InkPhysics

ANSWER BOOK

Momentum and impulse

Mechanics · Year 12

AQA 3.4.1.6 · CIE 3.1, 3.3 · OCR A 3.5.1, 3.5.2

10 questions · 31 marks

NAVY EDITION

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SECTION A · Warm-up

A1 $p = mv = 2.0 \times 8.0 = 16$ kg m s^{-1} (or N s). [2]

A2 In a collision or explosion, the total momentum before equals the total momentum after, provided no external resultant force acts on the system. [2]

A3 Impulse = force × time for which it acts ($F\Delta t$). It equals the change in momentum of the object, $\Delta(mv)$. [2]

SECTION B · Standard

B1 (a) Impulse = $F\Delta t = 20 \times 3.0 = 60$ N s. (b) Impulse = $\Delta(mv) = mv$, so $v = 60/4.0 = 15$ m s^{-1}. [4]

B2 Momentum: $2.0 \times 3.0 = (2.0 + 1.0)v$, so $v = 6.0/3.0 = 2.0$ m s^{-1}. [3]

B3 Before: $\frac{1}{2} \times 2.0 \times 3.0^2 = 9$ J. After: $\frac{1}{2} \times 3.0 \times 2.0^2 = 6$ J. Kinetic energy falls by 3 J, so the collision is inelastic. [4]

B4 Total momentum starts at zero: $0 = m_{gun}v_{gun} + m_{bullet}v_{bullet}$. $v_{gun} = -(0.040 \times 200)/4.0 = -2.0$ m s^{-1} (i.e. 2.0 m s^{-1} backwards). [3]

SECTION C · Stretch

C1 Taking right as positive: $(3.0 \times 4.0) + (1.0 \times -2.0) = (3.0 + 1.0)v$, so $v = 10/4.0 = 2.5$ m s^{-1} to the right. [4]

C2 $F = \Delta(mv)/\Delta t$. (a) $F = (1000 \times 20)/0.10 = 200000$ N. (b) $F = (1000 \times 20)/0.50 = 40000$ N. A crumple zone lengthens the stopping time, reducing the force for the same change in momentum. [4]

C3 The change in momentum of the occupant is fixed. Seatbelts and airbags increase the time over which they are brought to rest, and since force = change in momentum / time, a longer time means a smaller average force on the body. [3]