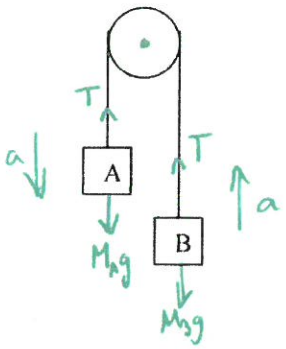
The Effect of N2L on Pulleys

When connected particles pass over a pulley and released, the resulting motion will produce the same acceleration in each body. However, it is not possible to consider the system as a whole as the particles will be travelling in different directions.

A smooth pulley means that the tensions in the string are equal on both sides of the pulley.

If $M_A > M_B$



Eg 25 Two particles of mass 7kg and 3 kg are connected by a light, inextensible string passing over a smooth fixed pulley. Find the acceleration of the particles, the tension in the string and the force exerted on the pulley.

Eg 26 Bodies of mass 3Mkg and Mkg are connected by a light inextensible string which passes over a smooth fixed pulley. With the masses hanging vertically, the system is released from rest. Find the acceleration of the system and the distance moved by the 3Mkg mass in the first 2 seconds of motion. After the 3M kg mass hits the floor 10metres below the point of release, how much farther will the Mkg body travel before beginning to fall again?

Exercise 3F Pg 64 Q4

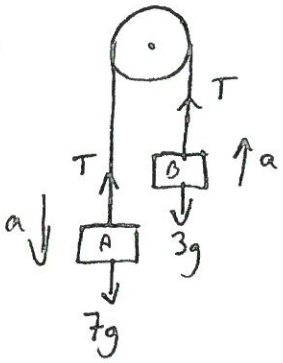
Eg 27 A particle of mass 3kg rests on a rough horizontal table ($\mu = 0.2$). It is connected by a light, inextensible string passing over a smooth pulley fixed at the edge of the table to a particle of mass 2kg which hangs freely. Find the acceleration of the system when it is released from rest. Find also the force exerted on the pulley.

Ex 3F Q5

Eg 28 A particle of mass Mkg rests on a smooth plane inclined at an angle of 30^o to the horizontal. It is connected by a light, inextensible string passing over a smooth pulley fixed at the top of the plane to a particle of mass 4Mkg which hangs freely. Find the acceleration of the system when it is released from rest, the tension in the string and also the force exerted by the string on the pulley.

Ex 3F Q's 6, 7, 9

Eg 15



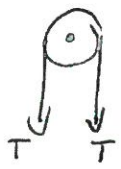
A: $7g - T = 7a$ — ①

B: $T - 3g = 3a$ — ②

① + ② $4g = 10a$

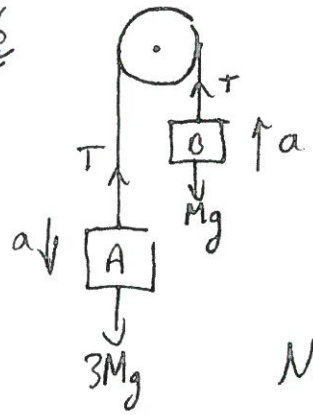
$a = \frac{4g}{10} = 3.92\,ms^{-2}$

in ② $T = 3(3.92) + 3(9.8) = 41.16\,N$



$R_y = T + T = 2T = 82.32\,N$

Eg 16



A: $3Mg - T = 3Ma$ — ①

B: $T - Mg = Ma$ — ②

① + ② $2Mg = 4Ma$

$a = \frac{g}{2} = 4.9\,ms^{-2}$

Now $s = ?$ $a = \frac{g}{2}\downarrow$ $u = 0$ $t = 2$

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

$s = \frac{1}{2} \times 4.9 \times 2^2 = 9.8$ metres.

PARTICLE B now travels as projectile. Speed at this point: $u = 0$ $v = ?$ $a = 4.9$ $s = 12$

$v^2 = 0^2 + 2 \times 4.9 \times 12 = 117.6$

$v = 10.8\,ms^{-1}$

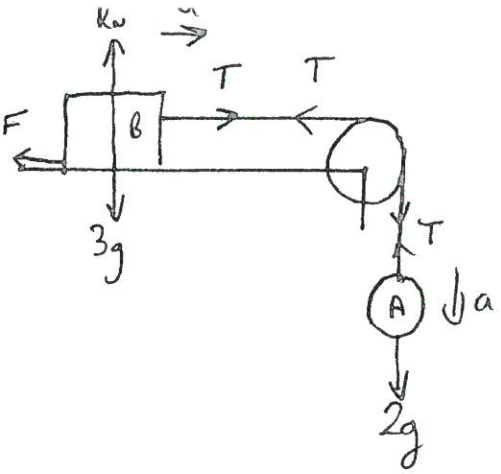
Now $u = 10.8 \uparrow$ $v = 0$ $a = 9.8\downarrow = -9.8\uparrow$ $s = ?$

$0^2 = 10.8^2 - 19.6s$

$s = 5.95$

∴ B will continue to rise for 6 metres.

eg 27



$2g - T = 2a$ — ①

$T - F = 3a$ — ②

$R_N - 3g = 0$ — ③

$F = \mu R_N$ — ④

$F = 0.2 \times 3g = 5.88$

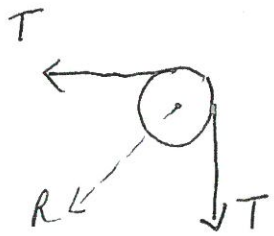
① + ② $2g - F = 5a$

$2g - 5.88 = 5a$

$a = 2.74 ms^{-2}$

in ② $T = 3 \times 2.74 + 5.88$

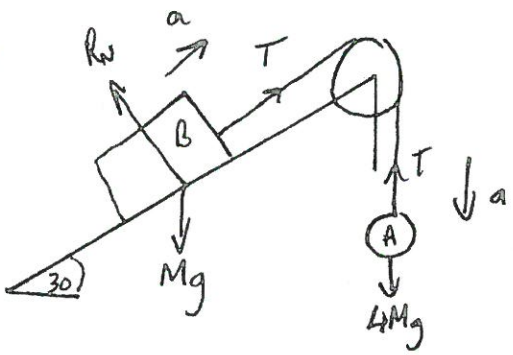
$T = 14.1 N$



$R_x = T \quad R_y = T$

$\therefore R = \sqrt{T^2 + T^2} = 19.9\ N$

eg 28



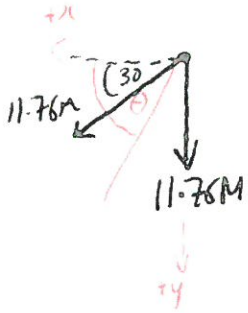
A: $4Mg - T = 4Ma$ — ①

B: $T - Mg\sin 30 = Ma$ — ②

① + ② $4Mg - \frac{1}{2}Mg = 5Ma$

$a = \frac{3.5g}{5} = 6.86 ms^{-2}$

in ② $T = 6.86M + 4.9M = 11.76M\ N.$



$R_x = 11.76M \cos 30 = 10.18M$

$R_y = 11.76M + 11.76M \sin 30 = 17.64M$

$R = \sqrt{(10.18M)^2 + (17.64M)^2} = \sqrt{414.802M^2} = 20.37M\ N$

$\theta = \tan^{-1}\left(\frac{17.64M}{10.18M}\right) = 60°$