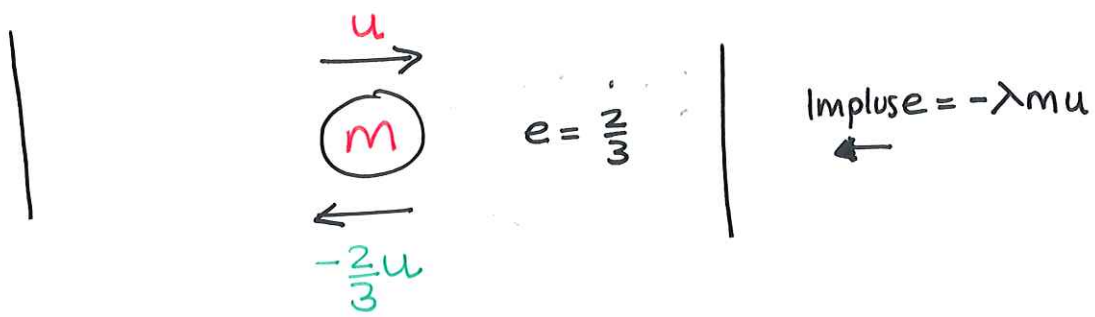
Q1.

(a)



Impluse = momentum after − momentum before

$$-\lambda mu = -\frac{2}{3}um - um$$

$$-\lambda = -\frac{2}{3} - 1$$

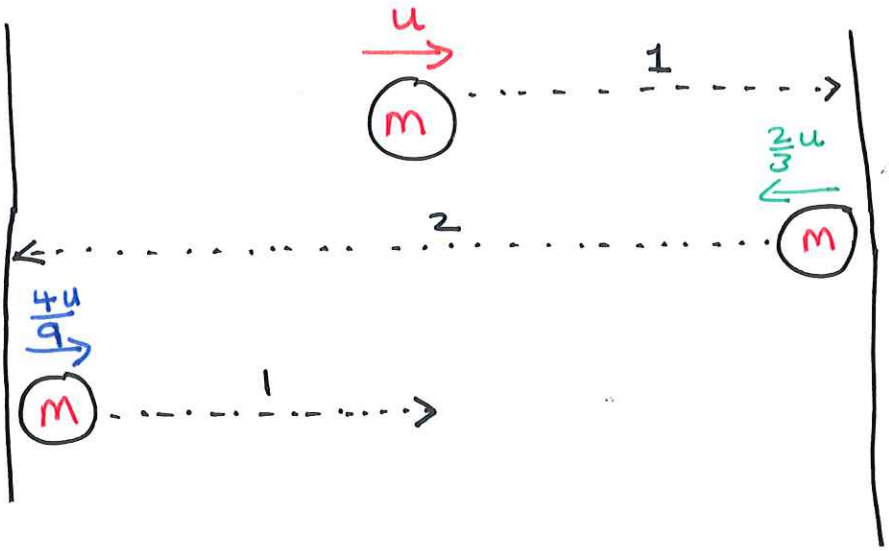
$$-\lambda = -\frac{5}{3}$$

$$\lambda = \frac{5}{3}$$

Q1.

(b)

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



$u = \frac{1}{T}$

$T = \frac{1}{u}$

$\frac{2u}{3} = \frac{2}{T}$

$T = \frac{6}{2u} = \frac{3}{u}$

$\frac{4u}{9} = \frac{1}{T}$

$T = \frac{9}{4u}$

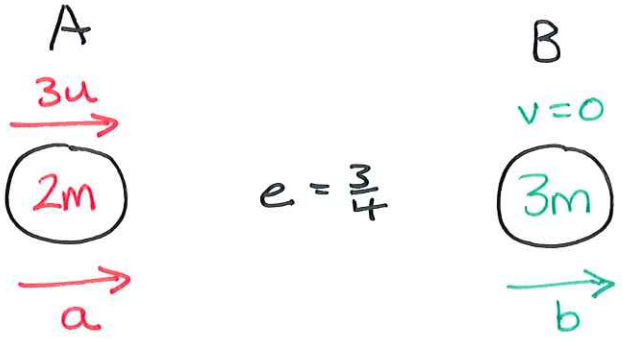
$$T = \frac{1}{u} + \frac{3}{u} + \frac{9}{4u}$$

$$3 = \frac{25}{4u}$$

$$12u = 25$$

$$u = \frac{25}{12}$$

Q2.



