Question	Answer	Marks	Guidance
1(a)	Power = 750000/10 = 75000 W or 75 kW	**B1**	Power = WD/Time
		1	
1(b)	Driving force DF = 75000/25	**B1FT**	Using $P = \text{DF} \times v$
	[DF – 2400 = 16000*a*]	**M1**	Using Newton's 2nd law
	$a = 0.0375 \text{ ms}^{-2}$	**A1**	Allow $a = \frac{3}{80}$
		3	

Question	Answer	Marks	Guidance
2(a)	$[1.44 = 0 + \frac{1}{2} \times 2t^2]$	M1	For using a complete method which would lead to an equation for finding a value of t such as $s = ut + \frac{1}{2}at^2$ with $u = 0$, $s = 1.44$ and $a = 2$
	$t = 1.2$ s	A1	
		2	
2(b)	$R = 0.4g - 3 \times \frac{3}{5} = 0.4g - 3\sin 36.9$ [= 2.2]	B1	
	$[3 \times \frac{4}{5} - F = 3\cos 36.9 - F = 0.4 \times 2]$ $[F = 1.6]$	M1	Use Newton's 2nd law, 3 terms, to find F.
	$\left[\mu = \frac{3 \times \frac{4}{5} - 0.4 \times 2}{0.4g - 3 \times \frac{3}{5}} = \frac{1.6}{2.2}\right]$	M1	Use of $\mu = \frac{F}{R}$
	$\mu = 0.727$	A1	Allow $\mu = \frac{8}{11}$
		4	

Question	Answer	Marks	Guidance
3(a)	Initial KE = $\frac{1}{2} \times 0.2 \times 5^2$ or Final KE = $\frac{1}{2} \times 0.2 \times 3^2$	**B1**	
	$\frac{1}{2} \times 0.2 \times 5^2 = 0.2gh + \frac{1}{2} \times 0.2 \times 3^2$	**M1**	Use conservation of energy
	$h = 0.8$	**A1**	
		3	
3(b)	Apply work-energy equation from *A* to *C*	**M1**	
	$\frac{1}{2} \times 0.2 \times 5^2 - 3.1 + 0.2g \times 0.5 = \frac{1}{2} \times 0.2v^2$	**A1**	Correct work-energy equation
	Speed = 2 ms^{-1}	**A1**	
		3	

Question	Answer	Marks	Guidance
4(a)	Use the constant acceleration equations to obtain an expression for either s_{AB} or s_{BC} in terms of a	M1	
	$s_{AB} = 2 \times 4.5 - ½ \times a \times 2^2$	A1	**or** $s_{AB} = ½(v_A + v_B) \times 2 = 9 - 2a$
	$s_{BC} = 2 \times 4.5 + ½ \times a \times 2^2$	A1	**or** $s_{BC} = ½(v_B + v_C) \times 2 = 9 + 2a$
	$[2 \times 4.5 - ½a \times 2^2 = \frac{4}{5}(2 \times 4.5 + ½a \times 2^2)]$	M1	Use the given information to find a valid equation for a
	$a = 0.5 \text{ ms}^{-2}$	A1	
	Alternative method for question 4(a)		
	$[4.5 = u + 2a, s_{AC} = 4u + 8a, s_{AB} = 2u + 2a]$	M1	Any two relevant equations in u, a, s_{AB} and s_{AC} where u is the velocity at A
	Two correct equations	A1	
	Three correct equations	A1	
	$[2(4.5 - 2a) + 6a = \frac{5}{4}\{2(4.5 - 2a) + 2a\}]$	M1	Use the given information that $BC = {}^5/_4AB$ to find a valid equation such as the one shown OE involving a only
	$a = 0.5 \text{ ms}^{-2}$	A1	
	Alternative method for question 4(a)		
	$[AC = 4.5 \times 4]$	M1	Using $AC = v_B \times 4$ since v_B is the average velocity over AC
	$BC = 5/9 \times AC$ **or** $AB = 4/9 \times AC$	M1	
	$BC = 10$ or $AB = 8$	A1	
	$[10 = 4.5 \times 2 + 2a$ **or** $8 = 4.5 \times 2 - 2a]$	M1	Using $s = ut + ½ at^2$ for BC **or** $s = vt - ½ at^2$ for AB
	$a = 0.5 \text{ ms}^{-2}$	A1	

