4728 Mechanics 1

1	70 x 9.8 or 70g	B1	=686
	70 x 0.3	B1	=21
	686 + 21	M1	+ cvs [70(9.8+0.3) gets B1B1M1]
	707 N	A1	
		[4]	

2	+/-(40 x 4 - 60 x 3)	B1	Difference of terms, accept with g
	+/-([40 + 60] v	B1	Sum of terms, accept with g.
	+/-(40 x 4 - 60 x 3) = +/-([40 + 60] v	M1	Accept inclusion of g in equation.
	Speed = 0.2 ms^{-1}	A1	Not if g used. *SR* 40x4-60x3=[40 + 60] v;
			v=0.2, as heavier, award 5 marks
	Same as heavier or opposite lighter/"she"	B1	"Left" requires diagram for B1
		[5]	If same direction before collision award
			B0B1M1A0B0

3i		M1	Applies Pythagoras, requires +.
	$\sqrt{(12^2 + 15^2)}$	A1	
	19.2 N	A1	
		M1	trig and R included between X and Y
	tanθ =12/15, tanθ =15/12, sinθ =12/19.2,cosθ =15/19.2	A1	Accept cv 19.2
	Bearing = 038.7^{o}	A1	Accept 039 or 39 or art 39 from below
		[6]	(not given if X and Y transposed)
3ii	E = 19.2	B1ft	ft cv 19.2
	Bearing = 180 + 38.7 = 219°	B1ft	180+cv 38.7(-360) or correct answer
		[2]	

4i	v = dx/dt	M1	Uses differentiation, may be seen in (ii)
	v = 4t^3 - 8 x 2t	A1	Accept with +c
	v(2) = 4x2^3 - 8x2x2	M1	Substitutes 2 in cv v, explicit
	= 0 AG	A1	A0 if +c
	x(2) = 2^4 - 8 x 2^2 + 16 =0 AG	B1	Substitutes 2 in displacement, explicit
		[5]	
4ii	a = dv/dt	M1	Uses differentiation of v formula
	a = 12t^2 - 16	A1	Accept with +c
	a(2) = 12 x 2^2 - 16 = 32 ms^{-2}	A1	A0 with +c
		[3]	

5ia	250a = -150	M1	Values used in N2L for trailer F=+/-150
	a = -0.6 ms^{-2} AG	A1	Or -ve convincingly argued
		[2]	
5ib		M1	Applies N2L to car or car/trailer with
	900 x -0.6 = D -600 or (900+250)x-0.6 = D -600 -150	A1	correct number of forces
	D = 60 N	A1	(including T if T=0 used later)
		[3]	
5ic	15^2 = 18^2 +2x (-0.6)s	M1	Uses v^2 = u^2 + 2(+/-0.6)s with 15, 18
	s = 82.5 m	A1	Positive, allow from 18^2 = 15^2 + 2x0.6s
		[2]	
5iia		M1	Applies N2L to car+trailer with F(driving)
			F(resisting), F(wt cmpt-allow without g),
			or each part, as above and T.
	(900+250)a = 980 - 600 -150	A1	900a = 980 - 600 +/- 900x9.8sin3 - T
5iib	+ /-(900+250)x9.8sin3	A1	250a = T - 150 +/- 250x9.8sin3
	a = 0.713 ms^{-2}	A1	Allow (art) 0.71 from correct work
		[4]	
		M1	N2L for trailer, cv a, with correct number
	250 x 0.713 = T - 150 + 250x9.8sin3	A1	of forces of correct type. Or for car
			900x0.713 = -T-600 + 900x9.8sin3 + 980
	T = 200 N	A1	Anything rounding to 200 (3sf)
		[3]	

6i	$4.9 = \mu \times 14.7$		M1	Uses $F = \mu R$
	$\mu = 1/3$	AG	A1	Allow 0.333 or 0.3 recurring
			[2]	
6iia			M1	3 force vertical equation
	$R + 4.9\sin30 = 14.7$		A1	
	$R = 12.25$ N		A1	Accept 12.2 or 12.3
	$F = 12.25 \times 1/3$		M1	Uses $F = \mu R$ with new R {may be seen in
	$F = 4.08(333..)$ N [or 49/12 N]		A1	{part b
			[5]	
6iib	$m = 14.7/9.8 = 1.5$kg		B1	
			M1	N2L horizontally with 2 relevant forces, including $4.9\sin/\cos30$
	$4.9\cos30 - 4.08(333..) = 1.5a$		A1	Allow cv(F) *SR* Award A1 if m=14.7 used
	$a = 0.107$ ms^{-2}		A2	*SR* A1 for 0.11, 0.109
6iii			[5]	or art 0.011 from m = 14.7
	$\mu R = (14.7 - 4.9\cos30)/3$		B1	3.49, accept 3.5
	Horizontal component of force $= 4.9\sin30$		B1	2.45, accept 2.4 or 2.5
	Horizontal component of force $< ③R$		M1	Comparing two values
	Friction $= 2.45$ N		A1	Not 2.4 or 2.5; Explicit (M1 essential)
			[4]	

7i	$s = 0.5 \times 1.4 \times 0.8^2$		M1	Uses $s = 0.5 \times 1.4t^2$
	$s = 0.448$ m		A1	Not 0.45
	$v = 1.4 \times 0.8$		M1	Uses $v = 1.4t$
	$v = 1.12$ ms^{-1}		A1	
			[4]	
7ii	$0^2 = 1.12^2 - 2 \times 9.8s$		M1	Uses $0^2 = u^2 – 2gs$ or $u^2 = 2gs$
	$s = 0.064$ m		A1	Allow verification
	$0 = 1.12 - 9.8t$ $(t = 0.114s)$		M1	or $0.064 = 1.12t - 4.9t^2$
	$t = (0.114 + 0.8) = 0.914s$		A1	Allow 0.91 {or $0 = 1.12t - 4.9t^2$ and halve t
			[4]	
7iii	Scalene triangle, base on t axis		B1	NB Award A1 for 0.91 on t axis if total
	right edge steeper and terminates on axis, or crosses axis at t = 0.91		B1	time not given in (ii)
			[2]	
7iv			M1	Uses N2L for A or B with attempt at 2 forces
			A1	Either
	$1.4 \times A = 9.8 \times A - 5.88$ or $1.4 \times B = 5.88 - 9.8 \times B$		A1	
	$A = 0.7$		A1	Not 0.53
7va	$B = 0.525$		[4]	
			M1	Uses tension and 0.5g without particle weights
	$T = 0.5 \times 9.8 + 2 \times 5.88$			
7vb	$T = 16.66$ N		A1	Allow 16.7
			[2]	
	$T = 4.9$ N		B1	
			[1]	