MyStudyBro - Revision Exercise Tool

This Revision Handout includes the Questions and Answers of a total of 5 exercises!

Chapters:

Dynamics - M1 (Pearson Edexcel)

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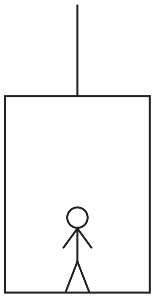

Figure 1

A lift of mass M kg is being raised by a vertical cable attached to the top of the lift. A person of mass m kg stands on the floor inside the lift, as shown in Figure 1. The lift ascends vertically with constant acceleration $1.4\,\text{m s}^{-2}$. The tension in the cable is 2800 N and the person experiences a constant normal reaction of magnitude 560 N from the floor of the lift. The cable is modelled as being light and inextensible, the person is modelled as a particle and air resistance is negligible.

(a) Write down an equation of motion for the person only.
(2)

(b) Write down an equation of motion for the lift only.
(2)

(c) Hence, or otherwise, find

(i) the value of m,

(ii) the value of M.
(3)

Question Number	Scheme	Marks
3(a)	$560 - mg = 1.4m$	M1 A1 (2)
(b)	$2800 - Mg - 560 = 1.4M$	M1 A1 (2)
(c) (i)	$560 = 11.2m$ $m = 50$	**DM**1 A1
(ii)	$2240 = 11.2M$ $M = 200$	A1 (3) **7**
	Notes	
(a)	M1 for equation of motion for the person only, with usual rules, condone sign errors, and with at least one value (560 or 1.4) substituted. *Credit given for this equation only if it appears in (a).*	
	A1 for a correct equation	
(b)	M1 for equation of motion for the lift only, with usual rules, condone sign errors, and with at least one value (2800, 560 or 1.4) substituted. *Credit given for this equation only if it appears in (b).*	
	A1 for a correct equation	
(c)	**Hence**: DM1, dependent on appropriate previous M mark, for solving one of their equations, wherever it appears, for either m or M **Otherwise**: DM1, dependent on appropriate previous M mark, for solving one of their equations and/or the whole system equation, wherever they appear, for either m or M **N.B.** There are no marks available for the whole system equation	
	First A1 for $m = 50$	
	Second A1 for $M = 200$	

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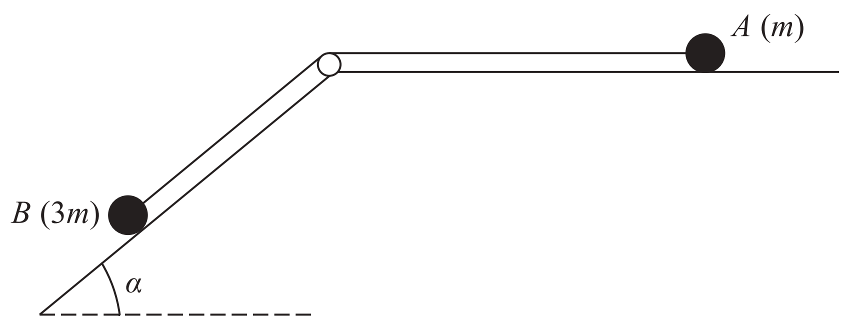

Figure 4

Two particles A and B have masses m and $3m$ respectively. The particles are attached to the ends of a light inextensible string. Particle A is held at rest on a rough horizontal table. The coefficient of friction between particle A and the table is $\frac{1}{5}$. The string lies along the table and passes over a small smooth light pulley that is fixed at the edge of the table. Particle B is at rest on a rough plane that is inclined to the horizontal at an angle α, where $\tan\alpha = \frac{4}{3}$, as shown in Figure 4. The coefficient of friction between particle B and the inclined plane is $\frac{1}{3}$. The string lies in the vertical plane that contains the pulley and a line of greatest slope of the inclined plane. The system is released from rest with the string taut and B slides down the inclined plane. Given that A does not reach the pulley,

(a) find the tension in the string,

(11)

(b) state where in your working you have used the fact that the string is modelled as being light,

(1)

(c) find the magnitude of the force exerted on the pulley by the string.

