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Dynamics Answers

****1 June 02 P1 Q10** B Apply F_{net} = ma. 12 – F_f = 0.60 x 4.0
****2 June 03 P1 Q10** D Apply F = ma. For acceleration constant, F $\propto$ m. For mass 4 m, force is F. For mass 3m, force = ?
*****3 June 03 P1 Q11** B Friction on wheel by ground is to the right, normal reaction on wheel by ground is vertically upwards.
****4 Nov 03 P1 Q10** B Same as **Nov 04 P1 Q10**
****5 Nov 03 P1 Q11** D Momentum is a vector. Momentum is negative in the opposite direction. Momentum change = final momentum – initial momentum = (-mu) – (mu)
****6 June 04 P1 Q10** B Newton's 3rd law
****7 June 04 P1 Q11** A If momentum of lorry is positive, momentum of car is negative in the opposite direction
****8 Nov 04 P1 Q10** B Apply F = ma. For a constant and not zero F, F has to be constant and not zero.
****9 Nov 04 P1 Q11** B Momentum change is negative means it is opposite in direction to the initial direction
***10 June 05 P1 Q10** B Newton's 2nd law
***11 June 05 P1 Q12** C
****12 Nov 05 P1 Q8** A For F = 0, acceleration = 0. For F constant, acceleration is constant. Hence velocity increases at a constant rate, and the graph is a straight line with positive gradient
****13 Nov 05 P1 Q10** B mass remains constant, weight = mg
****14 Nov 05 P1 Q11** A Force of gravity always acts vertically downwards
***15 40 June 06 P1 Q10** B
***16 Nov 06 P1 Q10** B. From F = ma, F is a vector and a is a vector. These 2 vectors have the same direction.
***17 June 07 P1 Q9** B
*****18 June 07 P Q10** D force = momentum change / time
****19 June 07 P1 Q11** B same as **June 04 P1 Q11**
****20 Nov 07 P1 Q10** D Apply F = ma. 12 – F_f = 0.60 x 4.0
*****21 Nov 07 P1 Q11** B same as **June 03 P1 Q11**
****22 June 08 P1 Q11** A Apply F = ma. 2.0 x 10^3 – F_R = 750 x 2.0
****23 Nov 08 P1 Q9** B Newton's 3rd law
*****24 Nov 08 P1 Q11** A Apply F = ma. 2.0 x 9.81 = (8.0 + 2.0) a
***25 Nov 08 P1 Q12** D
****26 June 09 P1 Q9** D Momentum in the opposite direction is negative.

Section B

1 Nov 03 P2 Q2

2 (a) mass: measure of body's resistance/inertia to changes in velocity/motion B1
weight: effect of gravitational field on mass or force of gravity B1
any further comment e.g. mass constant, weight varies/ weight = mg/scalar and vector .... B1 [3]

(b) e.g. where gravitational field strength changes
(change) in fluid surrounding body.... *1 each, max 2* .... B2 [2]

2 Nov 05 P2 Q4

4	(a)	(i)	use of tangent at time $t = 0$ acceleration = 42 ± 4 cm s^{-2}	B1 A1	[2]
		(ii)	use of area of loop distance = 0.031 ± 0.001 m allow 1 mark if 0.031 ± 0.002 m)	B1 B2	[3]
	(b)	(i)	$F = ma$ $= 0.93 \times 0.42$ {allow e.c.f. from (a)(i)} = 0.39 N	C1 A1	[2]
		(ii)	force reduces to zero in first 0.3 s then increases again in next 0.3 s in the opposite direction	B1 M1 A1	[3]

3 June 08 P2 Q3

3	(a)	(i)	$v^2 = 2as$ $1.2^2 = 2 \times a \times 1.9$ $a = 0.38$ m s^{-2}	 M1 A1	[2]
		(ii)	$F = ma$ $= 42 \times 0.38$ $= 16$ N	 M1 A0	[1]
	(b)		$power = Fv$ $= 16 \times 1.2$ $= 19$ W	C1 A1	[2]
	(c)	(i)	component $= 42 \times 9.8 \times \sin 2.8$ $= 20.1$ N	C1 A1	[2]
		(ii)	accelerating force = $20.1 - 16 = 4.1$ N acceleration of trolley = $4.1 / 42 = 0.098$ m s^{-2} $s = \frac{1}{2}at^2$ $3.5 = \frac{1}{2} \times 0.098 \times t^2$ $t = 8.5$ s	C1 C1 C1 A1	[4]

4.2 Conservation of Momentum

****1 June 02 P1 Q9** B For elastic collision, total kinetic energy of the system is conserved. Hence total k.e. after impact = total k.e. before impact.

*****2 June 02 Q11** B For explosion, no external force acts. Hence total momentum is conserved. Since total initial momentum = 0, total final momentum = 0. Momentum is a vector, Hence momentum is negative in the opposite direction. Hence $M_1v_1 – M_2v_2 = 0$. $M_1v_1 = M_2v_2$

****3 Nov 02 P1 Q11** A For elastic collision, relative speed of approach = relative speed of separation

****4 Nov 02 P1 Q12** A Apply conservation of momentum. Momentum is a vector. Momentum in the opposite direction is negative. m x 60 – m x 30 = (m+m) V

****5 June 03 P1 Q12** A For inelastic collision, total momentum is conserved. That is, total initial momentum = total final momentum. 2 x 8 + 4 x 2 = (2 + 4) v

***6 Nov 03 P1 Q9** C Isolated system means that is no external force applied.

****7 Nov 03 P1 Q12** A Same as **Nov 02 P1 Q11**

****8 June 05 P1 Q11** A Same as **Nov 02 P1 Q12**

****9 Nov 05 P1 Q9** D

****10 June 06 P1 Q11** B

****11 June 06 P1 Q12** A For inelastic collision, total momentum is conserved. That is, total initial momentum = total final momentum. m x (2v) – (3m) x v = (m + 3m) V

****12 Nov 06 P1 Q11** B Apply (i) conservation of momentum, and (ii) relative speed of approach = relative speed of separation. Form 2 equations and solve.

