Question Number	Answer	Mark
3(a)	Use of $P = Fv$ at least once $\left((D =) \frac{P}{18} \text{ or } (D' =) \frac{6P}{12} \right)$	M1
	Equation for motion **down** road $D + 900g\sin\theta - R = 0$	M1 A1
	Equation for motion **up** road $D' - 900g\sin\theta - R = 0$	M1 A1
	P = 2646: possible answers are 2650 or 2600 or 270g R = 735 (exact) or 740 or 75g	A1 A1
		(7)
3(b)	GPE term = $900g(40\sin\theta)\ (= 2400g)$	B1
	WD against R = $40R$	B1
	(Total work-done =) Increase in KE + GPE + WD against R $= \frac{1}{2}(900)16^2 - \frac{1}{2}(900)12^2 + 900g(40\sin\theta) + 40R$	M1 A1
	=103,320 (exact) So possible answers are only: 103 000 or 100 000 (J) or 103 kJ or 1.03×10^5 (J)	A1
(b) ALT 1	$900g\sin\theta \times 40$, seen or implied	B1
	$40R$ seen or implied (R does not need to be substituted)	B1
	Equation of motion: $\frac{W}{40} - R - 900g\sin\theta = 900\times\left(\frac{16^2 - 12^2}{2\times40}\right)$ **OR:** $\frac{W}{40} - \frac{6P}{12} = 900\times\frac{(16^2 - 12^2)}{2\times40}$	M1A1
	(W =) 103,320 (exact) So possible answers are only: 103 000 or 100 000 (J) or 103 kJ or 1.03×10^5 (J)	A1
		(5)
		(12)
	Notes for question	
(a)		
M1	Use of $P = Fv$ at least once	
M1	Equation of motion **down** the road. Dimensionally correct, correct number of terms, condone sin/cos confusion and sign errors. Trig and D do not need to be replaced.	
A1	Correct unsimplified equation	
M1	Equation of motion **up** the road. Dimensionally correct, correct number of terms, condone sin/cos confusion and sign errors. Trig and D do not need to be replaced.	
A1	Correct unsimplified equation	
A1	One correct value (P or R) 2/3 sf.	

	$P = 2650$ or 2600 or $270g$ $\quad R = 735$ or 740 or $75g$	
A1	Both correct values (P and R)	
(b)		
B1	GPE term seen	
B1	WD against R	
M1	Expression for total work-done by the engine. Dimensionally correct with all required terms present and no extras or double-counting. All terms of correct structure. Condone sign errors.	
A1	Correct unsimplified equation, R does NOT need to be substituted.	
A1	Correct answer 2 or 3 sf.	
(b) ALT 1	For the M mark, if no reference to 40 in the force term is seen or implied then M0: i.e. $F - R - 900g\sin\theta = 900 \times \left(\frac{16^2 - 12^2}{2 \times 40}\right)$ is M0 unless the F is then multiplied by 40.	