(4)

Question Number	Scheme	Marks
7(a)	For B, $S = 3mg\cos\alpha$	M1 A1
	For B, $3mg\sin\alpha - T - F_1 = 3ma$	M1 A2
	For A, $R = mg$	B1
	For A, $T - F_2 = ma$	M1 A1
	$F_1 = \frac{1}{3}S$; $F_2 = \frac{1}{5}R$	M1
	Solving for T	**DM**1
	$T = \dfrac{3mg}{5}$ or $5.88m$	A1 (11)
(b)	Constant tension throughout the string.	B1 (1)
(c)	$R = 2T\cos\dfrac{(180^o - \alpha)}{2}$	M1 A1
	$(= 2T\sin\frac{1}{2}\alpha)$ $(2T\cos 63.4^o)$	
	$= 2\times\dfrac{3mg}{5}\times\dfrac{\sqrt{5}}{5}$	DM1
	$= \dfrac{6mg\sqrt{5}}{25}$ $(5.3m$ or $5.26m)$	A1 (4)
		16
	OR:	
	$R = \sqrt{(T - T\cos\alpha)^2 + (T\sin\alpha)^2}$ or $R = \sqrt{(T^2 + T^2 - 2T^2\cos\alpha}$	M1A1
	Substitute their expression for T (MUST be in terms of m) and a correct value of α	DM1
	$= \dfrac{6mg\sqrt{5}}{25}$ $(5.3m$ or $5.26m)$	A1
	Notes	
	N.B. Use of sin(4/5) or similar, treat as an A error but allow recovery	
7(a)	First M1 for resolving perp to the plane , with usual rules	
	First A1 for a correct equation	
	Second M1 for equation of motion parallel to the inclined plane, with usual rules	
	Second and Third A1's for a correct equation -1 each error	
	B1 cao	
	Third M1 for equation of motion horizontally, with usual rules	
	Fourth A1 for a correct equation	
	Fourth M1 for using '$F = \mu R$' correctly twice	
	Fifth DM1, dependent on all M marks, for solving for T in terms of *m only*	
	Fifth A1 cao	
	N.B. Either equation of motion can be replaced by the whole system equation: $3mg\sin\alpha - F_1 - F_2 = 4ma$ (M1A2 or M1A1 as appropriate)	
(b)	Penalise extra wrong answers	
(c)	First M1 for attempt at correct expression for R in terms of T and α with usual rules i.e. condone cos/sin confusion but must be using the correct angle (can be in terms of α)	

	Special Case: Allow max M1A1DM0A0 if *m* is lost from their *T* but expression for *R* is otherwise correct.	
	First A1 for a correct expression for R in terms of T and α	
	Second DM1 for substituting in their expression for T and a correct value for α but must be in terms of m	
	Second A1 for a correct answer (any equivalent surd form)	

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6. A car pulls a trailer along a straight horizontal road using a light inextensible towbar. The mass of the car is M kg, the mass of the trailer is 600 kg and the towbar is horizontal and parallel to the direction of motion. There is a resistance to motion of magnitude 200 N acting on the car and a resistance to motion of magnitude 100 N acting on the trailer. The driver of the car spots a hazard ahead. Instantly he reduces the force produced by the engine of the car to zero and applies the brakes of the car. The brakes produce a braking force on the car of magnitude 6500 N and the car and the trailer have a constant deceleration of magnitude $4\,\text{m}\,\text{s}^{-2}$

Given that the resistances to motion on the car and trailer are unchanged and that the car comes to rest after travelling 40.5 m from the point where the brakes were applied, find

(a) the thrust in the towbar while the car is braking,

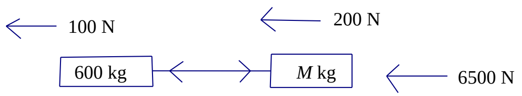
(3)

(b) the value of M,

(3)

(c) the time it takes for the car to stop after the brakes are applied.