Question	Answer	Marks	Guidance
		5	
4(b)	$s_{AB} = 2 \times 4.5 - ½ \times 0.5 \times 2^2 = 8$ **OR** $s_{BC} = 2 \times 4.5 + ½ \times 0.5 \times 2^2 = 10$	**M1**	Attempt to find the value of s_{AB} or s_{BC} **OR** attempt to find s_{AB} directly as $s_{AC} = 3.5 \times 4 + ½ \times a \times 4^2$ or ½ (4.5 – 2a + 4.5 + 2a) × 4 **or** add the 2 expressions found in **4(a)** for s_{AB} and s_{BC}
	$s_{AC} = 8 + {}^5/_4 \times 8 = 18$ m **OR** $s_{AC} = 10 + {}^4/_5 \times 10 = 18$ m	**A1**	
		2	

Question	Answer	Mark	Guidance
5(a)	[4 sin 30 + F sin 60 – 6 = 0]	**M1**	Resolve forces vertically and equate to zero
	Correct equation	**A1**	
	$F = 4.62$	**A1**	Allow $F = \frac{8}{\sqrt{3}}$ or $F = \frac{8}{3}\sqrt{3}$
		3	

Question	Answer	Marks	Guidance
5(b)	Resolve forces either vertically or horizontally	M1	
	$F \sin \alpha + 4 \sin 30 - 6 = 0$ and $F \cos \alpha + 3 - 4 \cos 30 = 0$	A1	Both equations correct [$F \sin \alpha = 4$] [$F \cos \alpha = 0.464102...$]
	[$F^2 = 4^2 + 0.464^2$] or $\left[F = \frac{4}{\sin 83.4} = \frac{0.464}{\cos 83.4}\right]$	M1	Attempt to solve for F using Pythagoras or from a value found for α
	$\left[\alpha = \tan^{-1}\left(\frac{4}{0.464}\right)\right]$ or $\left[\alpha = \sin^{-1}\left(\frac{4}{4.03}\right) = \cos^{-1}\left(\frac{0.464}{4.03}\right)\right]$	M1	Attempt to solve for α using trigonometry or from a value found for F
	$F = 4.03$ and $\alpha = 83.4$	A1	Both correct as shown [$F = 4.0268…$, $\alpha = 83.382…$]
		5	

Question	Answer	Marks	Guidance
6(a)	$[T - 200 = 700 \times -12]$ Car: $-T - 600 - F = 1600 \times -12$ System: $-600 - 200 - F = 2300 \times -12$	**M1**	Apply Newton's 2nd law to the trailer or apply Newton's 2nd law to the car and to the system and eliminate the braking force, F.
	Magnitude of T = 8200 N	**A1**	
		2	
6(b)	Car $[T - F - 600 = 1600 \times -12]$ or System $[-600 - 200 - F = 2300 \times -12]$	**M1**	Apply Newton's second law either to the car or to the system with braking force = F and use of *their* T from **6(a)**
	Braking force F = 26800 N	**A1**	
		2	
6(c)	$[v^2 = 22^2 + 2 \times -12 \times 17.5]$	**M1**	A complete method using constant acceleration equations which would lead to an equation for finding v, using $u = 22$, $s = 17.5$ and $a = -12$
	$v = 8\ \text{ms}^{-1}$	**A1**	AG
		2	
6(d)	$[2300 \times 8 + m \times 0 = 2300 \times 2 + m \times 5]$	**M1**	For applying the conservation of momentum equation to the system of car, trailer and van, where m = mass of the van
		A1	Correct equation
	m = 2760 kg	**A1**	
		3	

Question	Answer	Marks	Guidance
7(a)	[$v = 2t - 3$]	**M1**	For differentiation of s for $0 \leqslant t \leqslant 6$
	$t = 1.5$	**A1**	
		2	
7(b)	Velocity at arrival = 9 ms^{-1}	**B1**	$t = 6$ used in v
	$v = -\dfrac{24}{t^2} - 0.5t$	**M1**	For differentiation of s for $t \geqslant 6$
	Velocity when leaves = –3.67 ms^{-1}	**A1**	Allow $v = -11/3$
		3	
7(c)	At $t = 0$, $s = 2$ **or** at $t = 6$, $s = 20$	**B1**	SOI
	At $t = 1.5$, $s = -0.25$	**B1**	SOI
	At $t = 10$, $s = 2.4$	**B1**	SOI
	[Total distance = 2 + 0.25 + 0.25 + 20 + (20 – 2.4)]	**M1**	Evidence of distance rather than displacement involving all three sections, (0, 1.5), (1.5, 6) and (6, 10)
	So total distance travelled = 40.1 m	**A1**	
		5	