(a)

Com $\quad 6um = 2a + 3mb$

$$6u = 2a + 3b$$

e

$$\frac{3}{4} = \frac{b-a}{3u}$$

$$9u = 4b - 4a$$

Solve for a

$\times 2 \quad 12u = 4a + 6b$

$$\underline{9u = -4a + 4b}$$

$$21u = 10b$$

$$b = \frac{21u}{10}$$

$$6u = 2a + 3\left(\frac{21u}{10}\right)$$

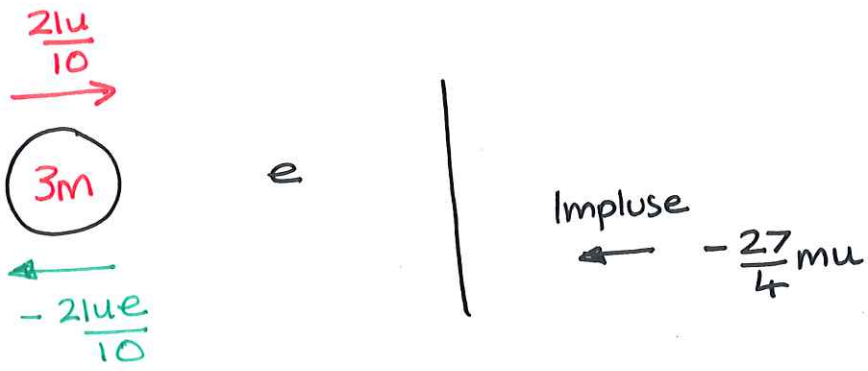
$$6u = 2a + \frac{63u}{10}$$

$$-\frac{3u}{10} = 2a$$

$$a = -\frac{3u}{20}$$

Q2.

(b)



Impulse = momentum after − momentum before

$$-\frac{27mu}{4} = -\frac{21ue}{10}(3m) - \frac{21u}{10}(3m)$$

$\div -mu$

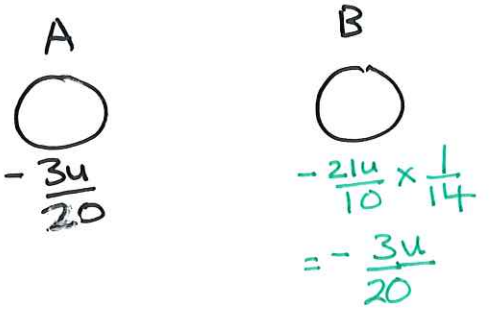
$$\frac{27}{4} = \frac{63e}{10} + \frac{63}{10}$$

$$\frac{9}{20} = \frac{63e}{10}$$

$$e = \frac{90}{1260}$$

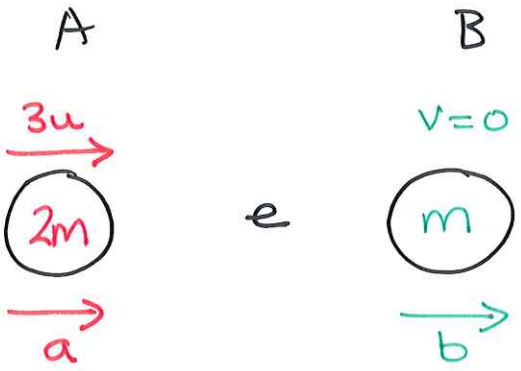
$$e = \frac{1}{14}$$

(c)



$\frac{3u}{20} = \frac{3u}{20}$ ∴ Same velocity so B can't catch A. No further collision

Q3.



