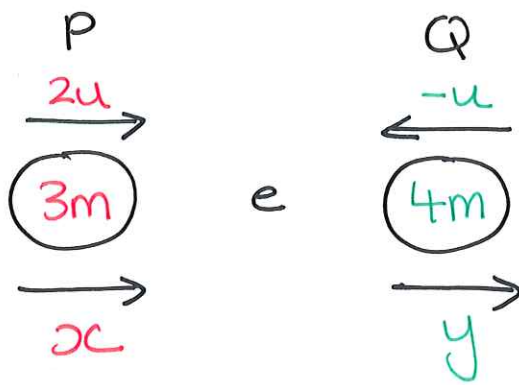


Q1.



Com

$$6um - 4um = 3mx + 4my$$

$$2u = 3x + 4y$$

e

$$e = \frac{y - x}{2u - (-u)}$$

$$3ue = y - x$$

Solve for y

$$x = y - 3ue$$

sub

$$2u = 3(y - 3ue) + 4y$$

$$2u = 3y - 9ue + 4y$$

$$2u + 9ue = 7y$$

$$y = \frac{u}{7}(2 + 9e)$$

Q2.



com

$$um + 0 = -mx + 3my$$

$$u = -x + 3y$$

e

$$e = \frac{y - (-x)}{u}$$

$$eu = y + x$$

(i) solve for x

$$y = eu - x$$

sub

$$u = -x + 3(eu - x)$$

$$u = -x + 3eu - 3x$$

$$4x = 3eu - u$$

$$x = \frac{u}{4}(3e - 1)$$

(ii) solve for y

$$u = -\frac{u}{4}(3e - 1) + 3y$$

$$4u = -u(3e - 1) + 12y$$

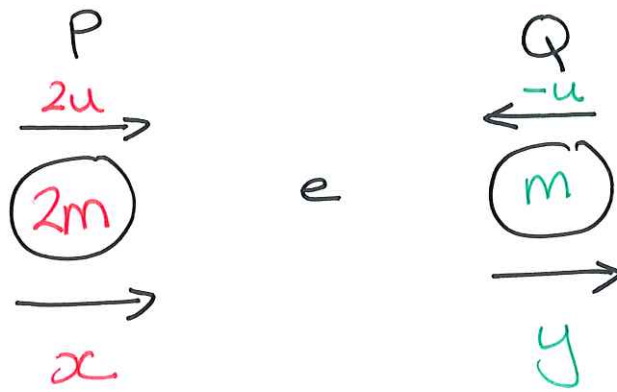
$$4u = -3ue + u + 12y$$

$$3u + 3ue = 12y$$

$$u + ue = 4y$$

$$\frac{u}{4}(1 + e) = y$$

Q3.



Com $4um - um = 2mx + my$

$$3u = 2x + y$$

e $e = \frac{y - x}{2u - (-u)}$

$$3eu = y - x$$

Solve for x

$$y = 3eu + x$$

sub

$$3u = 2x + 3eu + x$$

$$3u = 3x + 3eu$$

$$u = x + eu$$

$$x = u - eu$$

$$x = u(1 - e)$$

Solve for y

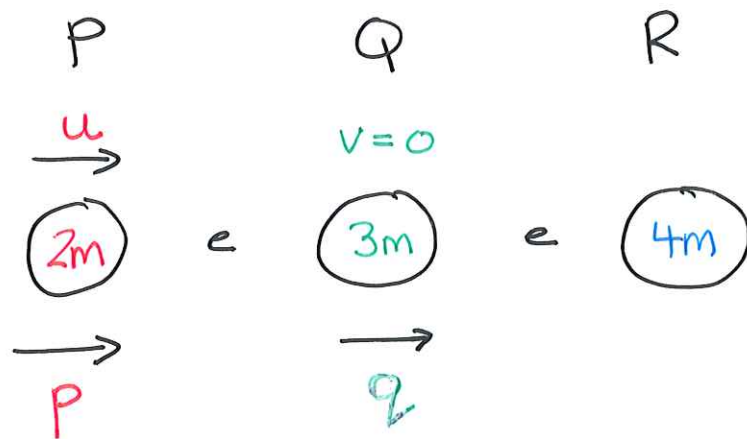
$$3eu = y - u(1 - e)$$

$$3eu = y - u + eu$$

$$2eu + u = y$$

$$y = u(2e + 1)$$

Q4.



Com

$$2mu + 0 = 2mp + 3mq$$

$$2u = 2p + 3q$$

e

$$e = \frac{q - p}{u}$$

$$eu = q - p$$

(a) Solve for q

$$p = q - eu$$

sub

$$2u = 2(q - eu) + 3q$$

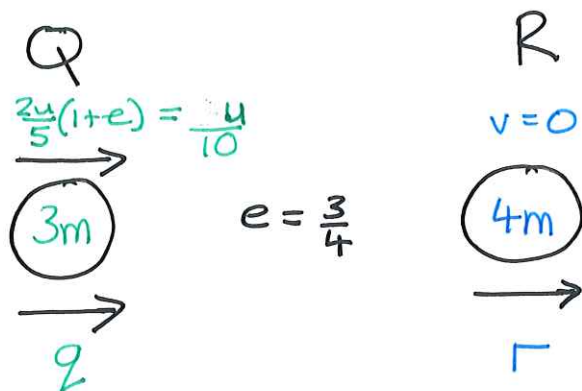
$$2u = 2q - 2eu + 3q$$

$$2u + 2eu = 5q$$

$$q = \frac{2u}{5}(1 + e)$$

Q4.

