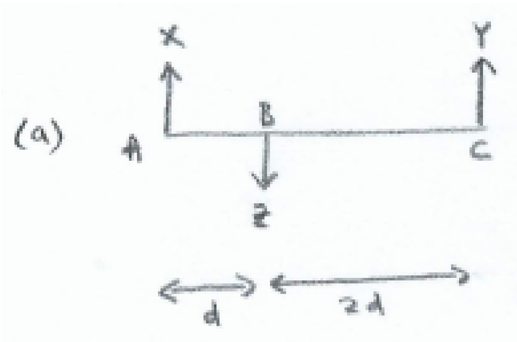
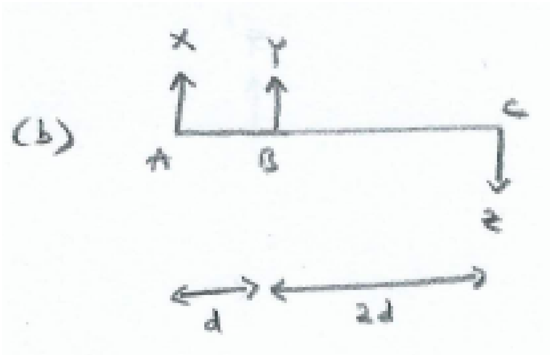
Forces – Q3 [Problem/M](2/6/21)

(i) Which of the following systems of forces could be in equilbrium? (with X, Y and Z > 0)





(ii) Assuming that $X + Y = Z,$ show that the total moments about A, B and C are equal, in both of the cases in (i).

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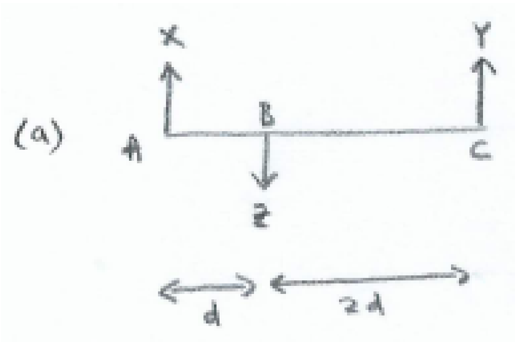

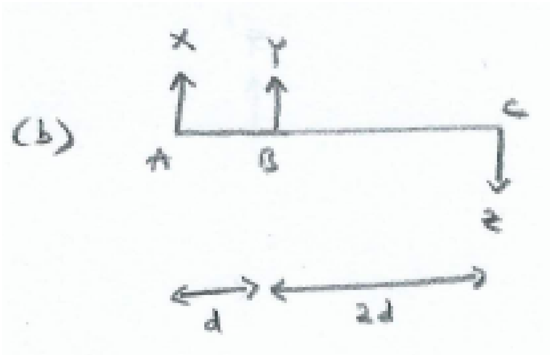

(ii) Assuming that $X + Y = Z$, show that the total moments about A, B and C are equal, in both of the cases in (i).

Solution

(i) (a) Vertical equilibrium requires that $X + Y = Z$.

For rotational equilibrium, taking moments about B, $2dY - dX = 0$, so that $X = 2Y$.

Thus there is equilibrium provided that $Y = \frac{X}{2}$ and $Z = \frac{3X}{2}$.

[Note: As about to be shown in (ii), we can take moments about any point, provided that $X + Y = Z$]

(b) If we take moments about B, we obtain $-dX - 2dZ$, which cannot equal zero. Thus the system cannot be in equilibrium.

[With 3 forces, the directions of the forces must alternate for equilibrium to be possible.]

(ii) (a) $M(A): 3dY - dZ = 3dY - d(X + Y) = d(2Y - X)$

$M(B): 2dY - dX = d(2Y - X)$

$M(C): 2dZ - 3dX = 2d(X + Y) - 3dX = d(2Y - X)$

(b) $M(A): dY - 3dZ = dY - 3d(X + Y) = -d(3X + 2Y)$

$M(B): - dX - 2dZ = -dX - 2d(X + Y) = -d(3X + 2Y)$

$M(C): - 2dY - 3dX = -d(3X + 2Y)$

[Thus the total moment will be the same about any point, provided that the forces balance; regardless of whether there is rotational equilibrium.]