(a)

Com $\quad 6um = 2ma + bm$

$$6u = 2a + b$$

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

$$3eu = b - a$$

Solve for b

$$a = b - 3eu$$

sub $\quad 6u = 2(b-3eu) + b$

$$6u = 2b - 6eu + b$$

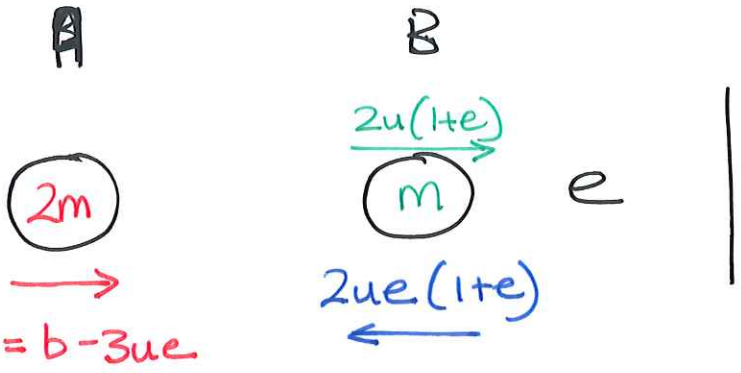
$$6u + 6eu = 3b$$

$$b = 2u + 2eu$$

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

Q3.

(b)



$a = b - 3ue$

$= 2u + 2ue - 3ue$

$= 2u - ue$

$= u(2-e)$

$0 \leq e < 1$

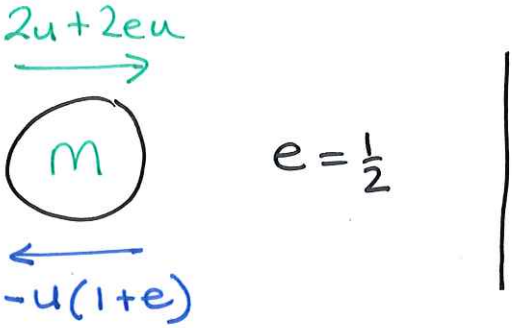
$\therefore \quad 2 - e > 0$

$\therefore \quad u(2-e) > 0$

$\therefore$ A will continue and collide again with B

Q3.

(c)



Impulse = $-u(1+e)m - (2um + 2eum)$

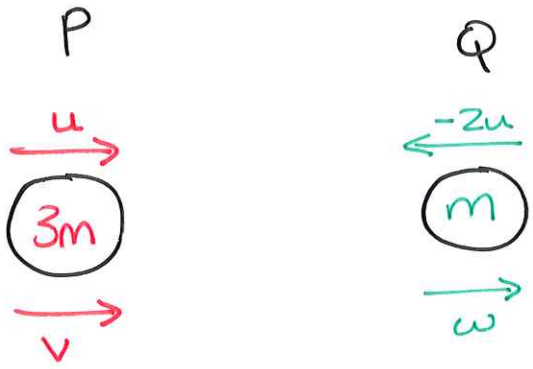
$= -um - emu - 2um - 2eum$

$= -3mu - 3meu$

$= -3mu(1+e)$

magnitude $= 3mu(1+e)$

Q4.



(a)

COM $\quad 3mu - 2um = 3mv + mw$

$$u = 3v + w$$

e

$$e = \frac{w - v}{3u}$$

$$3ue = w - v$$

Solve for v

$$w = 3ue + v$$

sub $\quad u = 3v + 3ue + v$

$$u - 3ue = 4v$$

$$v = \frac{u - 3ue}{4}$$

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

Q4.

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

to change direction $1 - 3e < 0$

$-3e < -1$

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

$\therefore \quad \frac{1}{3} < e \leq 1$

(c) $w = 3ue + V$

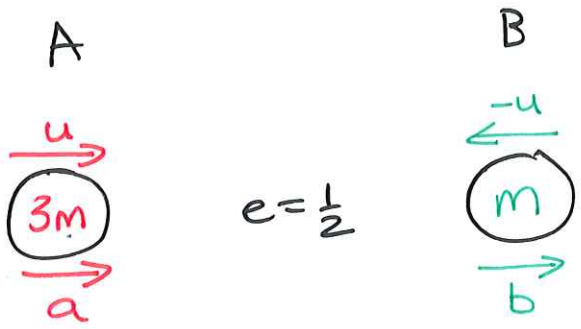
$w = 3ue + \frac{u}{4}(1 - 3e)$

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

$w = \frac{9}{4}ue + \frac{u}{4}$

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

Q5.



