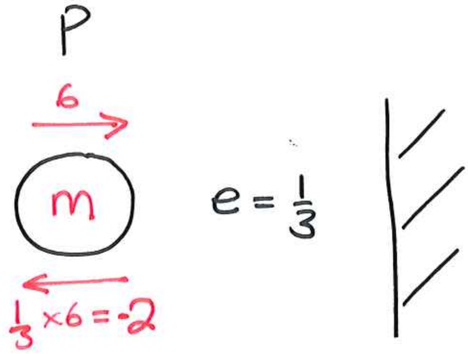
Chp 4D

Q1.

(a)



KE = 64

$$KE \text{ Before} = \frac{1}{2}(m)(6)^2 = 18m$$

$$KE \text{ After} = \frac{1}{2}(m)(-2)^2 = 2m$$

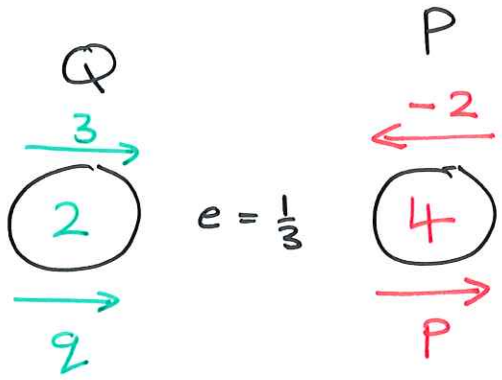
$$KE \text{ Loss} = 18m - 2m$$

$$64 = 16m$$

$$m = 4$$

Q1.

(b)



com

$$6 - 8 = 2q + 4p$$

$$-2 = 2q + 4p$$

e

$$\frac{1}{3} = \frac{p-q}{5}$$

$$\frac{5}{3} = p - q$$

Solve for P

$$q = p - \frac{5}{3}$$

sub

$$-2 = 2p - \frac{10}{3} + 4p$$

$$\frac{4}{3} = 6p$$

$$p = \frac{2}{9}$$

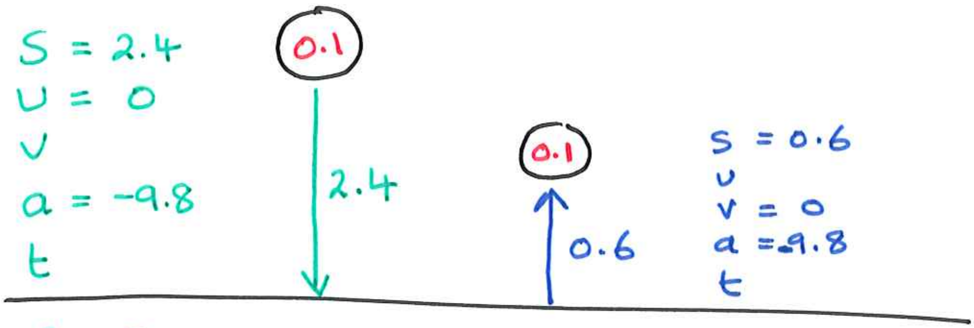
$\therefore$ $p > 0$

$\therefore$ changes direction
and will collide with the wall

Q2.

(a)

$s = 2.4$
$u = 0$
v
$a = -9.8$
t



$s = 0.6$
u
$v = 0$
$a = -9.8$
t

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

$v^2 = 19.6(2.4)$

$v = \sqrt{47.04}$

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

$0 = u^2 + 2(-9.8)0.6$

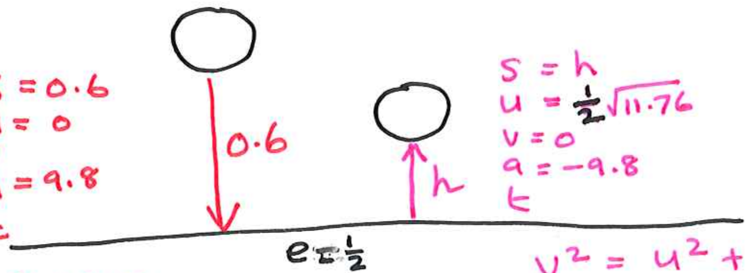
$u = \sqrt{11.76}$

$$e = \frac{\text{speed seperation}}{\text{speed approach}}$$

$$e = \frac{\sqrt{11.76}}{\sqrt{47.04}} = \frac{1}{2}$$

(b)

