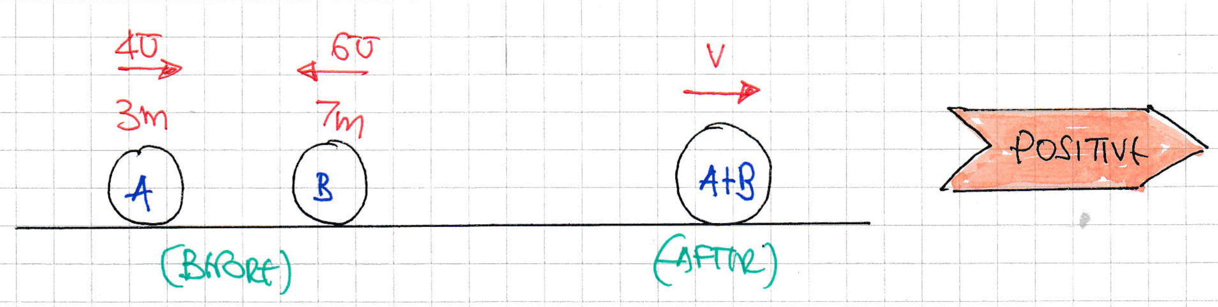
IYGB - FM1 PAPER N - QUESTION 1

a) DRAWING A DIAGRAM



BY CONSERVATION OF MOMENTUM

$$(4U \times 3m) - (6U \times 7m) = 10mv$$

$$12mU - 42mU = 10mv$$

$$-30mU = 10mv$$

$$V = -3U \quad \text{(IE OPPOSITE DIRECTION TO THAT MARKED)}$$

$\therefore$ SPEED $3U$

b) IMPULSE ON A

MOMENTUM OF A AFTER - MOMENTUM OF A BEFORE

$$= (3mv) - (4U \times 3m)$$

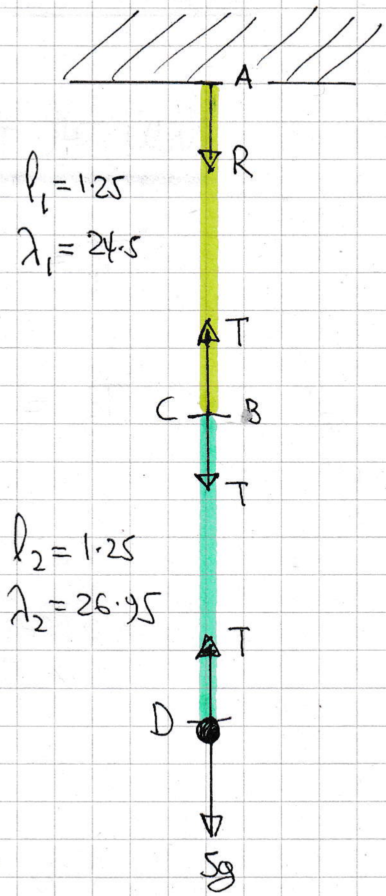
$$= 3m(-3U) - 12mU$$

$$= -21mU$$

$\therefore$ MAGNITUDE OF THE IMPULSE IS $21mU$

IYGB – FM1 PAPER N – QUESTION 2

a) LOOKING AT A DIAGRAM AND CONSIDERING THE TENSION



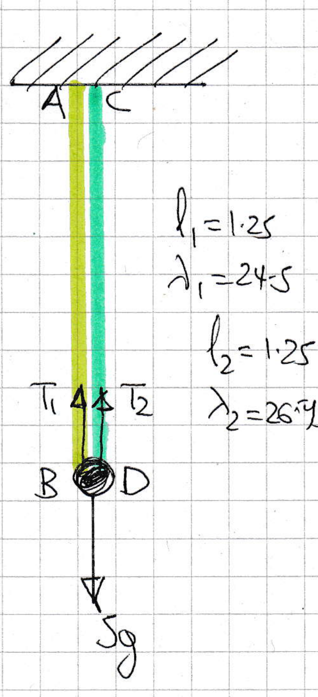
IN AB	IN CD
$T = \frac{\lambda_1 x_1}{l_1}$	$T = \frac{\lambda_2 x_2}{l_2}$
$5g = \frac{24.5 x_1}{1.25}$	$5g = \frac{26.95 x_2}{1.25}$
$x_1 = 2.5\text{ m}$	$x_2 = \frac{25}{11}\text{ m}$

