1		M1		For using WD = Fdcos α
	$8200 = 180 \times 50 \cos\alpha$	A1		
	$\alpha = 24.3$	A1	**[3]**	
2		M1		For using DF = P/v
		M1		For using Newton's second law when v = 19 or when v = 30
	$P/19 - R = 1250 \times 0.6$ and $P/30 - R = 1250 \times 0.16$	A1		
	$[19R + 19 \times 1250 \times 0.6 = 30R + 30 \times 1250 \times 0.16]$	M1		For attempting to eliminate P or R
	$R = 750$ or $P = 28500$	A1		
	$P = 28500$ or $R = 750$	B1ft	**[6]**	ft wrong answer for R or P substituted into a **correct** linear equation.
3	**(i)** $a_P = g\sin 30^o$	B1		
	$3.2 = \frac{1}{2} gt_q^2$	B1		
	$[6.4 = u(0.8) + \frac{1}{2} 5 \times (0.8)^2]$	M1		For applying $s = ut + \frac{1}{2} at^2$ to P
	$u = 6$	A1	**[4]**	
	(ii) $[v = 6 + 5 \times 0.8$ or $v^2 = 36 + 2\times5\times6.4]$	M1		For using $v = u + at$ or $v^2 = u^2 + 2as$ for P
	Speed of P is 10 ms^{-1}	A1	**[2]**	
	Alternative for Parts (i) and (ii) when a is not used:			
	Part (i)			
	$3.2 = \frac{1}{2} gt_q^2$	B1		
	For using KE gain = PE loss to obtain an equation in u and v			
	$[\frac{1}{2} (v^2 - u^2) = 6.4g\sin 30^o]$	M1		
	For using $s = \frac{1}{2} (u + v)t$ to obtain a second equation in u and v			
	$[6.4 = \frac{1}{2} (u + v) \times 0.8]$	DM1		
	$u = 6$	A1	**[4]**	
	Part (ii)			
	Substitutes for u to find v	M1		
	Speed is 10 ms^{-1}	A1	**[2]**	

4	**(i)**	For correct shading composite figure consisting of 2 rectangles: 1st has boundaries t = 0 & t = 20, v = 0 and v = 2.5; 2nd has boundaries t = 20 & t = T, v = 0 and v = 4	B1	**[1]**	
	(ii)	[50 + 4(T – 20) = 70 or 4T – 30 = 70]	M1		For attempt to find equation in T
		T = 25	A1	**[2]**	
	(iii)	[Distance = 70 + (4 – 2.5)20 or 50 + 4[(T – 20) + 20] – 50]	M1		For identifying and using area representing required distance
		Distance between P and Q is 100 m	A1ft	**[2]**	ft 4T
	(iv)	For 2 straight line segments representing P, 1st with +ve slope and 2nd with steeper slope, t = 20 indicated appropriately	B1		
		For Q, 1st & 2nd segments parallel to P's and displaced to the right, t = 25 and t = 45 indicated appropriately	B1ft	**[2]**	ft T and T + 20
5	**(i)**		M1		For resolving forces in the x direction or the y direction
		$F_x – 6.1 – 5 \times 0.28 = 0$ and $F_y + 4.8 – 5 \times 0.96 = 0$	A1		
		Frictional force acts parallel to x axis and to the right	A1		
		$F_y = 0 \rightarrow F = F_x$ $\rightarrow$ Frictional force has magnitude 7.5 N	A1	**[4]**	AG
	(ii)	[$\mu = 7.5/(1.25 \times 10)$]	M1		For using $F = \mu R$ and $R = mg$
		Coefficient is 0.6	A1	**[2]**	
	(iii)	[$7.5 – 8.6 – 1.4 = 1.25a \rightarrow a = –2$]	M1		For applying Newton's second law
		Magnitude of acceleration is 2 $ms^{–2}$	A1		
		Direction of acceleration is parallel to x axis and to the left	B1	**[3]**	

6	**(i)**	Gain in PE = $15000g \times 500\sin 2.5^o$ J	B1		
		WD against the resistance = 800×500 J	B1		
		[3271454 + 400000]	M1		For using WD by driving force = Gain in PE + WD against resistance
		Work done is 3670000 J or 3670 kJ	A1	**[4]**	
					Alternatively, For resolving forces up the plane M1 Driving Force = $800 + 15000g\sin 2.5^o$ A1 For using WD = Driving Force × 500 M1 Work done is 3670000J A1
	(ii)	Work done by DF = 2000×500 J	B1		
		Gain in KE = $\frac{1}{2}\ 15000(v^2 - 20^2)$	B1		
			M1		For using Gain in KE = Loss in PE – WD against resistance + WD by driving force
		$\frac{1}{2}\ 15000(v^2 - 20^2) = 3271454 - 400000 + 1000000$	A1		
		Speed of the lorry is 30.3 ms^{-1}	A1	**[5]**	
					Alternatively, For applying Newton's second law M1 $2000 + 15000g\sin 2.5 - 800 = 15000a$ A1 For using $v^2 = u^2 + 2as$ M1 $v^2 = 20^2 + 2 \times 0.5162 \times 500$ A1 Speed is 30.3 ms^{-1} A1
7	**(i)**		M1		For using $v(t) = \int a\,dt$
		$v = \frac{1}{160}t^3 - \frac{1}{3200}t^4 \quad (+ C_1)$	A1		
		[$0 = 8000/160 - 160000/3200 + C_1$ $\rightarrow C_1 = 0$]	M1		For using v(20) = 0
		Initial speed is zero	A1	**[4]**	AG
	(ii)	[$t^2/800(15 - t) = 0$]	M1		For solving a = 0
		$v_{max} = v(15) = 5.27$ ms^{-1}	A1	**[2]**	
	(iii)		M1		For using $s(t) = \int v\,dt$
		$s = \frac{1}{640}t^4 - \frac{1}{16000}t^5 \ (+ C_2)$	A1ft		
		[250 – 200]	M1		For using limits 0 and 20 (or equivalent)
		Distance AB is 50 m	A1	**[4]**	