Energy, Work & Power 1 MS

Q1.

2	(i)	[$\frac{1}{2}v^2 = 10\text{x}1.8$] Speed is 6ms^{-1}	M1 A1	[2]	For using $\frac{1}{2}mv^2 = mgh$
	(ii)	[$WD = \frac{1}{2}\text{x}0.5(6^2 - 5^2)$ or $0.5\text{x}10\text{x}1.8 = \frac{1}{2}\text{x}0.5\text{x}5^2$] Work done is 2.75 J	M1 A1	[2]	For using WD = loss of KE or $KE_A + PE_A - WD = KE_C + PE_C$

Q2.

1	(i)	[DF – 600 = 700 × 2]	M1		For using Newton's second law (3 terms needed)
		Driving force is 2000 N	A1	[2]	
	(ii)	[P = 2000 × 15]	M1		For using P = Fv
		Rate of working is 30000 W (or 30 kW)	A1ft	[2]	

Q3.

2	(i)	Gain in PE = 1250g × 1.54 (= 19250 J)	B1		
		[WD = 1250g × 1.54 + 5750]	M1		For using WD by crane = Gain in PE + WD against resistance
		Work done is 25000 J (or 25 kJ)	A1	[3]	
	(ii)	[1250 = 25000 / T]	M1		for using $P = \Delta(WD) / \Delta t$
		Time is 20 s	A1ft	[2]	ft Ans**(i)** ÷ 1250

Q4.

2		M1		For using 'loss of PE = gain in KE + WD against resistance'
	PE loss = $\frac{1}{2}\,8(8^2 - 3^2) + 120$ (= 340 J)	A1		
	[340 = 8gh]	DM1		For using PE = mgh
	Height is 4.25 m	A1	[4]	
				SR for candidates who assume without justification that the resistance to motion is constant, usually implicitly by using constant acceleration formulae (max 3/4) For using Newton's second law with 3 terms, $v^2 - u^2 = 2as$ and $h = s\sin\alpha$ M1 For attempting to eliminate α, a and s from the equations ($80\sin\alpha - 120/s = 8a$ $64 - 9 = 2as$, $h = s\sin\alpha$) M1 $80s\sin\alpha - 120 = 4(64 - 9)$ → $80h - 120 = 220$ → $h = 4.25$ A1

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Q5.

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 × 0.6 and P/30 – R = 1250 × 0.16	A1		
	[19R + 19 × 1250 × 0.6 = 30R + 30 × 1250 × 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.

Q6.

6	**(i)**	Gain in PE = 15000g × 500sin2.5° 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 + 15000gsin2.5° A1 For using WD = Driving Force × 500 M1 Work done is 3670000J A1
	(ii)	Work done by DF = 2000 × 500 J Gain in KE = ½ 15000(v^2 – 20^2)	B1 B1		
			M1		For using Gain in KE = Loss in PE – WD against resistance + WD by driving force
		½ 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 + 15000gsin2.5 – 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

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Q7.

6	**(i)**	PE gain = 1200g × 45	B1		
		WD = 1200g × 45 + 360 000	M1		For WD by car's engine = PE gain + WD against resistance
		Work done is 900 000 J or 900 kJ	A1	3	
	(ii)	WD against resistance = 360 × sin5/sin1 (kJ) or {360000 ÷ (45/sin5°)} × (45/sin1°) (J) or 697.24... × 2578.44... (J) or 1798 (kJ)	B1		
		KE gain = 1660 + 540 – 1798	B1ft		Accept 1660 + 540 – 1800
		[402000 = ½1200(v^2 – 225)]	M1		For using KE gain = ½ m(v^2 – 15^2)
		Speed is 29.9 ms^{-1}	A1	4	AG
	(iii)	$\frac{P_B}{P_C} = \left(\frac{DF_B}{DF_C}\right) \times \frac{v_B}{v_C}$ = 1.5 × 15/29.9	M1		For using P = Fv
			A1		
		Ratio is 0.75	A1	3	

Q8.

1	**(i)**	F = 720/12	B1		
		[F – R = 75 × 0.16]	M1		For use of Newton's second law
		R = 48	A1	3	
	(ii)	[720/v > 48]	M1		For using P/v – R = ma and a > 0 → P/v > R
		v < 15 i.e. speed is less than 15 ms^{-1}	A1	2	

Q9.

6	**(i)**	KE loss = ½ 16000(15^2 – 12^2)	B1		
		PE gain = 16000g(AB/20)	B1		
			M1		For using WD by DF = PE gain + WD against resistance – KE loss
		1200 = 0.8g(AB) + 1.24(AB) – 648	A1		
		Distance AB is 200m	A1	5	
	(ii)	Distance BD is 300m	B1	1	

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(iii) WD against resistance =			
1240(BC) + 1860(300 – BC)	B1ft		ft distance BD
	M1		For using KE loss = PE gain + WD against res'ce – WD by DF
$\frac{1}{2}$ 16000($12^2 - 7^2$) = 2400000 + (558000 – 620BC) – 7200 × 300	A1		
Distance BC is 61.3 m	A1	4	

Alternative for Q6 part **(iii)**.	
For BC16000a = 7200 – 1240 – 8000 and for CD 16000a = 7200 – 1860 – 8000	B1
For using $v^2 = u^2 + 2as$ for both BC and CD	M1
$v_C^2 = 144 - 2 \times 0.1275(BC)$ and $49 = v_c^2 - 2 \times 0.16625(300 - BC)$	A1
For eliminating v_c^2 and obtaining BC = 61.3 m	A1

SR for candidates who assume that the acceleration is constant in part **(i)**, although there is no justification for the assumption (max. 3/5)	
For appropriate use of Newton's second law and $v^2 = u^2 + 2as$	M1
[1200000÷AB – 1240 – 160000/20 = 16000a and $a = (12^2 - 15^2)/2(AB)$]	
For eliminating a and attempting to solve for AB	M1
Distance AB is 200m	A1