∴ TOTAL LENGTH IS

$$1.25 + 1.25 + 2.5 + \frac{25}{11} = \frac{80}{11}$$

$$\approx 7.27\text{ m}$$

b) NEW DIAGRAM FOR THE NEW CONFIGURATION



IN THIS CONFIGURATION $x_1 = x_2 = x$

$$\Rightarrow T_1 + T_2 = 5g$$

$$\Rightarrow \frac{\lambda_1 x_1}{l_1} + \frac{\lambda_2 x_2}{l_2} = 5g$$

$$\Rightarrow \frac{24.5x}{1.25} + \frac{26.95x}{1.25} = 5g$$

$$\Rightarrow \frac{98}{5}x + \frac{539}{25}x = 5g$$

$$\Rightarrow \frac{1029}{25}x = 49$$

$$\Rightarrow x = \frac{25}{21}$$

IYGB - FM1 PAPER N - QUESTION 2

NOW THE TENSION IN EACH STRING CAN BE FOUND

$$T_1 = \frac{\lambda_1 x_1}{l_1} = \frac{24.5 \times \frac{25}{21}}{1.25} = \frac{70}{3} = 23\tfrac{1}{3}\,N$$

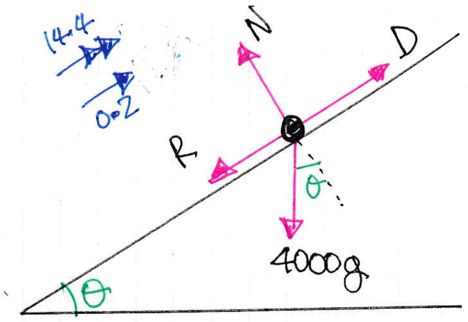
$$T_2 = 5g - \frac{70}{3} = \frac{77}{3} = 25\tfrac{2}{3}\,N$$

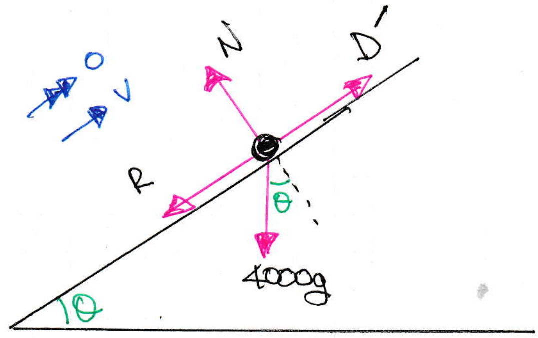
$\therefore$ TENSION IN AB IS $23\frac{1}{3}$ N

TENSION IN CD IS $25\frac{2}{3}$ N

IYGB - FM1 PAPER N - QUESTION 3

STARTING WITH TWO SEPARATE DIAGRAMS





- "$P = D \times V$"

$\Rightarrow 90000 = D \times 14.4$

$\Rightarrow D = 6250$

- "$F = m \times a$"

$\Rightarrow D - R - 4000g\sin\alpha = 4000a$

$\Rightarrow 6250 - R - 4000g\left(\frac{3}{49}\right) = 4000(0.2)$

$\Rightarrow 6250 - R - 2400 = 800$

$\Rightarrow R = 3050$ ← CONSTANT.

