

**Mark Scheme 4728
January 2007**

1	(i)	Net force on trailer is	B1		
		$\pm(700 - R_T)$	M1	For applying Newton's second law to the trailer with 2 terms on LHS (no vertical forces)	
	(ii)	$700 - R_T = 600 \times 0.8$	A1ft	ft cv ($\pm(700 - R_T)$)	
		Resistance is 220N	A1	4	
	(ii)		M1	For applying Newton's second law to the car or to the whole, with $a = \pm 0.8$ (no vertical forces)	
		$2100 - 700 - R_C =$	A1ft		
					ft cv(220)
	or				
		$2100 - (R_C + 220) =$			
		$(1100 + 600) \times$			
		0.8			
		Resistance is 520N	A1	3	
2	(i)		M1	For resolving forces vertically	
		15×0.28 and 11×0.8	A1	Allow use of $\sin = 16.3$ and $\cos = 53.1$	
		$Y = 15 \times 0.28 + 11 \times 0.8 - 13$	A1ft	Ft cv(15×0.28 and 11×0.8)	
	(ii)	Component is zero	A1	4	SR $15 \sin \theta + 11 \sin \theta - 13 = 0$ gets M1A0A1ftA0
		AG			
			M1		For resolving forces horizontally
	(iii)	$X = 15 \times 0.96 - 11 \times 0.6$	A1		Allow use of $\sin = 16.3$ and $\cos = 53.1$
		Magnitude is 7.8N	A1	3	Accept 7.79, -7.8
		Direction is that of the (+ve) x -axis	B1	1	Do not allow horizontal, 90° from vertical. Do not award if $\sin = 16.3$ and $\cos = 53.1$ have been used.
3	(i)	$T = 0.3g$	B1	At particle (or $0.3g - T = 0.3a$)	
		$F = T$	B1	Or $F = cv(T \text{ at particle})$ (or $T - F = 0.4a$)	
		$R = 0.4g$	B1		
			M1	For using $F = \mu R$	
	(ii)	Coefficient is 0.75	A1	5	
			M1		For resolving 3 relevant forces on B horizontally, $a=0$
		$X = 0.3g + 0.3g$	A1ft		Ft $X = 0.3g + cv(\mu)$
					cv(R)
		$X = 5.88N$	A1	3	

4	(i)	Momentum before collision $= +/- (0.8 \times 4 - 0.6 \times 2)$	B1	4	Or momentum change L $0.8 \times 4 +/- 0.8 v_L$ Accept inclusion of g in both terms
		Momentum after collision $= +/- 0.8 v_L + 0.6 \times 2$	B1		Momentum change N $0.6 \times 2 + 0.6 \times 2$ Accept inclusion of g in both terms
		Speed is 1 ms^{-1}	M1		For using the principle of conservation of momentum even if g is included throughout
			A1		Accept -1 from correct work (g not used).
	(ii)(a)	$0.6 \times 2 - 0.7 \times 0.5$	M1	4	Must be a difference. SR $0.6 \times 1 - 0.7 \times 0.5$ M1
		Total is 0.85 kgms^{-1}	A1		Must be positive
		<u>Total</u> momentum +ve after the collision. If N continues in its original direction, both particles have a negative momentum. N must reverse its direction.	DM 1		Or $0.6v + 0.7w$ is positive, confirming that the momentum is shared between two particles. No reference need be made to the physically impossible scenario where M and N both might continue in their original directions.
	(ii)(b)	$0.6 \times 2 - 0.7 \times 0.5 (= 0.85) = 0.7v$	A1ft	2	ft cv (0.85). Award M1 if not given in ii(a).
		Speed is 1.21 ms^{-1}	A1		Positive. Accept (a.r.t) 1.2 from correct work

