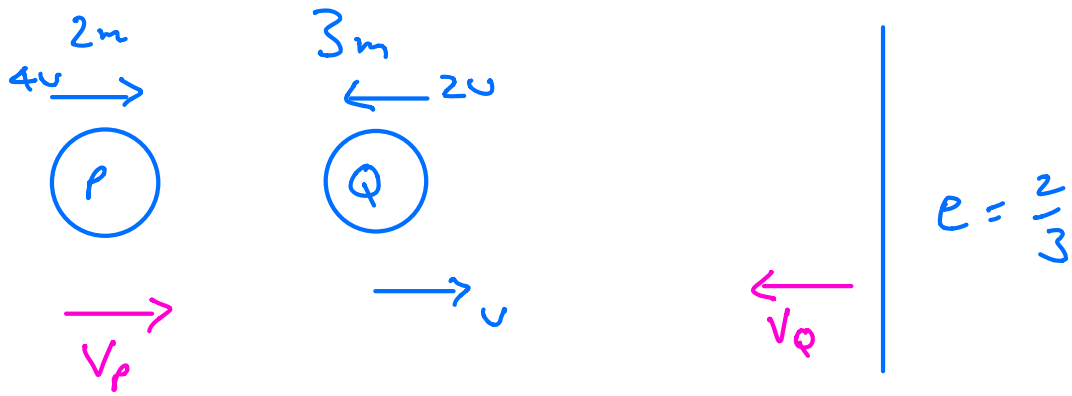
Exercise 4D

5)



First collision

PCLM

$$2m \times 4u - 3m \times 2u = 2m V_P + 3mu$$

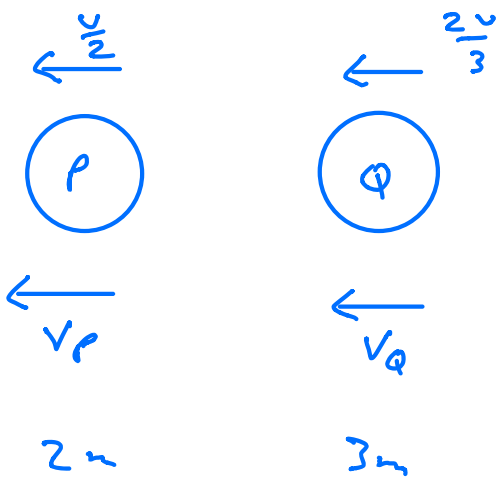
$$8mu - 6mu = 2m V_P + 3mu$$

$$-mu = 2m V_P$$

$$\underline{V_P = -\frac{u}{2}}$$

Collision with wall

$$V_Q = +\frac{2}{3}u$$



PCLM

$$2m \times \frac{u}{2} + 3m \times \frac{2}{3}u = 2m V_P + 3m V_Q$$

$$mu + 2mu = 2m V_P + 3m V_Q$$

$$3u = 2V_P + 3V_Q \quad (1)$$

Find e for P and Q

First collision $e = \dfrac{\text{speed of sep}}{\text{speed of app}} = \dfrac{u - -\frac{u}{2}}{6u}$

$= \dfrac{\frac{3u}{2}}{6u} = \dfrac{1}{4}$

Back to 2nd collision

$$e = \frac{1}{4} = \frac{V_P - V_Q}{\frac{2}{3}u - \frac{1}{2}u} = \frac{V_P - V_Q}{\frac{u}{6}}$$

$$\frac{u}{24} = V_P - V_Q \quad (2)$$

(1) + 3 (2)

$$3u + \frac{u}{8} = 5V_P$$

$$\frac{25u}{8} = 5V_P$$

$$V_P = \frac{5u}{8}$$

$$\frac{u}{24} = \frac{5u}{8} - V_Q$$

$$V_Q = \frac{5u}{8} - \frac{u}{24} = \frac{7u}{12}$$

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7)

0.4m ↓

speed at ground

$$v^2 = u^2 + 2as$$

$$v^2 = 0 + 2 \times 9.8 \times 0.4$$

$$v = \sqrt{2 \times 9.8 \times 0.4} = 2.8$$

Take off after first bounce

$$u = 0.7 \times 2.8 = \frac{49}{25}$$

At top of flight $v = 0$

$$v^2 = u^2 + 2as$$

$$0 = \left(\frac{49}{25}\right)^2 - 19.6\,s$$

$$s = \frac{\left(\frac{49}{25}\right)^2}{19.6} = 0.196\,m$$

<u>1st bounce to 0.196 m</u>

Speed at 2nd landing = take off speed after first landing

$$= \frac{49}{25}$$

Take off after 2nd landing

$$u = \frac{49}{25} \times 0.7$$

Height s

$$v^2 = u^2 + 2as$$

$$0 = \left(\frac{49}{25} \times 0.7\right)^2 - 19.6\,s$$

$$s = \frac{\left(\frac{49}{25} \times 0.7\right)^2}{19.6} = 0.0960\,m$$

Height 0.096 m

Continues as a geometric progression with each height = 0.49 × previous height

c) GP $a = 0.196$ $r = 0.49$

$$S_\infty = \frac{a}{1-r} = \frac{0.196}{1-0.49}$$

Total Dist $= 0.4 + 2S_\infty$

$$0.4 + 2 \times \left(\frac{0.196}{0.51}\right)$$

$$= 1.17\,m$$

Hwk Ex 4D Q4, 6, 8