- MAX SPEED ⟹ NO ACCELERATION ⟹ EQUILIBRIUM

$\Rightarrow D' = R + 4000g\sin\theta$

$\Rightarrow D' = 3050 + 4000g\left(\frac{3}{49}\right)$

$\Rightarrow D' = 3050 + 2400$

$\Rightarrow D' = 5450$

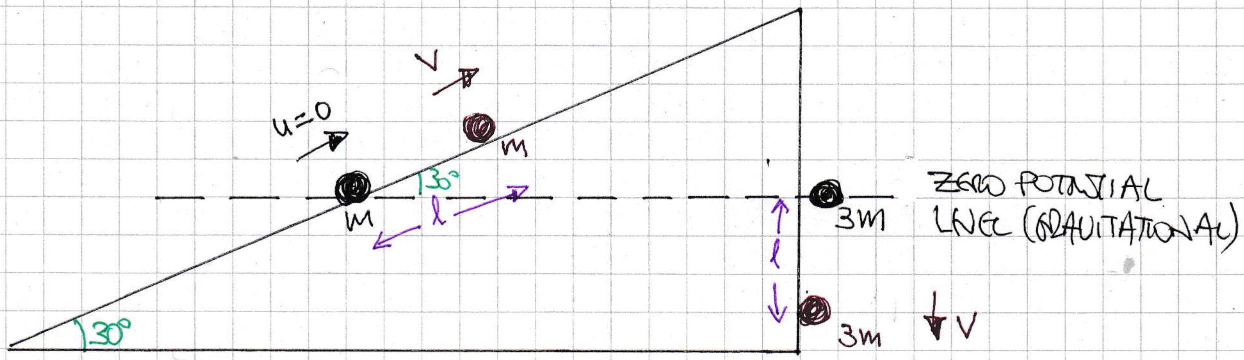
- "$P = D' \times V$"

$\Rightarrow 90000 = 5450V$

$\Rightarrow V_{MAX} = \frac{1800}{109} \simeq 16.5 \text{ ms}^{-1}$

IYGB – FM1 PAPER N – QUESTION 4

STARTING WITH AN ENERGY DIAGRAM



$$\underbrace{\cancel{KE_A} + \cancel{KE_B} + \cancel{PE_A} + \cancel{PE_B}}_{\text{ON RELEASE}} = \underbrace{KE_A + KE_B + PE_A + P.E_B}_{\text{AFTER BOTH MOVING BY } l.}$$

$$\Rightarrow 0 = \tfrac{1}{2}mv^2 + \tfrac{1}{2}(3m)v^2 + mg(l\sin 30) + 3mg(-l)$$

$$\Rightarrow 0 = \tfrac{1}{2}mv^2 + \tfrac{3}{2}mv^2 + \tfrac{1}{2}mgl - 3mgl$$

$$\Rightarrow 0 = mv^2 + 3mv^2 + mgl - 6mgl.$$

$$\Rightarrow 0 = 4mv^2 - 5mgl.$$

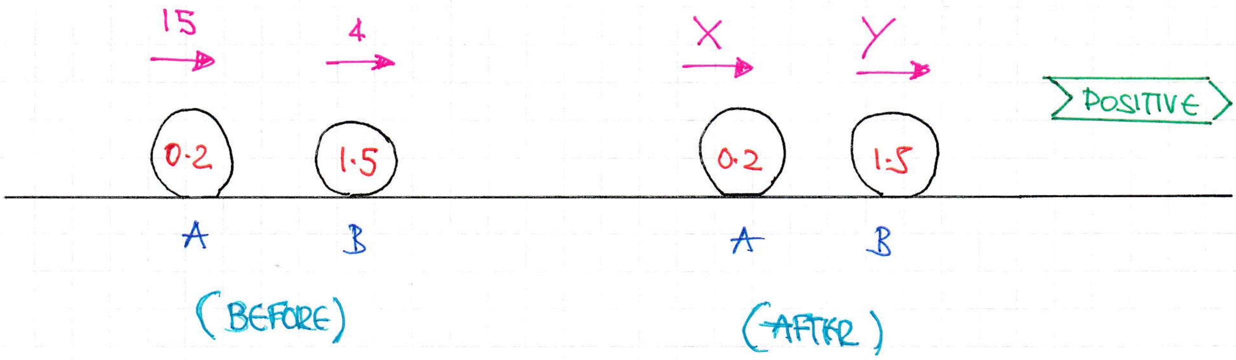
$$\Rightarrow 0 = 4v^2 - 5gl$$

$$\Rightarrow 5gl = 4v^2$$

$$\Rightarrow v^2 = \tfrac{5}{4}gl$$

$$\Rightarrow |v| = \tfrac{1}{2}\sqrt{5gl}$$

IYGB – FM1 PAPER N – QUESTION 5



- **BY CONSERVATION OF MOMENTUM**

$$(15\times0.2)+(4\times1.5) = 0.2X+1.5Y$$
$$(15\times2)+(4\times15) = 2X+15Y$$
$$2X+15Y = 90$$