(3)

Question Number	Scheme	Marks	Notes
			
6a	For the trailer:	M1	Complete method to form an equation in T. e.g. equation of motion for the trailer. Need all 3 terms. Condone sign errors.
	$-100-T=600\times(-4)$	A1	Correct unsimplified equation. Allow with $\pm T$
	$T=2300$ N	A1	Must be positive
		(3)	
6b	For the car and trailer:	M1	Complete method to solve for M. Equation of motion for the car + trailer. Need all terms. Condone sign errors.
	$6500+100+200=4(M+600)$	A1	Correct unsimplified equation
	$M=1100$	A1	
			Allow M1A1 if a correct equation is seen in (a) and used in (b)
6balt	For the car:	M1	Equation of motion for the car. Need all terms. Condone sign errors.
	$6500+200-T=4M$	A1	Correct unsimplified equation in T or their T
	$M=1100$	A1	
		(3)	
6c	$s=vt-\frac{1}{2}at^2$	M1	Complete method using *suvat* to find t Clear use of $s=ut+\frac{1}{2}at^2$ with $u=0, a=4$ is M0. e.g. $40.5=-2t^2$ from no working is M0A0
	$40.5=\frac{1}{2}.4.t^2$	A1	Correct unsimplified equation
	$t=4.5$ s	A1	
		(3)	
		[9]	

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7. A truck of mass 1600 kg is towing a car of mass 960 kg along a straight horizontal road. The truck and the car are joined by a light rigid tow bar. The tow bar is horizontal and is parallel to the direction of motion. The truck and the car experience constant resistances to motion of magnitude 640 N and R newtons respectively. The truck's engine produces a constant driving force of magnitude 2100 N. The magnitude of the acceleration of the truck and the car is $0.4\,\text{m}\,\text{s}^{-2}$.

(a) Show that $R = 436$

(3)

(b) Find the tension in the tow bar.

(3)

The two vehicles come to a hill inclined at an angle α to the horizontal where $\sin\alpha = \frac{1}{15}$.

The truck and the car move down a line of greatest slope of the hill with the tow bar parallel to the direction of motion. The truck's engine produces a constant driving force of magnitude 2100 N. The magnitudes of the resistances to motion on the truck and the car are 640 N and 436 N respectively.

(c) Find the magnitude of the acceleration of the truck and the car as they move down the hill.

(4)

Question Number	Scheme	Marks
7(a)	$2560\times0.4 = 2100 - 640 - R$	M1A1
	$R = 436$ * GIVEN ANSWER	A1 * (3)
(b)	Truck: $1600\times0.4 = 2100 - 640 - T$ **OR** car: $960\times0.4 = T - 436$	M1A1
	$T = 820$ N	A1 (3)
(c)	$2560a' = 2100 - 640 - 436 + 1600g\sin\alpha + 960g\sin\alpha$ (omission of g is one error)	M1A1A1
	$a' = 1.05$ or 1.1 m s^{-2}	A1 (4) **[10]**
	Notes for qu 7	
	Use the *mass* which is being used, in *F=ma*, to decide which part of the system an equation applies to.	
7a	M1 for an equation of motion, dim correct with correct no.of terms, condone sign errors, *in R only*	
	First A1 for a correct equation	
	Second A1 for $R = 436$ GIVEN ANSWER **N.B**. They may do (b) first, using the Truck equation to find $T = 820$, and then use Car equation here to show that $R = 436$	
7b	M1 for an equation of motion, dim correct with correct no.of terms, condone sign errors, for either truck or car, in T only. (Equation could appear in (a) but must be being used in (b))	
	First A1 for a correct equation	
	Second A1 for $T = 820$ (N)	
7c	M1 for an equation of motion *in a' only*, dim correct with correct no.of terms, condone sign errors and missing g's,	
	First and second A1 for a correct equation, -1 each error (Omission of g is one error) If both weight cpts are negative, treat as one error.	
	Third A1 for 1.05 or 1.1 (m s^{-2}) **N.B.** Note that $T = 820$ again but if they just assume that $T = 820$, M0	