(b)



Com

$$\frac{7u}{10}(3m) + 0 = 3mq + 4mr$$

$$\frac{21um}{10} = 3mq + 4mr$$

$$21u = 30q + 40r$$

e

$$\frac{3}{4} = \frac{r - q}{\frac{7}{10}u}$$

$$\frac{21u}{40} = r - q$$

Solve for r

$$q = r - \frac{21u}{40}$$

Sub

$$21u = 30\left(r - \frac{21u}{40}\right) + 40r$$

$$21u = 30r - \frac{63u}{4} + 40r$$

$$\frac{147u}{4} = 70r$$

$$r = \frac{147u}{280}$$

$$r = \frac{21}{40}u$$

Q4.

(C)

P



$$q - eu$$

$$e = \frac{3}{4}$$

R



$$r = \frac{21}{40}u$$

$$p = q - eu$$

$$p = \frac{2u}{5}(1+e) - eu$$

$$p = \frac{2u}{5}\left(1 + \frac{3}{4}\right) - \frac{3}{4}u$$

$$p = \frac{2u}{5} + \frac{6u}{20} - \frac{3}{4}u$$

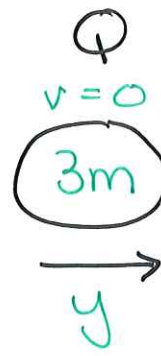
$$p = -\frac{1}{20}u$$

Speed of separation

$$\frac{21u}{40} - \left(-\frac{1}{20}u\right)$$

$$= \frac{23u}{40}$$

Q5.



Com

$$4um + 0 = -xm + 3my$$

$$4u = -x + 3y$$

e

$$e = \frac{y - (-x)}{4u}$$

$$4eu = y + x$$

Solve for x

$$3y = 4u + x$$

sub

$$12eu = 3y + 3x$$

$$12eu = 4u + x + 3x$$

$$12eu - 4u = 4x$$

$$x = 3eu - u$$

$$x = u(3e - 1)$$

$$3e - 1 > 0$$

$$3e > 1$$

$$e > \frac{1}{3}$$

Q6.



Com

$$um + e^2um = mp + emq$$

$$u + e^2u = p + eq$$

e

$$e = \frac{q - p}{u - eu}$$

$$eu - e^2u = q - p$$

(a) Solve for q

$$u + e^2u = q - eu + e^2u + eq$$

$$u + eu = q + eq$$

$$u(e+1) = q(e+1)$$

$$q = u$$

Q6.

$$(b) \quad eu - e^2u = q - p$$

$$p = q - eu + e^2u$$

$$p = u - eu + e^2u$$

$$p = u(1 - e + e^2)$$

complete the square

$$p = u \left(\left(e - \frac{1}{2} \right)^2 - \frac{1}{2} + 1 \right)$$

$$p = u \left(\left(e - \frac{1}{2} \right)^2 + \frac{3}{4} \right)$$

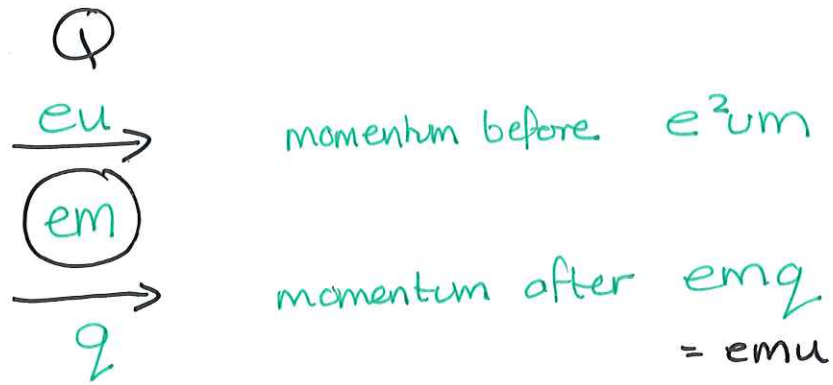
$$\begin{array}{c} \nearrow \\ \left(e - \frac{1}{2} \right)^2 + \frac{3}{4} > 0 \end{array}$$

$$\therefore p > 0$$

$\therefore$ no change of direction

Q6.

(c)



$$\text{Impulse} = emu - e^2um$$

$$\frac{2}{9}mu = emu - e^2um$$

$$\frac{2}{9}u = e - e^2u$$

$$\frac{2}{9} = e - e^2$$

$$e^2 - e + \frac{2}{9} = 0$$

$$e = \frac{1}{3} \text{ or } \frac{2}{3}$$