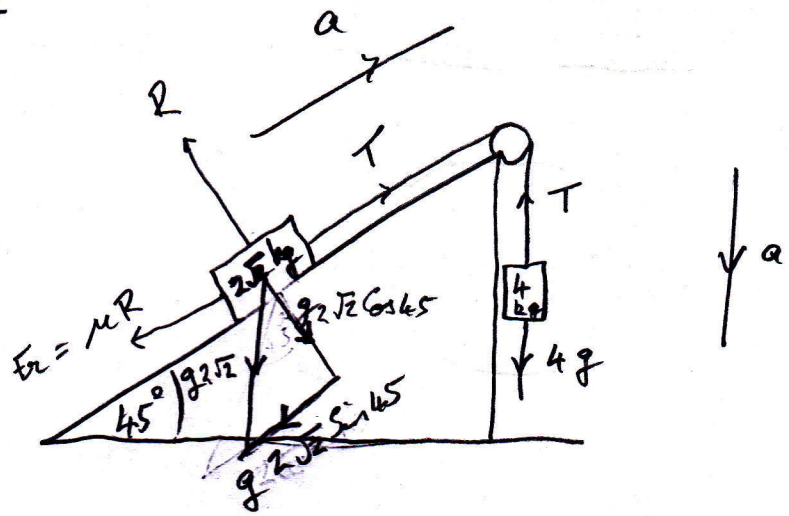
2011 Q4.

(a)



$F = ma$

4kg wgt: $\Rightarrow 4g - T = 4a$ ①

$2\sqrt{2}$ kg wgt: $\Rightarrow T - 2g\sqrt{2}\sin 45 - \mu R = 2\sqrt{2}\,a$

$\Rightarrow T - 2g - \frac{1}{4}\,2g\sqrt{2}\cos 45 = 2\sqrt{2}\,a$

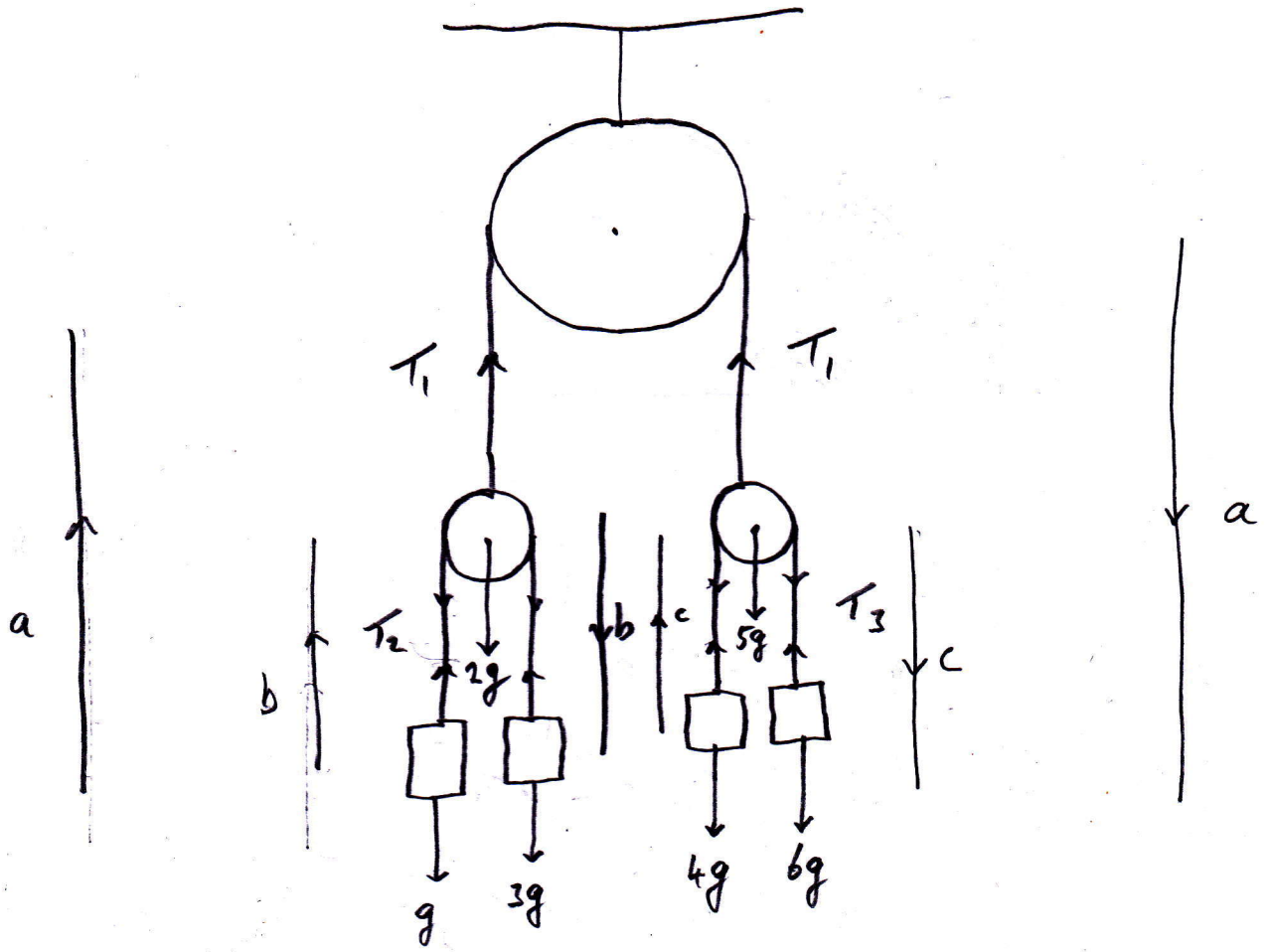
$\Rightarrow T - 2g - \frac{1}{2}g = 2\sqrt{2}\,a$ ②

