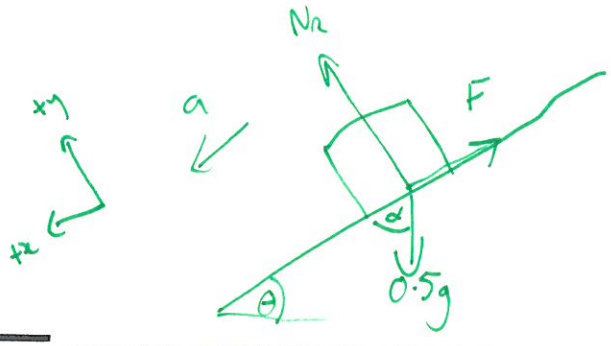

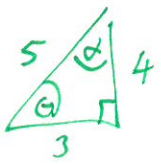

M1 - Jones9

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4. A small brick of mass 0.5 kg is placed on a rough plane which is inclined to the horizontal at an angle θ, where $\tan\theta = \frac{4}{3}$, and released from rest. The coefficient of friction between the brick and the plane is $\frac{1}{3}$.

Find the acceleration of the brick.

(9)

$\Sigma F_x = Ma$

$0.5g\cos\alpha - F = 0.5a$ — (1) M1 A1 A1

$\Sigma F_y = 0$

$N_R - 0.5g\sin\alpha = 0$ — (2) M1 A1

$F = \frac{1}{3}N_R$ — (3) B1

From (2) $N_R = 0.5g \times \frac{3}{5} = 2.94$ B1

In (3) $F = \frac{2.94}{3} = 0.98$

In (1) $0.5g \times \frac{4}{5} - 0.98 = 0.5a$

$2.94 = 0.5a$ M1

$a = 5.88\ ms^{-2}$ A1

M/9

M1 - June 09

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5.

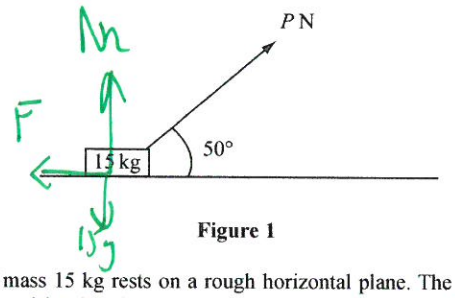

Figure 1

A small box of mass 15 kg rests on a rough horizontal plane. The coefficient of friction between the box and the plane is 0.2. A force of magnitude P newtons is applied to the box at 50° to the horizontal, as shown in Figure 1. The box is on the point of sliding along the plane.

Find the value of P, giving your answer to 2 significant figures.

(9)

$P\cos 50 - F = 0$ — (1) M1 A1

$N + P\sin 50 - 15g = 0$ — (2) M1 A1 A1

$F = 0.2N$ — (3) B1

From (1) $F = P\cos 50$

in (3) $P\cos 50 = 0.2N$

$N = \frac{P\cos 50}{0.2}$

in (2) $\frac{P\cos 50}{0.2} + P\sin 50 = 15g$ M1 M1

$P\left[\frac{\cos 50}{0.2} + \sin 50\right] = 15g$

$P = \frac{15g}{\left[\frac{\cos 50}{0.2} + \sin 50\right]} = 37\text{ N}$ to 2 sig figs. A1

M/9

M1 – June 09

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6. A car of mass 800 kg pulls a trailer of mass 200 kg along a straight horizontal road using a light towbar which is parallel to the road. The horizontal resistances to motion of the car and the trailer have magnitudes 400 N and 200 N respectively. The engine of the car produces a constant horizontal driving force on the car of magnitude 1200 N. Find

(a) the acceleration of the car and trailer,

(3)

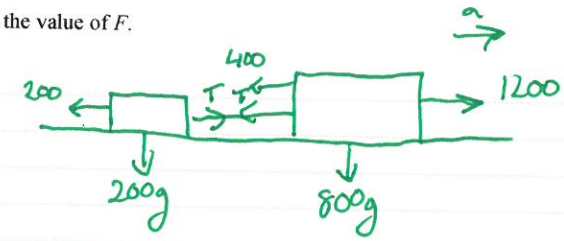
(b) the magnitude of the tension in the towbar.

(3)

The car is moving along the road when the driver sees a hazard ahead. He reduces the force produced by the engine to zero and applies the brakes. The brakes produce a force on the car of magnitude F newtons and the car and trailer decelerate. Given that the resistances to motion are unchanged and the magnitude of the thrust in the towbar is 100 N,

(c) find the value of F.