$s = 0.6$
$u = 0$
v
$a = 9.8$
t



$s = h$
$u = \frac{1}{2}\sqrt{11.76}$
$v = 0$
$a = -9.8$
t

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

$v^2 = 2(9.8)(0.6)$

$v = \sqrt{11.76}$

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

$0 = \left(\frac{1}{2}\sqrt{11.76}\right)^2 + (-9.8)(2)(h)$

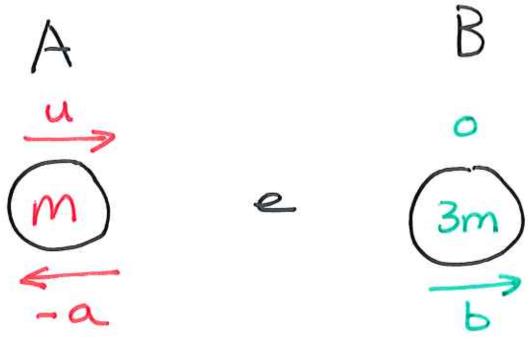
$-\frac{147}{50} = -19.6h$

$h = \underline{\underline{0.15}}$

(c) continues to bounce
each time $\frac{1}{4}$ of the height of the previous.

Q3.

(a)



<u>CoM</u>

$$um = -am + 3mb$$

$$u = -a + 3b$$

<u>e</u>

$$e = \frac{b-(-a)}{u}$$

$$eu = b + a$$

(i)

<u>Solve for a</u>

$$b = eu - a$$

sub

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

$$u = -a + 3eu - 3a$$

$$4a = 3eu - u$$

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

(ii)

<u>Solve for b</u>

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

$$b = eu - \frac{3eu}{4} + \frac{u}{4}$$

$$b = \frac{eu}{4} + \frac{u}{4}$$

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

Q3.

(b)

<u>CoM</u>

$$3bm = -3mx + 4my$$

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

<u>e</u>

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

$$2eb = y + x$$

<u>Solve for x</u>

$$y = 2eb - x$$

sub

$$3b = -3x + 4(2eb - x)$$

$$3b = -3x + 8eb - 4x$$

$$7x = 8eb - 3b$$

$$7x = b(8e-3)$$

$$x = \frac{b}{7}(8e-3)$$

$$\therefore \quad 8e - 3 > 0$$

$$8e > 3$$

$$e > \frac{3}{8}$$

coefficient $= 2e$

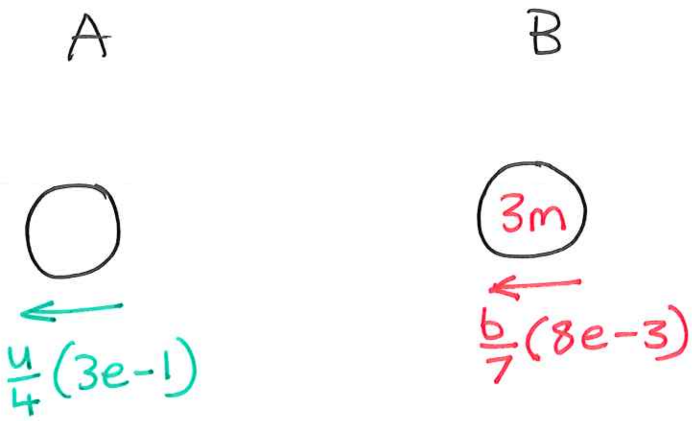
$$\therefore \; e \le \frac{1}{2}$$

because coefficient has to be ≤ 1.