(a)

com $3mu - um = 3ma + mb$

$2u = 3a + b$

e $\frac{1}{2} = \frac{b-a}{2u}$

$2u = 2b - 2a$

Solve for a

$b = 2u - 3a$

sub

$2u = 2(2u - 3a) - 2a$

$2u = 4u - 6a - 2a$

$-2u = -8a$

$a = \frac{u}{4}$

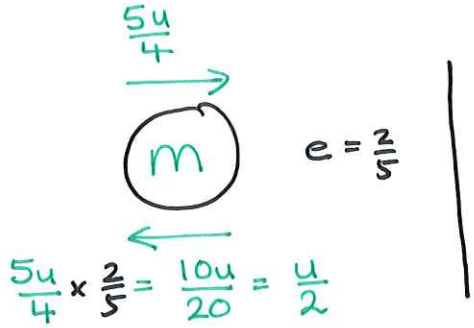
Solve for b $b = 2u - 3\left(\frac{u}{4}\right)$

$b = 2u - \frac{3u}{4}$

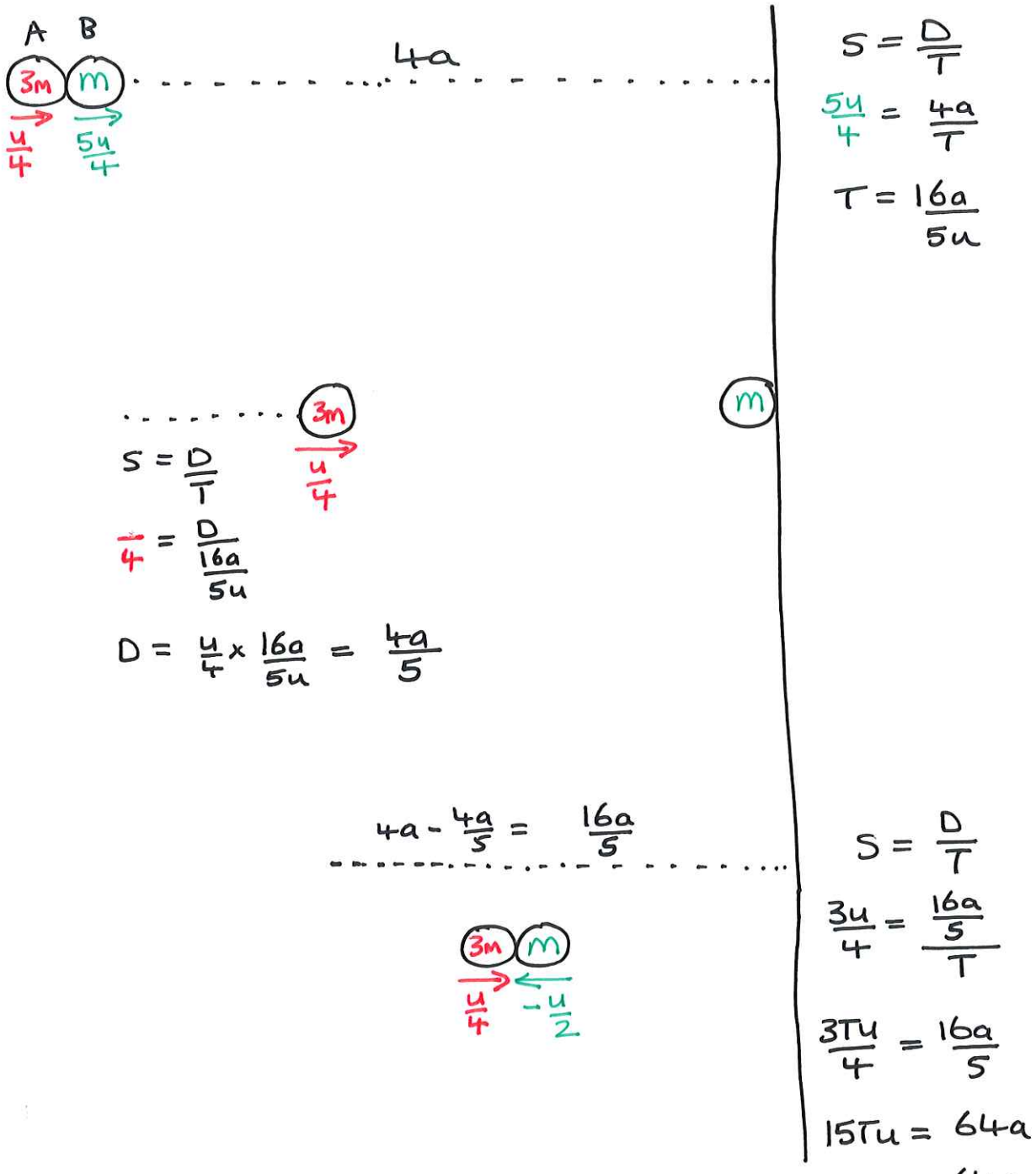
$b = \frac{5u}{4}$

Q5.

(b)

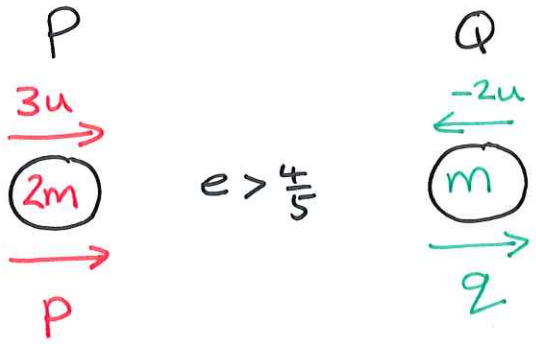


(c)



Total Time $= \frac{16a}{5u} + \frac{64a}{15u} = \frac{112a}{15u}$

Q6.



(a)

Com

$$6um - 2um = 2mp + mq$$

$$4u = 2p + q$$

e