****13 Nov Q6 P1 Q12** B Explosion. Same as June 02 Q11

****14 June 07 P1 Q12** B Conservation of momentum: 2 x 4 + 4 x 1 = (2 + 4) V
k.e. = ½ (2 + 4) V^2

***15 June 08 P1 Q9** D

****16 June 08 P1 Q10** D Assume both bodies move to the right after collision. Conservation of momentum: $50 – 30 = V_x + V_y$. Relative speed: $50 + 30 = V_y - V_x$

****17 Nov 08 P1 Q10** D Relative speed of approach = relative speed of separation

*****18 June 09 P1 Q7** A

*****19 June 09 P1 Q10** C Apply conservation of momentum to determine the velocity of X and Y. Calculate the k.e. of X and Y, and take ratio.

Section B

1 June 02 P2 Q4

4 (a) $v^2 = 2gh$

$v^2 = 2 \times 9.8 \times 1.6$ C1

$v = 5.6 \text{ m s}^{-1}$ .... A1 [2]

(b) (i) working leading to idea that $h = 0.90 \times 1.6$ C1
$h = 1.44$ m A1
(ii) $mgh = \frac{1}{2}mv^2$
$v^2 = 2 \times 9.8 \times 1.44$ C1
$v = 5.3$ m s^{-1} .... A1 **[4]**

(c) $\Delta p = m(v - u)$ OR $p = mv$ C1
$m = 0.073$ kg
$\Delta p = 0.073 \times (5.6 + 5.3)$ C1
$= 0.80$ N s .... A1 [3]

(d) steel plate (and Earth) B1
must gain momentum of 0.80 N s M1
in downward direction .... A1 [3]
(idea of Earth/plate and ball as the system scores 1/3)

2 June 04 P2 Q4

Q4 (a)(i) momentum p = mv

Kinetic energy = ½ mv^2. From (i), $v^2 = \frac{p^2}{m^2}$. Substitute into k.e. and simplify

(b)(i) momentum change = mv – mu = 35 x 10^{-3} [(4.5 – (-3.5)]
Average force = momentum change / time

(ii) k.e. of ball before impact =
k.e. of ball after impact =
loss = k.e. before impact – k.e. after impact
=

(b) Momentum is not conserved becuse there is an external force acting on the ball by the plate during impact.

3 June 05 P2 Q3 Q6. (a) (i) Change in g.p.e. = mgh – 0 = (600 + 2.0) x 10^{-3} x 9.81 x(8.6 x 10^{-2}) J

(ii) apply conservation of energy: loss in k.e. = gain in g.p.e.
v =

(b) total momentum before impact = total momentum after impact
2.0 x 10^{-3} u + 0 = (600 + 2.0) 10^{-3} x v in (a)(ii)

(c)(i) apply k.e. of bullet = ½ mu^2 =

(ii) Total k.e. before impact = k.e. of bullet
Total k.e. before impact > total k.e. after impact. Hence there is a loss in k.e. of the system. The collision is inelastic.

4 Nov 06 P2 Q3

Q7. (a) helium nucleus

(b) Mass of α-particle ≈ 4 u = 4 x (1.66 x 10^{-27}) kg

(refer to Casio calculator Const 17)
Use formula k.e. = ½ mv^2. v_α =

(c) (i) refer to Q5(e)(i)

(ii) explosion. No external force acting. Hence total momentum is conserved.
Total initial momentum = 0. Hence total final momentum = 0
Momentum of Francium-208 + (- momentum of α-particle) = 0
Momentum of Francium-208 = momentum of α-particle
(Mass of Francium -208 = 208 u; mass of α-particle = 4 u.)
Hence 208 $V_F = 4v_\alpha$

(d) Another unknown particle is emitted. This particle carries extra moemtum.

5 June 09 P2 Q2

2 (a)	ball moving in <u>opposite</u> direction (after collision)	B1	[1]
(b) (i)	change in momentum = 1.2 (4.0 + 0.8) .... (*correct values, 1 mark; correct sign {values added}, 1 mark*) = 5.76 N s …(*allow 5.8*)	C2 A1	[3]
(ii)	force = $\Delta p / \Delta t$ or $m\Delta v / \Delta t$ .... = 5.76 / 0.08 or 1.2 × 4.8 / 0.08 .... = 72 N	C1 C1 A1	[3]
(c)	5.76 = 3.6 × *V* .... *V* = 1.6 m s^{-1}	C1 A1	[2]
(d)	*either* speed of approach = 4.0 m s^{-1} and speed of separation = 2.4 m s^{-1} .... not equal and so inelastic .... *or* kinetic energy before = 9.6 J and kinetic energy after collision = 4.99 J .... kinetic energy after is less / not conserved so inelastic	 M1 A1 M1 A1	 [2]