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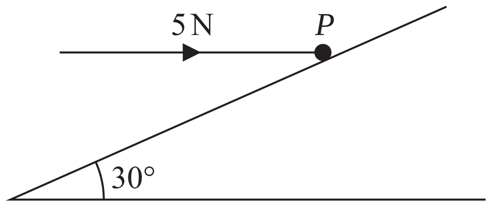

Figure 4

A rough plane is inclined at 30° to the horizontal. A particle P of mass 0.5 kg is held at rest on the plane by a horizontal force of magnitude 5 N, as shown in Figure 4. The force acts in a vertical plane containing a line of greatest slope of the inclined plane. The particle is on the point of moving up the plane.

(a) Find the magnitude of the normal reaction of the plane on P.
(4)

(b) Find the coefficient of friction between P and the plane.
(5)

The force of magnitude 5 N is now removed and P accelerates from rest down the plane.

(c) Find the speed of P after it has travelled 3 m down the plane.
(8)

Question Number	Scheme	Marks
8(a)	$\text{R}(\perp \text{ plane})$: $R = 0.5g\cos 30^\circ + 5\sin 30^\circ$	M1A1A1
	$R = 6.743... = 6.7$ or 6.74 N	A1 (4)
(b)	$\text{R}(\parallel \text{ plane})$: $F = 5\cos 30^\circ - 0.5g\sin 30^\circ \ (= 1.880...)$	M1A1A1
	$\mu = \frac{F}{R} = \frac{1.880}{6.743}, = 0.27880... = 0.28$ or 0.279	M1A1 (5)
(c)	NL2: $0.5g\sin 30^\circ - F' = 0.5a$	M1A1
	$\text{R}(\perp \text{ plane})$: $R' = 0.5g\cos 30^\circ \ (= 4.2435...)$	M1A1
	Use of $F' = \mu R' = 0.2787... \times R' \ (= 1.18345...)$ and solve for a	**DM**1
	$a = 2.53...$ m s^{-2}	A1
	$v^2 = 2as = 2 \times 2.533 \times 3$	M1
	$v = 3.9$ or 3.90 ms^{-1}	A1 (8) **[17]**
	Notes for qu 8	
8a	M1 for resolution perp to the plane, with usual rules	
	First and second A1 for a correct equation, -1 each error	
	Third A1 for 6.7 or 6.74 (N) must be positive	
8b	First M1 for resolution parallel to the plane, with usual rules	
	First and second A1 for a correct equation, -1 each error	
	Second M1 for *use* of $\mu = \frac{F}{R}$	
	Third A1 for 0.28 or 0.279	
8c	**SC: If 5N force is not removed, can score max: M1A0M1A0DM1A0M0A0** with usual rules applying for M marks assuming that 5N force still acting.	
	First M1 for equation of motion parallel to plane, with usual rules	
	First A1 for a correct equation (*F*' does not need to be substituted and allow if they use the value of *F* from part (b))	
	Second M1 for resolution perp to the plane, with usual rules	
	Second A1 for a correct equation	
	Third DM1, dependent on both previous M marks, for use of $F' = \mu R'$ and	

Question Number	Scheme	Marks
	solving for *a*	
	Third A1 for $a = 2.53$ or better, if they get *v* wrong, but if they get $v = 3.9$ then allow $a = 2.5$ or 2.54	
	Fourth M1 (independent but must have used an equation of motion to find *a*) for complete method to find *v* using their *a* M0 if particle is decelerating i.e if their *a* is negative down the plane.	
	Fourth A1 for $v = 3.9$ or $3.90\ \text{ms}^{-1}$	