes 50 s to travel 1500 m $1500 = ½ (30 + 50) \times V$ or $1500 = 30V + 0.5 \times 20V$]	**M1**		For setting up an equation for distance travelled by M / C (v–t graph or other) involving V or a and up to one other variable.
	$V = 37.5\,\text{ms}^{-1}$	**A1**		
	[20 s is split between 5 s accelerating and 15 s decelerating]	**M1**		For finding time taken to accelerate to speed V
	$a = 37.5 / 5 = 7.5\,\text{ms}^{-2}$	**A1**	[6]	
(iii)	Displacement-time graph	**B1**		Two of the three graph stages correct with correct curvature
		B1		All three stages of the graph correct with correct curvature
		B1	[3]	Correct graph, fully labelled t=10,40,70s = 150,1050, 1500