$$\frac{3}{8} < e \le \frac{1}{2}$$

Q3

(c)



for a collision

$$\frac{b}{7}(8e-3) > \frac{u}{4}(3e-1)$$

sub b

$$\frac{u}{4}(e+1)\,\frac{1}{7}(8e-3) > \frac{u}{4}(3e-1)$$

$$\frac{u}{28}(e+1)(8e-3) > \frac{u}{4}(3e-1)$$

$$(e+1)(8e-3) > 7(3e-1)$$

$$8e^2 + 5e - 3 > 21e - 7$$

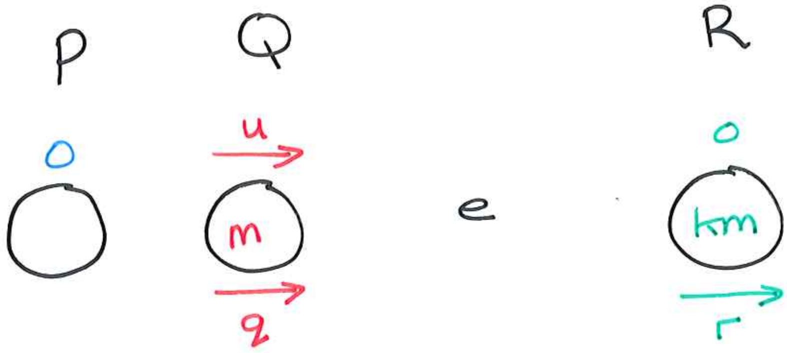
$$8e^2 - 16e + 4 > 0$$

so for collision $e < 0.293$ and $e > 1.707$ $\quad$ $e > 0.375$ and $e \leq 0.5$

$\therefore$ no second collision

Q4.

(a)



__CoM__

$$um = qm + rkm$$

$$u = q + rk$$

__e__

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

$$eu = r - q$$

__Solve for q__

$$r = eu + q$$

sub

$$u = q + (eu + q)k$$

$$u = q + euk + qk$$

$$u - euk = q(1+k)$$

$$q = \frac{u - euk}{1+k}$$

for second collision

$$q < 0$$

$$\frac{u - euk}{1+k} < 0$$

$$u - euk < 0$$

$$u < euk$$

$$1 < ek$$

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

Q4.

(b)

<u>CoM</u>

$$qm = kmp + xm$$

$$q = kp + x$$

<u>e</u>

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

$$eq = p - x$$

<u>Solve for x</u>

$$p = eq + x$$

sub

$$q = (eq + x)k + x$$

$$q = eqk + xk + x$$

$$q - qek = x + xk$$

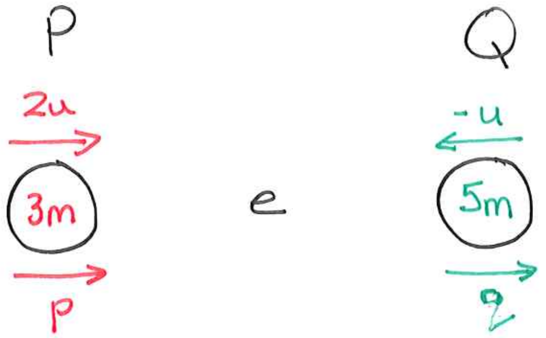
$$q(1 - ek) = x(1 + k)$$

$$x = q\frac{(1 - ek)}{(1 + k)}$$

$$x = \frac{u(1 - ek)}{(1 + k)}\frac{(1 - ek)}{(1 + k)} = \frac{u(1 - ek)^2}{(1 + k)^2}$$

Q5.

