Linear Momentum

Mark Scheme 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Dynamics
Sub Topic	Linear Momentum
Paper Type	Theory
Booklet	Mark Scheme 1

Time Allowed: **52 minutes**

Score: **/43**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a** $4.5 \times 50 - 2.8 \times M$ (= ...) C1

(...) = $-1.8 \times 50 + 1.4 \times M$ C1

(M =) 75 g A1 [3]

(b) <u>total</u> initial kinetic energy/KE not equal to the total final kinetic energy/KE

or <u>relative</u> speed of approach is not equal to relative speed of separation

so not elastic or is inelastic B1 [1]

(c) force on X is equal and opposite to force on Y (Newton III) M1

force equals/is proportional to rate of change of momentum (Newton II) M1

time of collision same for both balls hence change in momentum is the same A1 [3]

2 **(a** (p =) mv C1

Δp (= $-6.64 \times 10^{-27} \times 1250 - 6.64 \times 10^{-27} \times 1250$) = 1.66×10^{-23} N s A1 [2]

(b) (i) molecule collides with wall/container **and** there is a change in momentum B1

change in momentum / time is force or $\Delta p = Ft$ B1

<u>many/all/sum of</u> molecular collisions over surface/area of container produces pressure [3]

(ii) more collisions per unit time so greater pressure **B1** [1

3 **(a** for a system (of interacting bodies) the <u>total</u> momentum remains constant M1
provided there is no <u>resultant</u> force acting (on the system) A1 [2]

(b) (i) total momentum = $m_1v_1 + m_2v_2$ C1
= $0.4 \times 0.65 + 0.6 \times 0.45$ C1
= $0.26 + 0.27 = 0.53\,\text{N s}$ A [3]

(ii) $0.53 = 0.4 \times 0.41 + 0.6 \times v$ C1

$v = 0.366 / 0.6 = 0.61\,\text{m s}^{-1}$ A1 [2]

(iii) KE = $\frac{1}{2}mv^2$ C1
total initial KE = $\frac{1}{2} \times 0.4 \times (0.65)^2 + \frac{1}{2} \times 0.6 \times (0.45)^2$ C1
= $0.0845 + 0.06075 = 0.15\,(0.145)\,\text{J}$ A [3]

(c) check relative speed of approach equals relative speed of separation
or:
total final kinetic energy equals the total initial kinetic energy B1 [1]

(d) the forces on the two bodies (or on X and Y) are equal and opposite B1
time same for both forces <u>and</u> force is change in momentum / time [2]

4 **(a (i)** the total momentum of a system (of interacting bodies) remains constant M1
provided there are no resultant external forces / isolated system A1 [2]

(ii) elastic: total kinetic energy is conserved, inelastic: loss of kinetic energy B1 [1]
[allow elastic: relative speed of approach equals relative speed of separation]

(b) (i) initial mom: $4.2 \times 3.6 - 1.2 \times 1.5$ (= 15.12 – 1.8 = 13.3) C1
final mom: $4.2 \times v + 1.5 \times 3$ C1
$v = (13.3 - 4.5) / 4.2 = 2.1\,\text{m s}^{-1}$ A1 [3]

(ii) initial kinetic energy $= ½\, m_A(v_A)^2 + ½\, m_B(v_B)^2$
$= 27.21 + 1.08 = 28(.28)$ M1
final kinetic energy = 9.26 + 6.75 = 16 M1
initial KE is not the same as final KE hence inelastic A1 [3]
provided final KE less than initial KE
[allow in terms of relative speeds of approach and separation]

5 **(a (i)** horizontal velocity = $15 \cos 60° = 7.5\,\text{m s}^{-1}$ A1 [1]

(ii) vertical velocity = $15 \sin 60° = 13\,\text{m s}^{-1}$ A1 [1]

(b) (i) $v^2 = u^2 + 2as$
$s = (13)^2 / (2 \times 9.81) = 8.6(1)$ m A1 [1]
using $g = 10$ then max. 1

(ii) $t = 13 / 9.81 = 1.326$ s or $t = 9.95 / 7.5 = 1.327$ s A1 [1]

(iii) velocity = 6.15 / 1.33 M1
$= 4.6\,\text{m s}^{-1}$ A0 [1]

(c) (i) change in momentum $= 60 \times 10^{-3}$ [–4.6 – 7.5] C1
$= (-)0.73\,\text{N s}$ A1 [2]

(ii) final velocity / kinetic energy is less after the collision or
relative speed of separation < relative speed of approach M1
hence inelastic A0 [1]