5	(i)	$1.8t^2/2$ (+C)	M*1	3	For using $v = \int adt$
		(t = 0, v = 0) C = 0	B1		May be awarded in (ii). Accept c written and deleted.
	(ii)	Expression is $1.8t^2/2$	A1	4	also for $1.8t^2 + c$
		$0.9t^3/3$ (+K)	M1		For using $s = \int vdt$
	(iii)	0.3×64	A1	5	SR Award B1 for (s = 0, t = 0) K = 0 if not already given in (i), or +K included and limits used.
		19.2m AG	M1		For using limits 0 to 4 (or equivalent)
		$u = 0.9 \times 4^2$	A1		For using 'u' = v(4)
		$s = 14.4 \times 3 + \frac{1}{2} \times 7.2 \times 3^2$	D*		For using $s = ut + \frac{1}{2} \times 7.2t^2$ with non-zero u (s = 75.6)
		19.2 + 75.6	M1		For adding distances for the two distinct stages
		Displacement is 94.8m	A1		
		OR			
		$v = \int 7.2dt$	D*		For finding v(4)
		t = 0, v = 14.4, c = 14.4	M1		Integration and finding non-zero integration constant Nb Using t=4, v=14.4 gives c = -14.4
		$s = \int 7.2t + 14.4dt$			$s = \int 7.2t - 14.4dt$
	t = 0, s = 0, k = 0		Integration and finding integration constant. Nb t=4 with s=19.2 and v=7.2t-14.4 gives k=19.2		
$s = 3.6 \times 3^2 + 14.4 \times 3$	M1	Substituting t = 3 (OR 7 into $s = 3.6t^2 - 14.4t + 19.2$) (s=75.6) (OR $s = 3.6 \times 7^2 - 14.4 \times 7 + 19.2$)			
19.2 + 75.6 = 94.8	A1	Adding two distinct stages OR			
Displacement is 94.8m	M1 A1	$s = 3.6 \times 7^2 - 14.4 \times 7 + 19.2 = 94.8$ final M1A1			

6	(i)	$\frac{1}{2} 25v_m = 8$ or $\frac{1}{2} T v_m + \frac{1}{2} (25 - T) v_m =$	B*1	Do not accept solution based on isosceles or right angled triangle
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	8			
	Greatest speed is	D*B	2	
	0.64	1		
	ms ⁻¹			
(ii)		M1		For using $v = u + at$ or the idea that gradient represents acceleration
	$V = 0.02 \times 40$	A1		
	$V = 0.8$	A1	3	
(iii)		M1		For using the idea that the area represents displacement. nb trapezium area is $16+8+8$
		M1		For $A = \frac{1}{2}(L_1 + L_2)h$ or other appropriate breakdown
	$\frac{1}{2}(70 + T) \times 0.8 = 40 - 8$	A1ft		$\frac{1}{2}(30 + T) \times 0.8 = 40 - 8 - \frac{1}{2} \times 40 \times 0.8$ ft cv(0.8)
	8			
	Duration is 10s	A1	4	
(iv)		M1		For using $v = u + at$ or the idea that gradient represents acceleration
	$0 = 0.8 + a(30 - 10)$	A1ft		ft cv(10) and cv(0.8)
	Deceleration is	A1	3	Accept -0.04 from correct work
	0.04ms^{-2}			
	Or	M1		Using the idea that the area represents displacement.
	$40 - 8 - \frac{1}{2} \times 40 \times 0.8 - 10 \times 0.8$	A1ft		Ft cv(0.8 and 10)
	$= 0.8(30 - 10) - a(30 - 10)^2/2$	A1		Accept -0.04 from correct work. d=-0.04 A0
	Deceleration is			
	0.04ms^{-2}			

7	(i)	$R = 0.5g\cos 40^\circ$	B1	$R = 3.7536$	
		$F = 0.6 \times 0.5g\cos 40^\circ$	M1	For using $F = \mu R$	
		Magnitude is 2.25N AG	A1	3	
	(ii)		M1	For applying Newton's second law (either case) //slope, two forces	
		$-/+0.5g\sin 40^\circ - F = 0.5a$	A1	Either case	
		(a) Acceleration is – 10.8ms^{-2}	A1	Accept 10.8 from correct working (both forces have the same sign)	
		(b) Acceleration is 1.79ms^{-2}	A1	4	Accept -1.79 from correct working (the forces have opposite sign) Accept ! 1.8(0)
	(iii)a)	$0 = 4 + (-10.8)T_1$	M1	Requires appropriate sign	
		$T_1 = 0.370(3)$	A1	Accept 0.37	
	b)		M1	For complete method of finding distance from A to highest point using a(up) with appropriate sign	
		$0 = 4^2 + 2(-10.8)s$ or $s = (0 + 4) \times 0.37/2$ or $s = 4(0.370) + \frac{1}{2}(-10.8)(0.370)^2$	A1 ft	ft a(up) and/or T_1 ($s = 0.7405$)	
			M1	For method of finding time taken from highest point to A and not using a(up)	
$0.7405 = \frac{1}{2}(1.79)T_2^2$		A1ft	ft a(down) and cv(0.7405) ($T_2 = 0.908$ approx)		
$0.370 + 0.908 = 1.28\text{s}$		M1 A1	Using $T = T_1 + T_2$ with different values for T_1, T_2 3 significant figures cao	8	