(7)



(a) NL $\quad 1200 - 400 - 200 = 1000a$ M1 A1

$600 = 1000a$

$a = \frac{600}{1000} = 0.6\ ms^{-2}$ A1

(b) Consider Forces on trailer $\quad T - 200 = 200 \times 0.6$ M1 A1

$T = 120 + 200$

$= 320\ N$ A1

(c) on trailer $\quad -100 - 200 = 200a \quad a = -1.5\ ms^{-2}$ M1 A1 A1

on car $\quad +100 - (400 + F) = 800 \times -1.5$ M1 A1 A1

$-300 - F = -1200$

$F = 900\ N$ A1

M 13

M1 - June 07

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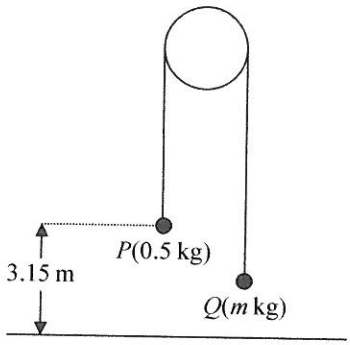
6.

Figure 4



Two particles P and Q have mass 0.5 kg and m kg respectively, where $m < 0.5$. The particles are connected by a light inextensible string which passes over a smooth, fixed pulley. Initially P is 3.15 m above horizontal ground. The particles are released from rest with the string taut and the hanging parts of the string vertical, as shown in Figure 4. After P has been descending for 1.5 s, it strikes the ground. Particle P reaches the ground before Q has reached the pulley.

(a) Show that the acceleration of P as it descends is 2.8 m s^{-2}.

(3)

(b) Find the tension in the string as P descends.

(3)

(c) Show that $m = \frac{5}{18}$.

(4)

(d) State how you have used the information that the string is inextensible.

(1)

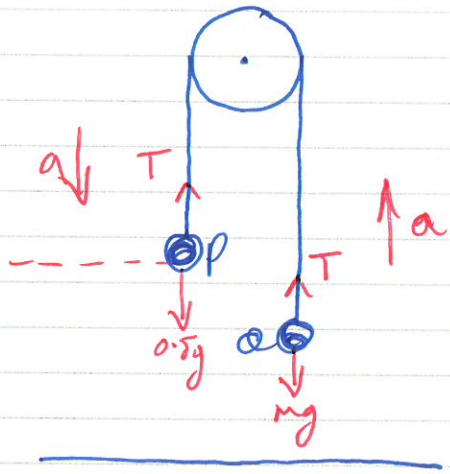
When P strikes the ground, P does not rebound and the string becomes slack. Particle Q then moves freely under gravity, without reaching the pulley, until the string becomes taut again.

(e) Find the time between the instant when P strikes the ground and the instant when the string becomes taut again.

(6)

M1 – JUNE 07

Q6



(a) $u=0 \quad t=1.5 \quad s=3.15 \quad a=?$

Using $s=ut+\frac{1}{2}at^2$

$3.15 = 0 + \frac{1}{2} \times a \times 1.5^2$ M1 A1

$3.15 = 1.125a$

$a = 2.8 \text{ ms}^{-2} \downarrow$ As required. A1

(b) on NEL on P $0.5g - T = 0.5(2.8)$ M1 A1

$T = 0.5(9.8-2.8) = 3.5 \text{ N}$ A1

(c) NEL on Q

$Mg - T = Ma$

$Mg - 3.5 = 2.8M$

$Mg - 2.8M = 3.5$

$M(9.8-2.8) = 3.5$

$M = \frac{3.5}{7}$

$T - Mg = Ma$ M1 A1

$3.5 = M(9.8+2.8)$

$M = \frac{3.5}{12.6} = \frac{5}{18}$ M1 A1 As required

(d) inextensible string $\therefore$ const accel throughout system B1

M1 – June 07

Q6 (e) initial speed of Q when string goes slack = speed P hits ground

for P: $u=0$ $t=1.5$ $a=2.8$ $V=?$

$V = 0 + 1.5 \times 2.8 = 4.2$ M1 A1

So for Q moving under gravity: $u = 4.2\uparrow$ $t=?$ $a = 9.8\downarrow = -9.8\uparrow$ $V=0$

$0 = 4.2 - 9.8t$ M1 A1

$t = \frac{3}{7}$ sec to max ht

∴ total time before string tight again $= \frac{3}{7} \times 2 = \frac{6}{7}$ sec. M1 A1

(M/17).