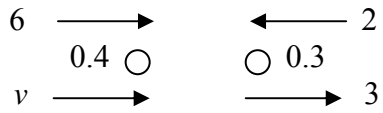
June 2006
6677 Mechanics M1
Mark Scheme

Question Number	Scheme	Marks
Qu 1	(a) Constant acceleration (b) Constant speed/velocity (c) Distance = ½ (2 + 5) x 3, + (4 x 5) = 30.5 m (a) and (b) Accept 'steady' instead of 'constant. Allow 'o.e.' (= 'or equivalent') within reason! But must have idea of constant. 'constant speed and constant acceleration' for (a) or (b) is B0 (c) M1 for valid attempt at area of *this* trap. as area of a trap. Or this trap. as = triangle + rectangle, i.e. correct formula used with at most a slip in numbers. B1 for area of rectangle as 5 x 4 Treating whole as a single const acceln situation, or whole as a single trapezium, is M0. If assume that top speed is 5.1 or 5.2, allow full marks on f.t. basis (but must be consistent)	B1 (1) B1 (1) M1 A1, B1 A1 (4)

Qu 2	. (a) 	
	CLM: $0.4 \times 6 - 0.3 \times 2 = 0.4 \times v + 0.3 \times 3$	M1 A1
	$\Rightarrow v = (+)\ \underline{2.25\ \text{m s}^{-1}}$	A1
	('+' $\Rightarrow$) direction unchanged	A1√ (4)
	(b) $I = 0.3 \times (2 + 3) = \underline{1.5, \text{Ns (o.e.)}}$	M1 A1, B1 (3)
	(a) M1 for 4 term equation dimensionally correct ($\pm g$). A1 correct A1 answer must be positive A1 f.t. – accept correct answer from correct working without justification; if working is incorrect allow f.t. from a clear diagram with answer consistent with their statement; also allow A1 if their ans is +ve and they say direction unchanged. (b) M1 – need (*one* mass) x (sum *or* difference of the two speeds associated with the mass chosen) A1 – answer must be positive B1 allow o.e. e.g. kg m s^{-1}	

Question Number	Scheme	Marks
Qu 3	(a) AB: $50 = 2 \times 22.5 + \frac{1}{2} a.4$	M1 A1
	$\Rightarrow a = \underline{2.5 \text{ m s}^{-2}}$	A1 (3)
	(b) $v^2 = 22.5^2 + 2 \times 2.5 \times 100$	M1 A1√
	$\Rightarrow v \approx \underline{31.7(2) \text{ m s}^{-1}}$	A1 (3)
	(c) $v_B = 22.5 + 2 \times 2.5 = 27.5$ (must be used)	M1 ↓
	$31.72 = 27.5 + 2.5t$ OR $50 = 27.5t + \frac{1}{2} \times 2.5t^2$ OR $50 = \frac{1}{2}(27.5 + 31.72)t$	M1 A1√
	$\Rightarrow t \approx \underline{1.69 \text{ s}}$	A1 (4)
	OR $31.72 = 22.5 + 2.5T$ OR $100 = 22.5t + \frac{1}{2} \times 2.5T^2$	M1 A1√ ↓
	$\Rightarrow T \approx 3.69$	
	$\Rightarrow t \approx 3.69 - 2 = \underline{1.69 \text{ s}}$	M1 A1 (4)
	OR $50 = 31.7t - \frac{1}{2} \times 2.5t^2$	M2 A1√
	Solve quadratic to get $t = \underline{1.69 \text{ s}}$	A1 (4)

NB note slight changes to scheme: dependency now in (c) and new rule on accuracy of answers.

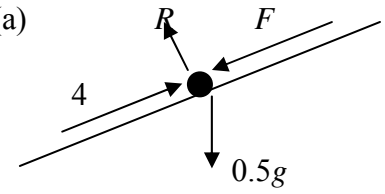
(b) M1 for valid use of data (e.g. finding speed at B by spurious means and using this to get v at C is M0.
Accept answer as AWRT 31.7

In (b) and (c), f.t. A marks are for f.t. on wrong a and/or answer from (b).

(c) M1 + M1 to get to an equation in the required t (normally two stages, but they can do it in one via 3rd alternative above)
Ans is cao. Hence premature approx (–> e.g. 1.68) is A0.
But if they use a 3 sf answer from (b) and then give answer to (c) as 1.7, allow full marks. And accept 2 or 3 s.f. answer or better to (c).

Qu 4

(a)



$R = 0.5g \cos \alpha = 0.4g$

$4 = F + 0.5g \sin \alpha$

$F = \mu R$ used

$4 = 0.4g.\mu + 0.3g$

$\Rightarrow \mu \approx \underline{0.27(0)}$

M1 A1

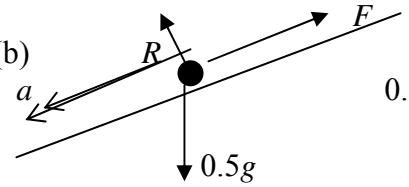
M1 A1

M1

M1 A1

(7)

(b)



$0.5a = 0.3g - 0.27 \times 0.4g$

$\Rightarrow a \approx (+) \underline{3.76 \text{ m s}^{-2}}$ (or 3.8)

M1 A2,1,0√

A1

(4)

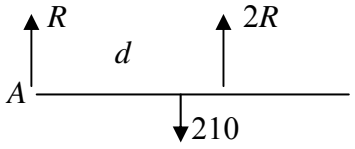
(a) 1st two M1's require correct number of the correct terms, with valid attempt to resolve the correct relevant term (valid 'resolve' = x sin/cos).

4th M1 (dept) for forming equn in μ + numbers only

(b) In first equn, allow their *R* or *F* in the equation for full marks.

