Mark Scheme 4728
January 2007

1	**(i)**	Net force on trailer is +/-(700 - R_T)	B1		
			M1		For applying Newton's second law to the trailer with 2 terms on LHS (no vertical forces)
		700 - R_T = 600 x 0.8	A1ft		ft cv (+/-(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 =+/- 0.8 (no vertical forces)
		2100 – 700 – R_C = 1100 x 0.8	A1ft		
		or 2100 – (R_C + 220) = (1100 + 600)x 0.8			ft cv(220)
		Resistance is 520N	A1	3	

2	**(i)**		M1		For resolving forces vertically
		15 x 0.28 and 11x 0.8	A1		Allow use of = 16.3 and =53.1
		Y= 15x0.28 + 11x0.8 - 13	A1ft		Ft cv(15 x 0.28 and 11x 0.8)
		Component is zero AG	A1	4	**SR** 15sin + 11sin -13 = 0 gets M1A0A1ftA0
	(ii)		M1		For resolving forces horizontally
		X = 15 x 0.96 – 11 x 0.6	A1		Allow use of = 16.3 and =53.1
		Magnitude is 7.8N	A1	3	Accept 7.79, -7.8
	(iii)	Direction is that of the (+ve) x -axis	B1	1	Do not allow horizontal, 90^o from vertical. Do not award if = 16.3 and =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 at particle) (or T - F = 0.4a)
		R = 0.4g	B1		
			M1		For using F = μR
		Coefficient is 0.75	A1	5	
	(ii)		M1		For resolving 3 relevant forces on B horizontally, a=0
		X = 0.3g + 0.3g	A1ft		Ft X = 0.3g + cv(μ) cv(R)
		X = 5.88N	A1	3	

4	**(i)**	Momentum before collision $= +/-(0.8 \times 4 - 0.6 \times 2)$	B1		Or momentum change L $0.8x4 +/- 0.8v_L$ Accept inclusion of g in both terms
		Momentum after collision $= +/-0.8v_L + 0.6 \times 2$	B1		Momentum change N $0.6x2 + 0.6x2$ Accept inclusion of g in both terms
			M1		For using the principle of conservation of momentum even if g is included throughout
		Speed is 1 ms^{-1}	A1	4	Accept -1 from correct work (g not used).
	(ii)(a)	$0.6x2 - 0.7x0.5$	M1		Must be a difference. **SR** $0.6x1 - 0.7x0.5$ M1
		Total is $0.85kgms^{-1}$	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.	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.
		N must reverse its direction.	A1	4	
	(ii)(b)	$0.6x2 - 0.7x0.5$ (= 0.85) = 0.7v	A1ft		ft cv (0.85). Award M1 if not given in ii(a).
		Speed is $1.21ms^{-1}$	A1	2	Positive. Accept (a.r.t) 1.2 from correct work

5	**(i)**	$1.8t^2/2$ (+C)	M*1		For using $v = \int a\,dt$
		(t = 0,v = 0) C = 0	B1		May be awarded in (ii). Accept c written and deleted.
		Expression is $1.8t^2/2$	A1	3	also for $1.8t^2$ +c
	(ii)		M1		For using $s = \int v\,dt$
		$0.9t^3/3$ (+K)	A1		**SR** Award B1 for (s = 0, t = 0) K = 0 if not already given in (i), or +K included and limits used.
		0.3 x 64	M1		For using limits 0 to 4 (or equivalent)
		19.2m AG	A1	4	
	(iii)	$u = 0.9 \times 4^2$	D* M1		For using 'u' = v(4)
			M1		For using $s = ut + ½ \times 7.2t^2$ with non-zero u
		$s = 14.4 \times 3 + ½\ 7.2 \times 3^2$	A1		(s = 75.6)
		19.2 + 75.6	M1		For adding distances for the two distinct stages
		Displacement is 94.8m	A1	5	
		OR			
		$v = \int 7.2\,dt$	D* M1		For finding v(4) Integration and finding non-zero integration constant
		t = 0, v = 14.4, c = 14.4			Nb Using t=4, v=14.4 gives c = -14.4 $s = \int 7.2t - 14.4\,dt$
		$s = \int 7.2t + 14.4\,dt$ 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
			M1		Substituting t = 3 (OR 7 into $s = 3.6t^2 - 14.4t + 19.2$)
		$s=3.6x3^2+14.4x3$	A1		(s=75.6) (OR $s = 3.6\ x7^2 - 14.4x7 + 19.2$)
		19.2 + 75.6 = 94.8	M1		Adding two distinct stages OR
		Displacement is 94.8m	A1		$s = 3.6\ x7^2 - 14.4x7+19.2 = 94.8$ final M1A1

6	**(i)**	$½\ 25v_m = 8$ or $½Tv_m+½(25 – T)v_m =$	B*1		Do not accept solution based on isosceles or right angled triangle

	8			
	Greatest speed is 0.64 ms^{-1}	D*B 1	2	
(ii)		M1		For using v = u + at or the idea that gradient represents acceleration
	V = 0.02 x 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 = ½ (L_1 + L_2)h or other appropriate breakdown
	½ (70 + T) x 0.8 = 40 - 8	A1ft		½ (30 + T) x 0.8 = 40 - 8- ½ x 40 x 0.8 ft cv(0.8)
	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 0.04ms^{-2}	A1	3	Accept -0.04 from correct work
	Or	M1		Using the idea that the area represents displacement.
	40-8-½ x 40 x 0.8-10x0.8	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)**	$R = 0.5g\cos 40^o$	B1		R = 3.7536
		$F = 0.6 \times 0.5g\cos 40^o$	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
		$-/+0.5g\sin 40^o - F = 0.5a$	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 $s = 4(0.370) + ½(-10.8)(0.370)^2$	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)
		$0.7405 = ½(1.79)T_2^2$	A1ft		ft a(down) and cv(0.7405) (T_2 = 0.908 approx)
		0.370 + 0.908	M1		Using $T = T_1 + T_2$ with different values for T_1, T_2
		= 1.28s	A1	8	3 significant figures cao