G.C.E. (A/L) Grade 12 – Unit Test

Answer Key – Final Answers

Physics II – Mechanics · Working is not repeated; full marks need full working (see the marking scheme).

Section A – Relative motion (parallel paths)

A1 **(4)** A2 **(1)** A3 **(1)** A4 **(5)** A5 **(4)** A6 **(3)** A7 **(4)**

A8. (a) v = 2.5 m s⁻¹; t = 60/2.5 = 24 s; (b) v = 0.5 m s⁻¹ forward; t = 120 s; (c) 60/1.5 = 40 s; (d) 2.5 − 3.0 = −0.5 m s⁻¹ (0.5 m s⁻¹ backwards)

Section B – Graphs of motion

B1 **(4)** B2 **(1)** B3 **(1)** B4 **(3)** B5 **(2)** B6 **(2)** B7 **(5)** B9 **(5)**

B8. (a) Values 20 m s⁻¹, 10 s, 30 s, 38 s marked; (b) deceleration = 20/8 = 2.5 m s⁻²; (c) 580/38 = 15.3 m s⁻¹

B10. (a) $t^2 = 20t \rightarrow t = 20$ s; (b) $v_A = 2 \times 20 = 40$ m s⁻¹; (c) 200 − 100 = 100 m

Section C – Equations of motion (line, vertical, incline)

C1 **(5)** C2 **(1)** C3 **(3)** C4 **(3)** C5 **(3)** C6 **(3)** C7 **(5)** C8 **(3)** C9 **(3)** C11 **(4)** C12 **(5)**

C10. (a) t = 4 s; (b) $v = 15 - 10(4) = -25 \rightarrow 25$ m s⁻¹; (c) $20 + 15^2/20 = 31.25$ m

C13. (a) Trapezium shape with 20 m s⁻¹ marked; (b) $t_3 = 20$ s, $s_3 = 200$ m; (c) Total = 130 s

Section D – Projectile motion

D1 **(4)** D2 **(1)** D3 **(2)** D4 **(2)** D5 **(4)** D6 **(4)** D7 **(5)** D9 **(1)**

D8. (a) 15 m s⁻¹ and 20 m s⁻¹; (b) y = 20(2) − 5(4) = 20 m; (c) $v_y = 0 \rightarrow 15$ m s⁻¹ horizontal; it is at its highest point

D10. (a) $45 = 5t^2 \rightarrow t = 3.0$ s; (b) 20 × 3 = 60 m; (c) $\tan\alpha = 30/20 \rightarrow \alpha \approx 56°$ below the horizontal; (d) $v_y = v_x = 20 \rightarrow t = 2.0$ s

Section E – Resultant of forces

E1 **(5)** E2 **(5)** E3 **(1)** E4 **(4)** E6 **(1)** E7 **(4)**

E5. (a) the diagonal through that point represents their resultant; (b) $W = \sqrt{(6^2 + 8^2)} = 10$ N; (c) $\tan\alpha = 6/8 \rightarrow \alpha \approx 37°$; (d) Pulleys must be frictionless / knot free of the board / read directions with the eye directly above

Section F – Moments, couples and parallel forces

F1 **(5)** F2 **(1)** F3 **(2)** F4 **(3)** F5 **(2)** F6 **(5)** F7 **(2)**

F8. (a) 15 × 0.40 = 6.0 N m; (b) The resultant force of a couple is zero, so there is no translation (only rotation); (c) A single force always has a non-zero resultant and would cause translation

Section G – Centre of gravity and centre of mass

G1 **(5)** G2 **(1)** G3 **(3)** G4 **(1)** G5 **(2)** G7 **(2)** G8 **(2)**

G6. (a) = 40 cm mark; (b) At the 40 cm mark (under the centre of gravity)

G9. The point where the lines cross is the centre of gravity, because when freely suspended G lies vertically below the point of suspension

Section H – Inertia and Newton's laws

H1 **(4)** H2 **(1)** H3 **(1)** H4 **(5)** H5 **(2)** H6 **(4)** H7 **(5)** H8 **(5)** H9 **(5)** H10 **(4)** H12 **(1)**

H11. (a) 500 N; (b) 50(10 + 2) = 600 N; (c) 500 N (a = 0); (d) 0 – the person and scale fall together with acceleration g (apparent weightlessness); (e) Weight 500 N down, normal reaction 600 N up, net force up

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Section I – Momentum, impulse and conservation of momentum

I1 **(4)** I2 **(4)** I3 **(2)** I4 **(3)** I5 **(5)** I6 **(2)** I7 **(3)** I8 **(5)** I9 **(1)** I10 **(3)**

I11. (a) 0.15(30 − (−20)) = 7.5 N s; (b) 7.5/0.010 = 750 N; (c) Newton's third law; 750 N opposite; (d) Same change of momentum over a longer time → smaller force

Section J – Friction and self-adjusting forces

J1 **(4)** J2 **(4)** J3 **(3)** J4 **(3)** J5 **(3)** J6 **(3)** J7 **(3)** J8 **(3)** J9 **(3)**

J10. (a) W down, R normal to plank, F up the plank – all labelled; (b) = 0.75; (c) $\mu_k = 0.55$; (d) 20 × 0.34 = 6.8 N (self-adjusting)

Section K – Applying Newton's laws: connected bodies

K1 **(2)** K2 **(2)** K3 **(2)** K4 **(2)** K6 **(2)** K7 **(4)**

K5. (a) B: P forward, friction 4 N backward, weight and normal reaction; (b) a = 3.0 m s^{-2}; (c) B pushes A with 10 N backward (Newton's third law)

Section L – Equilibrium

L1 **(5)** L2 **(4)** L3 **(4)** L4 **(1)** L5 **(1)** L6 **(1)** L7 **(2)** L10 **(3)** L11 **(5)**

L8. (a) The weight of the rule has no moment about G; (b) For equilibrium, sum of clockwise moments = sum of anticlockwise moments about any point; (c) W a = 1.0 b (b = W a with W in N); (d) W ≈ 1.6 N

L9. (a) W at midpoint, S horizontal at the wall, R and F at the floor; (b) S = 75 N; (c) $\mu_{min} = 0.375$; (d) x ≈ 3.6 m

Section M – Work, energy and power

M1 **(1)** M2 **(5)** M3 **(2)** M4 **(3)** M5 **(4)** M6 **(2)** M7 **(3)** M8 **(3)** M9 **(4)** M10 **(2)**
M11 **(5)** M12 **(1)** M13 **(2)** M14 **(3)**

M15. (a) 1600 J; (b) 90 N

M16. (a) Output = 1520 W; (b) 1520/2000 = 76 %

Section N – Collisions and explosions

N1 **(1)** N2 **(4)** N3 **(3)** N4 **(3)** N5 **(3)** N6 **(5)** N7 **(3)**

N8. (a) 0.02 × 300 = 2.00v → v = 3.0 m s^{-1}; (b) h = $v^2/2g$ = 0.45 m; (c) Inelastic; (d) KE is converted to heat/sound/deformation during the impact; only momentum is conserved

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