(a)



<u>Com</u>

$$6mu - 5mu = 3mp + 5mq$$

<u>e</u>

$$e = \frac{q - p}{2u - (-u)}$$

$$3eu = q - p$$

<u>Solve for q</u>

$$p = q - 3ue$$

sub

$$u = 3(q - 3ue) + 5q$$

$$u = 3q - 9ue + 5q$$

$$u + 9ue = 8q$$

$$q = \frac{u}{8}(1 + 9e)$$

Q5

(b) <u>solve for p</u>

$$p = \frac{u}{8}(9e+1) - 3ue$$

$$p = \frac{9eu}{8} + \frac{u}{8} - 3ue$$

$$p = \frac{u}{8} - \frac{15eu}{8}$$

$$p = \frac{u}{8}(1 - 15eu)$$

$$p > 0$$

$$\therefore \quad 1 - 15eu > 0$$

$$1 > 15e$$

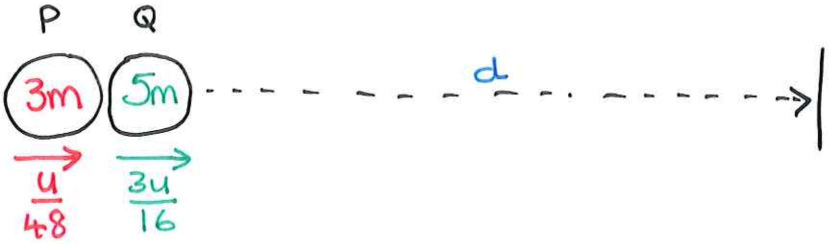
$$e < \frac{1}{15}$$

$$0 \leq e < \frac{1}{15}$$

Q5
(c)

$e = \frac{1}{18}$ $\quad q = \frac{u}{8}\left(1 + 9\left(\frac{1}{18}\right)\right)$ $\quad p = \frac{u}{8}\left(1 - 15\left(\frac{1}{18}\right)u\right)$

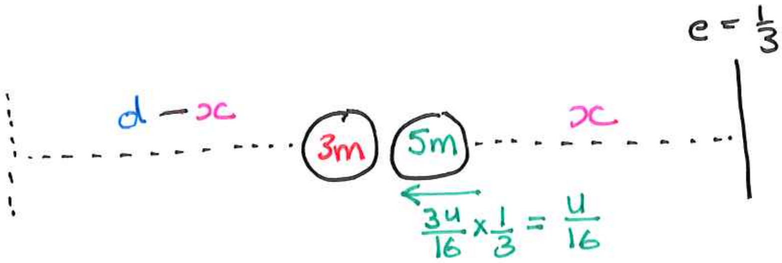
$q = \frac{u}{48}$ $\quad p = \frac{3u}{16}$



$S = \frac{D}{T}$

$\frac{3u}{16} = \frac{d}{T}$

$T = \frac{16d}{3u}$



$S = \frac{D}{T}$

$\frac{u}{48} = \frac{d-x}{T}$

$T = \frac{48(d-x)}{u}$

$S = \frac{D}{T}$

$\frac{u}{16} = \frac{x}{T}$

$T = \frac{16x}{u}$

Time for Q (between 1st and 2nd collision)

$$\text{Total time} = \frac{16d}{3u} + \frac{16x}{u} = \frac{16d + 48x}{3u}$$

Time for P (between 1st and 2nd collision)

$$\text{Total time} = \frac{48(d-x)}{u}$$

$$\therefore \quad \frac{48(d-x)}{u} = \frac{16d + 48x}{3u}$$

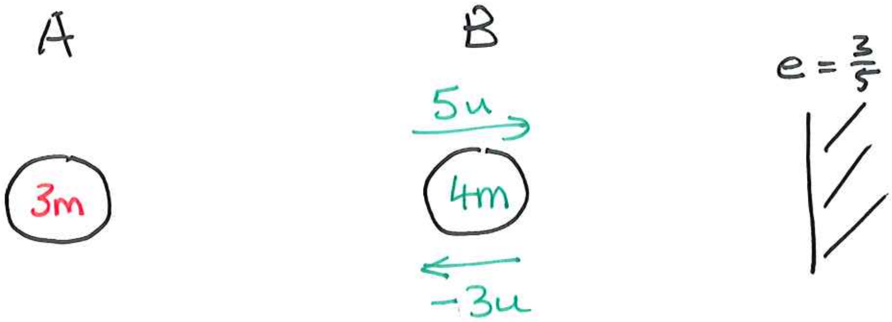
$$144u(d-x) = 16du + 48xu$$

$$144du - 144ux = 16du + 48xu$$

$$128du = 192xu$$

$$x = \frac{128u}{192} = \frac{2d}{3}$$

Q6.

