$T - 3g = 6b$ **Equation 3**

$$\Rightarrow b = \frac{T - 3g}{6}$$

$10g - T = 5a + 5b$ **Equation 2**

$$\Rightarrow 10g - T = 5\left(\frac{T - 5g}{10}\right) + 5\left(\frac{T - 3g}{6}\right)$$

… multiply by 6

$$\Rightarrow 60g - 6T = 3T - 15g + 5T - 15g$$

$$\Rightarrow 14T = 90g$$

$$\Rightarrow T = \frac{45g}{7} = 63 \text{ N}$$

$$a = \frac{T - 5g}{10} = \frac{63 - 49}{10}$$

$= 1.4$ m/s^2 … acceleration of 10 kg particle.

$$b = \frac{T - 3g}{6} = \frac{63 - 29.4}{6}$$

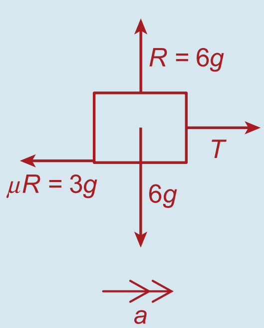
$= 5.6$ m/s^2 … acceleration of 6 kg particle

$$\frac{a + b}{2} = \frac{1.4 + 5.6}{2}$$

$= 3.5$ m/s^2 … acceleration of 20 kg pulley

Q. 9. Note firstly that, as M increases, the first particle to move will be the 6 kg mass. Initially, therefore, the only moving particles will be the 6 kg mass and the pulley. The system forces, just as the 6 kg mass starts to move, will look like this:

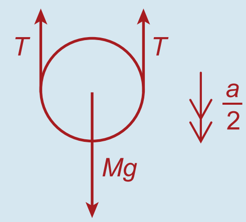
6 kg Mass



$T - 3g = 6a$

$\Rightarrow 2T - 6g = 12a$ **Equation 1**

Pulley



$Mg - 2T = M\left(\frac{a}{2}\right)$ **Equation 2**

Adding equations **1** and **2** gives

$$Mg - 6g = \frac{Ma}{2} + 12a$$

$$\Rightarrow g(M - 6) = a\left(\frac{M}{2} + 12\right)$$

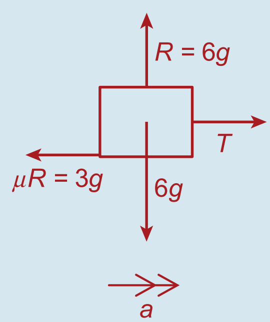
$$\Rightarrow a = \frac{g(M - 6)}{\frac{M}{2} + 12} = \frac{2g(M - 6)}{M + 24}$$

$a = 0$

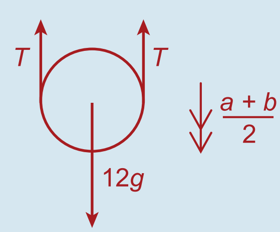
$\Rightarrow M - 6 = 0$

$\Rightarrow M = 6$ … this is the value of M at which the friction between the 6 kg mass and the table is just overcome. If the value of M is below this, there will be no movement.

Now, let $M = 12$



$T - 3g = 6a$ **Equation 1**



$$12g - 2T = 12\left(\frac{a + b}{2}\right)$$

$\Rightarrow 6g - T = 3a + 3b$ **Equation 2**