Question	Answer	Marks	Guidance
1	$4.5 = 2.5 + a \times 5$	**M1**	For use of $v = u + at$
	$a = 0.4$	**A1**	
	$F - 1.5 = 0.2a$	**M1**	For use of Newton's second law
	$F = 1.58$	**A1**	
		4	

Question	Answer	Marks	Guidance
2(i)	Resistance = Driving force = $\frac{4\,080\,000}{85} = 48\,000$ N	**B1**	Correct use of $P = Fv$ and using DF = Resistance
		1	
2(ii)	DF = $\frac{P}{85}$	**B1**	DF = $\frac{P}{v}$
	DF $- 48\,000 - 490\,000$ g $\times \frac{1}{200} = 0$	**M1**	For applying Newton's second law (3 terms)
	$P = 72\,500 \times 85 = 6.16$ MW	**A1**	
		3	

Question	Answer	Marks	Guidance
3	[KE gained $= \frac{1}{2} \times 2500 \times \left(30^2 - 20^2\right) \left(= 625000\,\text{J}\right)$ PE lost $= 2500g \times 400 \sin 4 \left(= 697564.7\,\text{J}\right)$	**M1**	KE gained or PE lost attempted
		A1	Both KE and PE correct
	[WD by engine $+2500g \times 400 \sin 4 + \frac{1}{2} \times 2500 \times 20^2$ $= 600 \times 400 + \frac{1}{2} \times 2500 \times 30^2$]	**M1**	Using work-energy equation in the form WD by engine + PE lost = WD against F + KE gain
	Work done by engine + PE lost $= 600 \times 400 + 625\,000$	**A1**	Work-energy equation all correct
	Work done = 167 000 J (167 435.2…)	**A1**	
		5	

Question	Answer	Marks	Guidance
4(i)	$0.6^2 = 0 + 2a \times 0.8$	**M1**	For use of $v^2 = u^2 + 2as$
	$a = 0.225$	**A1**	
	$T - 0.3\,g = 0.3a$	**M1**	For using Newton's second law for the 0.3 kg particle
	$T = 3.07$ N (3.0675 N)	**A1**	
		4	

Question	Answer	Marks	Guidance
4(ii)	$mg - T = ma$, $m(10 - 0.225) = 3.0675$	**M1**	For using Newton's second law applied to the m kg particle
	$m = 0.314$ kg (0.31381…)	**A1**	
		2	

Question	Answer	Marks	Guidance
5(i)		**M1**	For resolving forces horizontally or vertically o.e.
	25 cos 30 – 15 cos 40 (= 10.1599…)	**A1**	
	25 sin 30 + 15 sin 40 – 30 (= –7.8581…)	**A1**	
		M1	For using a method for either magnitude or direction
	Magnitude = $\sqrt{(10.15...^2 + 7.858...^2)}$ = 12.8 N	**A1**	Magnitude = 12.844…
	Angle 37.7° below the horizontal in the direction BA	**A1**	
		6	

Question	Answer	Marks	Guidance
5(ii)	$F\cos 40 = 25\cos 30$	**M1**	For equating forces in the direction BC to zero
	$F = 28.3$	**A1**	$F = 28.2628\ldots$
	New resultant force $= 28.26\ldots\sin 40 + 25\sin 30 - 30 = 0.667$ N upwards	**B1**	
		3	

Question	Answer	Marks	Guidance
6(i)		**M1**	For using constant acceleration equations such as $s = ut + \frac{1}{2}at^2$ or equivalent complete methods to find expressions for PQ or QR or PR
	For PQ $0.8 = 0.6u + 0.18a$	**A1**	
	For PR $1.6 = 1.6u + 1.28a$	**A1**	or for QR $0.8 = (u + a \times 0.6) \times 1 + 0.5a$
		M1	Solving simultaneously two relevant equations in u and a
	Deceleration $= \frac{2}{3}$ ms^{-2}	**A1**	**AG**
	$u = \frac{23}{15}$	**B1**	
		6	

Question	Answer	Marks	Guidance
6(ii)	$R = mg\cos 3$	**B1**	
	$F = \mu mg\cos 3$	**M1**	For use of $F = \mu R$
	$-mg\sin 3 - \mu \times mg\cos 3 = m \times \left(-\frac{2}{3}\right)$	**M1**	For using Newton's second law (3 terms)
	$\mu = 0.0144\ (0.014350\ldots)$	**A1**	
		4	

Question	Answer	Marks	Guidance
7(i)	$v = \int (5.4 - 1.62t)\,\mathrm{d}t$	**M1**	For using integration of a to find v
	$v = 5.4t - 0.81t^2\ (+C)$	**A1**	
	$5.4t - 0.81t^2 = 0$	**M1**	For solving $v = 0$
	$t = 6\frac{2}{3} = \frac{20}{3}s$	**A1**	
		4	
7(ii)	$v(10) = -27\ \mathrm{ms}^{-1}$	**B1**	
	Inverted parabola	**B1**	
	$v = 0$ at $t = 0$, negative at $t = 10$ and through $\left(6\frac{2}{3}, 0\right)$	**B1**	
		3	

Question	Answer	Marks	Guidance
7(iii)	$s = \int\left(5.4t - 0.81t^2\right)dt$	**M1**	For using integration of v to find s
	$s = 2.7t^2 - 0.27t^3\left(+C\right)$	**A1**	
	At $t = 6\frac{2}{3}$, displacement = 40	**M1**	For evaluating the integral at the time when $v = 0$
	At $t = 10$ displacement = 0	**M1**	For evaluating the integral at time $t = 10$
	Total distance = 80 m	**A1**	
		5	