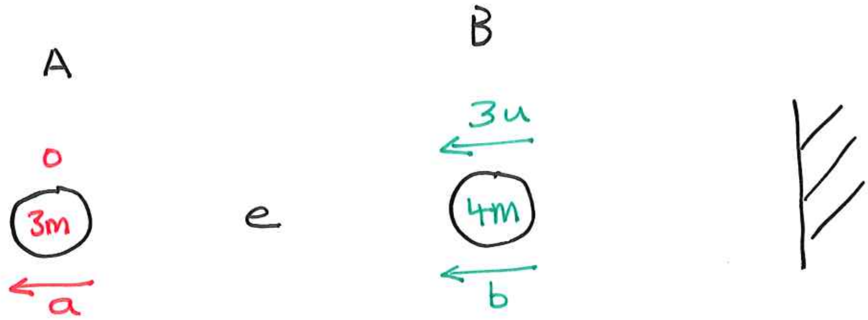


(a) momentum before $= (5u)(4m) = 20mu$

after $= (-3u)(4m) = -12mu$

Impulse = change in momentum = $32mu$

(b)



<u>com</u>

$$3u(4m) = 4mb + 3ma$$

$$12u = 3a + 4b$$

<u>e</u>

$$e = \frac{a - b}{3u}$$

$$3ue = a - b$$

<u>Solve for b</u>

$a = 3ue + b$

sub

$12u = 3(3ue + b) + 4b$

$12u = 9ue + 3b + 4b$

$7b = 12u - 9ue$

$b = \frac{3u}{7}(4 - 3e)$

continued on the next page...

Q6.

(b) continued $\quad b > 0$ for further collision

e is unknown but $\max e = 1$

$\min e = 0$

$\max e = 1$

$$b = \frac{3u}{7}(4-3e)$$

$$b = \frac{3u}{7}(4-3)$$

$$b = \frac{3u}{7}$$

$\min e = 0$

$$b = \frac{3u}{7}(4-3e)$$

$$b = \frac{3u}{7}(4)$$

$$b = \frac{12u}{7}$$

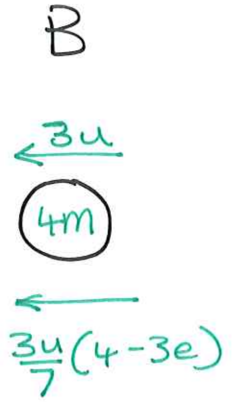
$$\frac{3u}{7} \leq b \leq \frac{12u}{7}$$

$\therefore \quad b > 0$

$\therefore \quad$ B is moving in the same direction as A

Q6.

(c)



$$\text{momentum before} = \tfrac{1}{2}(4m)(3u)^2 = 18mu^2$$

$$\text{momentum after} = \tfrac{1}{2}(4m)\left(\tfrac{3u}{7}(4-3e)\right)^2$$

$$= 2m\left(\frac{9u^2}{49}(4-3e)^2\right)$$

$$= \frac{18mu^2}{49}(4-3e)^2$$

$$\tfrac{1}{4}\,\text{momentum before} = \text{momentum after}$$

$$\frac{18mu^2}{4} = \frac{18mu^2}{49}(4-3e)^2$$

$$49 = 4(4-3e)^2$$

$$\frac{49}{4} = (4-3e)^2$$

$$\frac{7}{2} = 4-3e$$

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

$$e = \frac{1}{6}$$