A marks: f.t. on their *R*, *F* etc. Deduct one A mark (up to 2) for each wrong term. (Note slight change from original scheme)

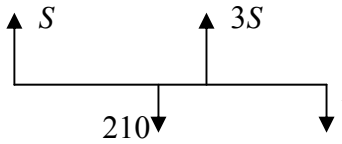
Qu 5

(a) 

$R + 2R = 210 \Rightarrow R = \underline{70\text{ N}}$ M1 A1 (2)

(b) e.g. M(A): $140 \times 90 = 210 \times d$ M1 A1√

$\Rightarrow d = 60 \Rightarrow AB = \underline{120\text{ cm}}$ M1 A1 (4)

(c) 

$4S = 210 + W$ M1 A1

e.g. M(B): $S \times 120 + 3S \times 30 = 210 \times 60$ M1 A2,1,0

Solve → ($S = 60$ and) $W = \underline{30}$ M1 A1 (7)

Note that they can take moments legitimately about many points

(a) M1 for a valid method to get R (almost always resolving!)

(b) 1st M1 for a valid moments equation
2nd M1 for complete solution to find AB (or verification)

Allow 'verification', e.g. showing $140 \times 90 = 210 \times 60$ M1 A1
$1260 = 1260$ QED M1 A1

(c) In both equations, allow whatever they think S is in their equations for full marks (e.g. if using $S = 70$).
2nd M1 A2 is for a moments equation (which may be about any one of 4+ points!)
1st M1 A1 is for a second equation (resolving or moments)
If they have two moments equations, given M1 A2 if possible for the best one
2 M marks only available *without* using $S = 70$.

If take mass as 210 (hence use 210g) consistently: treat as MR, i.e. deduct up to two A marks and treat rest as f.t. (Answers all as given = 9.8). But allow full marks in (b) (g's should all cancel and give correct result).

Qu 6	(a) Car + trailer: $2100a = 2380 - 280 - 630$ $= 1470 \Rightarrow a = \underline{0.7 \text{ m s}^{-2}}$ (3)	M1 A1 A1
	(b) e.g. trailer: $700 \times 0.7 = T - 280$ $\Rightarrow T = \underline{770 \text{ N}}$ (3)	M1 A1√ A1
	(c) Car: $1400a' = 2380 - 630$ $\Rightarrow a' = 1.25 \text{ m s}^{-2}$ distance $= 12 \times 4 + \frac{1}{2} \times 1.25 \times 4^2$ $= \underline{58 \text{ m}}$ (6)	M1 A1 A1 M1 A1√ A1
	(d) Same acceleration for car and trailer (1)	B1

(a) M1 for a complete (potential) valid method to get a

(b) If consider car: then get $1400a = 2380 - 630 - T$.
Allow M1 A1 for equn of motion for car or trailer wherever seen (e.g. in (a)).

So if consider two separately in (a), can get M1 A1 from (b) for one equation; then M1 A1 from (a) for second equation, and then A1 [(a)] for a and A1 [(b)] for T.

In equations of motion, M1 requires no missing or extra terms and dimensionally correct (e.g. extra force, or missing mass, is M0). If unclear which body is being considered, assume that the body is determined by the mass used. Hence if '$1400a$' used, assume it is the car and mark forces etc accordingly. But allow e.g. 630/280 confused as an A error.

(c) Must be finding a *new* acceleration here. (If they get 1.25 erroneously in (a), and then simply assume it is the same acceln here, it is M0).

(d) Allow o.e. but you must be convinced they are saying that it is same acceleration for both bodies. E.g. 'acceleration constant' on its own is B0
Ignore extras, but 'acceleration and tension same at A and B' is B0

Qu 7	(a) Speed $= \sqrt{(2.5^2 + 6^2)} = \underline{6.5 \text{ km h}^{-1}}$	M1 A1 (2)
	(b) Bearing $= 360 - \arctan(2.5/6) \approx \underline{337}$	M1 A1 (2)
	(c) $\mathbf{R} = (16 - 3 \times 2.5)\mathbf{i} + (5 + 3 \times 6)\mathbf{j}$ $= \underline{8.5\mathbf{i} + 23\mathbf{j}}$	M1 **A**1 (2)
	(d) At 1400 $\mathbf{s} = 11\mathbf{i} + 17\mathbf{j}$ At time t, $\mathbf{s} = \underline{11\mathbf{i} + (17 + 5t)\mathbf{j}}$	M1 A1 ↓ M1 A1 (4)
	(e) East of $R \Rightarrow 17 + 5t = 23$ $\Rightarrow t = 6/5 \Rightarrow \underline{1512 \text{ hours}}$	M1 A1 (2)
	(f) At 1600 $\mathbf{s} = 11\mathbf{i} + 27\mathbf{j}$ $\mathbf{s} - \mathbf{r} = 2.5\mathbf{i} + 4\mathbf{j}$ Distance $= \sqrt{(2.5^2 + 4^2)} \approx \underline{4.72 \text{ km}}$	M1 ↓ M1 A1 (3)

(a) M1 needs square, add and √ correct components

(b) M1 for finding acute angle = arctan (2.5/6) or arctan (6/2.5) (i.e. 67°/23°). Accept answer as AWRT 337.

(c) M1 needs non-zero initial p.v. used + 'their 3' x velocity vector

(d) Allow 1st M1 even if non-zero initial p.v. not used here

(e) A1 is for answer as a time of the day

(f) 1st M1 for using $t = 2$ or 4 (but *not* 200, 400, 6, 16 etc) and forming $\mathbf{s} - \mathbf{r}$ *or* $\mathbf{r} - \mathbf{s}$