Adding ① + ② $\Rightarrow 4g - 2g - \frac{1}{2}g = (4 + 2\sqrt{2})\,a$

$\Rightarrow a = \dfrac{1\frac{1}{2}g}{4 + 2\sqrt{2}}$

$\Rightarrow a = 2.15\ ms^{-1}$

(b)



6kg: $F = ma$ $\Rightarrow$ $6g - T_3 = 6(c+a) \Rightarrow 6g - T_3 = 6c + 6a$ ①

4kg: $\Rightarrow$ $T_3 - 4g = 4(c-a) \Rightarrow T_3 - 4g = 4c - 4a$ ②

$\Rightarrow$ $12g - 2T_3 = 12c + 12a$ ② $\times 2$

and $-3T_3 + 12g = -12c + 12a$ ② $\times -3$

$\Rightarrow$ $-5T_3 + 24g = 24a$ ③

3kg: $F = ma$ $\Rightarrow$ $3g - T_2 = 3(b-a) \Rightarrow 3g - T_2 = 3b - 3a$ ①

$T_2 - g = (b+a) \Rightarrow T_2 - g = b + a$ ②

$3g - T_2 = 3b - 3a$ ①

$-3T_2 + 3g = -3b - 3a$ ② $\times -3$

$\Rightarrow$ $6g - 4T_2 = -6a$ ④

2kg Pulley: $T_1 - 2T_2 - 2g = 2a$ ⑤

5kg Pulley: $2T_3 + 5g - T_1 = 5a$

$\Rightarrow 2T_3 - 2T_2 + 3g = 7a$

Substituting in ③ and ④

$\Rightarrow 2\left(\frac{24g - 24a}{5}\right) - 2\left(\frac{6g + 6a}{4}\right) + 3g = 7a$

$\Rightarrow \frac{48g}{5} - \frac{48a}{5} - \frac{12g}{4} - \frac{12a}{4} + 3g = 7a$

$\Rightarrow 192g - 192a - 60g - 60a + 60g = 140a$

$\Rightarrow 192g = 392a$

$\Rightarrow a = 4.8\ ms^{-2}$

③ $-5T_3 + 24g = 24a \Rightarrow -5T_3 + 24g = 24(4.8)$

$\Rightarrow T_3 = 24N$ *

④ $6g - 4T_2 = -6a \Rightarrow 6g - 4T_2 = -6(4.8)$

$\Rightarrow T_2 = 21.9N$ *

⑤ $T_1 - 2T_2 - 2g = 2a \Rightarrow T_1 - 2(21.9) - 2g = 2(4.8)$

$\Rightarrow T_1 = 73N$