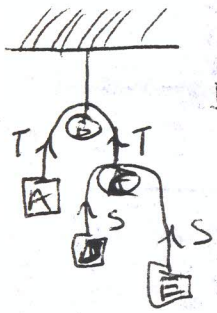
1976 Q3 [Connected Bodies]



	A	C	D	E
MASS	3m	0	2m	m
Accel	↓a	↓a	↓a	↓a
FORCES	↑T, ↓3mg	↑T, ↓S	↑S, ↓2mg	↑S, ↓mg
NII	$T-3mg=3ma$	$T-2S=0a$	$2mg-S=2m(f+a)$	$mg-S=m(a-f)$
		$\Rightarrow T=2S$		

∴ Eqns of motion are

$$T-3mg=3ma \quad (1)$$

$$T=2S \quad (2)$$

$$2mg-S=2mf+2ma \quad (3)$$

$$mg-S=ma-mf \quad (4)$$

Needs: Eliminate S from (3) and (4)

(3) $\Rightarrow 2mg-S=2mf+2ma$

(4)×2 $\Rightarrow -2S+2mg=2ma-2mf$

$$\Rightarrow -3S+4mg=4ma \Rightarrow S=\frac{4m(g-a)}{3}$$

So Eqn (2) $\Rightarrow T=2\left(\frac{4m(g-a)}{3}\right)=\frac{8m(g-a)}{3}$ (*)

So (1) $\Rightarrow$ (Sub for T) $\frac{8mg-8ma}{3}-3mg=3ma$

$$\Rightarrow 8mg-8ma-9mg=9ma$$

$$\Rightarrow -mg=17ma$$

$$\Rightarrow \boxed{\frac{-g}{17}=a}$$

∴ (*) $\Rightarrow T=\frac{8m\left(g-\left(\frac{-g}{17}\right)\right)}{3}=\frac{8m\left(\frac{18g}{17}\right)}{3}$

$$=\frac{8m\,6\,g}{17}$$

$$\Rightarrow T=\frac{48mg}{17} \text{ Newtons}$$

qed