$$e = \frac{q-p}{5u}$$

$$5ue = q - p$$

Solve for q

$$p = q - 5eu$$

sub

$$4u = 2(q - 5eu) + q$$

$$4u = 2q - 10eu + q$$

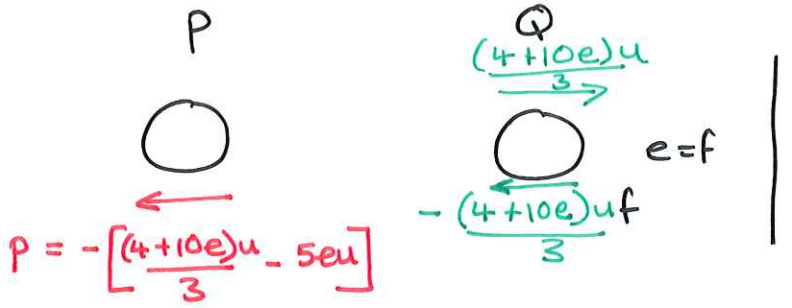
$$4u = 3q - 10eu$$

$$3q = 4u + 10eu$$

$$q = \frac{(4+10e)u}{3}$$

Q6.

(b)



$$P = -\left[\frac{(4+10e)u}{3} - 5eu\right]$$

$$P = -\left[\frac{4u+10eu-15eu}{3}\right]$$

$$P = -\left[\frac{4u-5eu}{3}\right]$$

2nd collision if

$$-\left[\frac{4u-5eu}{3}\right] > -\frac{(4+10e)uf}{3}$$

$$\frac{4u-5eu}{3} < \frac{(4+10e)uf}{3}$$

$$4u - 5eu < (4+10e)uf$$

$$f > \frac{u(4-5e)}{u(4+10e)}$$

$$f > \frac{4-5e}{4+10e}$$