- **BY CONSIDERING RESTITUTION**

$$\frac{Y-X}{15-4} = e$$
$$Y-X = 11e$$
$$Y = X+11e$$

- IT IS GIVEN THAT BOTH PARTICLES CONTINUE IN THE ORIGINAL DIRECTION OF MOTION, OF WHICH "B" HAS TO BUT "A" MAY HAVE REBOUNDED

- HENCE WE NEED AN EXPRESSION FOR X, THEN SET IT POSITIVE

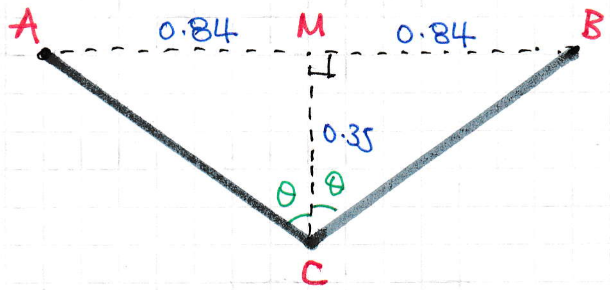
$$\Rightarrow 2X+15(X+11e)=90$$
$$\Rightarrow 2X+15X+165e=90$$
$$\Rightarrow 17X = 90-165e$$
$$\Rightarrow X = \frac{15}{17}(6-11e)$$

BUT $X>0$

$$\Rightarrow 6-11e>0$$
$$-11e>-6$$
$$e<\frac{6}{11}$$

IYGB - FM1 PAPER N - QUESTION 6

- START BY TRYING TO FIND THE MODULUS OF ELASTICITY



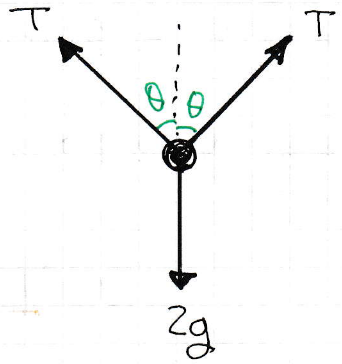
- BY PYTHAGORAS

$$|BC| = \sqrt{0.35^2 + 0.84^2} = 0.91$$

AND BY TRIGONOMETRY

$$\sin\theta = \frac{0.84}{0.91} = \frac{12}{13}$$

$$\cos\theta = \frac{0.35}{0.91} = \frac{5}{13}$$



- RESOLVING VERTICALLY, NOTING THAT THE EXTENSION IN EACH STRING IS $0.91 - 0.71 = 0.2$

$$\Rightarrow \cancel{2}T\cos\theta = \cancel{2}g$$

$$\Rightarrow T \times \frac{5}{13} = g$$

$$\Rightarrow \frac{\lambda}{\ell}x \times \frac{5}{13} = g$$

$$\Rightarrow \frac{\lambda}{0.71} \times 0.2 \times \frac{5}{13} = g$$

$$\Rightarrow \frac{\lambda}{9.23} = g$$

$$\Rightarrow \lambda = 90.454$$

- NOW BY ENERGIES TAKING THE LEVEL OF AB AS THE ZERO POTENTIAL LEVEL

$$\Rightarrow \cancel{KE_M} + \cancel{PE_M} + EE_M + \cancel{W_{IN}} - \cancel{W_{OUT}} = KE_C + P.E_C + EE_C$$

$$\Rightarrow \frac{\lambda}{2\ell}x_M^2 = \frac{1}{2}mv_c^2 - mg|MC| + \frac{\lambda}{2\ell}x_c^2$$

IYGB - FM1 PAPER N - QUESTION 6

$$\Longrightarrow 2\left[\frac{90.454}{2\times 0.71}(0.13)^2\right] = \frac{1}{2}\times 2\times V_c^2 - 2g(0.35) + 2\left[\frac{90.454}{2\times 0.71}\times(0.2)^2\right]$$

"2 PIECES OF STRING" "2 PIECES OF STRING"

$$\Longrightarrow 2.15306 = V^2 - 6.86 + 5.096$$

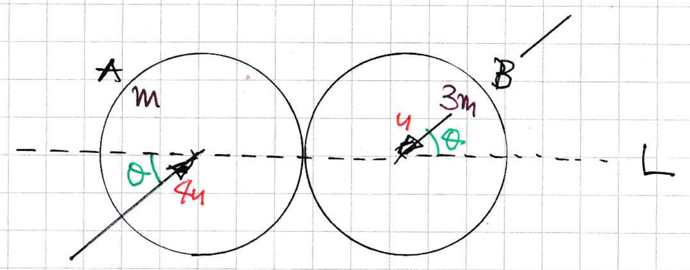
$$\Longrightarrow V^2 = 3.91706$$

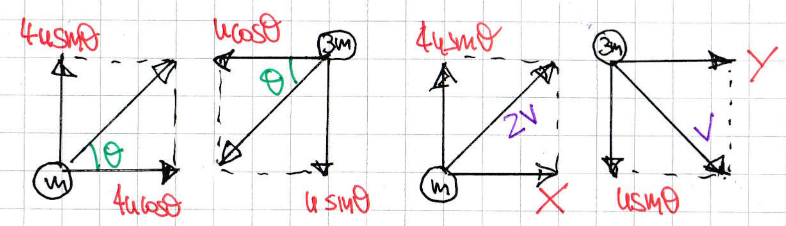
$$\Longrightarrow V \approx 1.979156386\ldots$$

$$\therefore V \approx 1.98 \text{ ms}^{-1}$$

IYGB - FM1 PAPER N - QUESTION 7

STARTING WITH THE STANDARD DIAGRAM





BY CONSERVATION OF MOMENTUM ALONG "L"

$$4mu\cos\theta - 3mu\cos\theta = mX + 3mY$$

$$\boxed{X + 3Y = u\cos\theta}$$

BY RESTITUTION ALONG "L"

$$e = \frac{SEP}{APP} \implies \frac{1}{4} = \frac{Y - X}{5u\cos\theta}$$

$$\implies \boxed{-X + Y = \tfrac{5}{4}u\cos\theta}$$

ADDING THE EQUATIONS IN THE "BOXES"

$$4Y = \tfrac{9}{4}u\cos\theta \qquad \& \qquad X = Y - \tfrac{5}{4}u\cos\theta$$

$$Y = \tfrac{9}{16}u\cos\theta \qquad\qquad X = \tfrac{9}{16}u\cos\theta - \tfrac{5}{4}u\cos\theta$$

$$X = -\tfrac{11}{16}u\cos\theta$$

(REBOUNDS)

FINALLY WE HAVE CONDITION ON THE "AFTER SPEEDS"

$$\implies \sqrt{(4u\sin\theta)^2 + X^2} = 2\sqrt{(u\sin\theta)^2 + Y^2}$$

$$\implies 16u^2\sin^2\theta + X^2 = 4(u^2\sin^2\theta + Y^2)$$

$$\implies 16u^2\sin^2\theta + X^2 = 4u^2\sin^2\theta + 4Y^2$$

$$\implies 12u^2\sin^2\theta = 4Y^2 - X^2$$

$$\implies 12u^2\sin^2\theta = \tfrac{81}{256}u^2\cos^2\theta \times 4 - \tfrac{121}{256}u^2\cos^2\theta$$

$$\implies 12\cancel{u^2}\sin^2\theta = \tfrac{203}{256}\cancel{u^2}\cos^2\theta$$

$$\implies \frac{\sin^2\theta}{\cos^2\theta} = \frac{203}{3072}$$

$$\implies \tan\theta = +\sqrt{609}/96$$

$$\implies \theta = 14.4° \quad (3\text{ sf})$$