
PHYSICS

9702/23

Paper 2 AS Level Structured Questions

May/June 2016

MARK SCHEME

Maximum Mark: 60

Published

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Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2016	9702	23

- 1 (a) scalars: energy, power and time A1
- vectors: momentum and weight A1 [2]
- (b) (i) triangle with right angles between 120 m and 80 m, arrows in correct direction and result displacement from start to finish arrow in correct direction and labelled R B1 [1]
- (ii) 1. average speed $(= 200/27) = 7.4 \text{ m s}^{-1}$ A1 [1]
2. resultant displacement $(= [120^2 + 80^2]^{1/2}) = 144 \text{ (m)}$ C1
- average velocity $(= 144/27) = 5.3(3) \text{ m s}^{-1}$ A1
- direction $(= \tan^{-1} 80/120) = 34^\circ (33.7)$ A1 [3]
- 2 (a) systematic: the reading is larger or smaller than (or varying from) the true reading by a constant amount B1
- random: scatter in readings about the true reading B1 [2]
- (b) precision: the size of the smallest division (on the measuring instrument)
or
0.01 mm for the micrometer B1
- accuracy: how close (diameter) value is to the true (diameter) value B1 [2]
- 3 (a) (gravitational potential energy is) the energy/ability to do work of a mass that it has or is stored due to its position/height in a gravitational field B1
- kinetic energy is energy/ability to do work a object/body/mass has due to its speed/velocity/motion/movement B1 [2]
- (b) (i) $s = [(u + v)t]/2$ or acceleration = 9.8/9.75 (using gradient) C1
- $= [(7.8 + 3.9) \times 0.4]/2$ or $s = 3.9 \times 0.4 + \frac{1}{2} \times 9.75 \times (0.4)^2$ C1
- $s = 2.3(4) \text{ m}$ A1 [3]
- (ii) $a = (v - u)/t$ or gradient of line C1
- $= (7.8 - 3.9)/0.4 = 9.8 (9.75) \text{ m s}^{-2}$ (allow $\pm \frac{1}{2}$ small square in readings) A1 [2]

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2016	9702	23

(iii) $KE = \frac{1}{2}mv^2$ C1

change in kinetic energy = $\frac{1}{2}mv^2 - \frac{1}{2}mu^2$
 $= \frac{1}{2} \times 1.5 \times (7.8^2 - 3.9^2)$ C1

$= 34$ (34.22) J A1 [3]

(c) work done = force $\times$ distance (moved) or Fd or Fx or mgh or mgd or mgx M1

$= 1.5 \times 9.8 \times 2.3 = 34$ (33.8) J (equals the change in KE) A1 [2]

4 (a) (resultant force = 0) (equilibrium)

therefore: weight – upthrust = force from thin wire (allow tension in wire)
or

5.3 (N) – upthrust = 4.8 (N) B1 [1]

(b) difference in weight = upthrust or upthrust = 0.5 (N)

$0.5 = \rho ghA$ or $m = 0.5/9.81$ and $V = 5.0 \times 13 \times 10^{-6} \text{ (m}^3\text{)}$ C1

$\rho = 0.5 / (9.81 \times 5.0 \times 13 \times 10^{-6})$ C1

$= 780$ (784) kg m^{-3} A1 [3]

5 (a) the total momentum of a system (of colliding particles) remains constant M1

provided there is no resultant external force acting on the system/isolated or closed system A1 [2]

(b) (i) the total kinetic energy before (the collision) is equal to the total kinetic energy after (the collision) B1 [1]

(ii) $p (= mv = 1.67 \times 10^{-27} \times 500) = 8.4$ (8.35) $\times 10^{-25} \text{ N s}$ A1 [1]

(iii) 1. $mv_A \cos 60^\circ + mv_B \cos 30^\circ$ or $m(v_A^2 + v_B^2)^{1/2}$ B1

2. $mv_A \sin 60^\circ - mv_B \sin 30^\circ$ B1 [2]

(iv) 8.35×10^{-25} or $500m = mv_A \cos 60^\circ + mv_B \cos 30^\circ$
and
 $0 = mv_A \sin 60^\circ - mv_B \sin 30^\circ$
or using a vector triangle C1

$v_A = 250 \text{ m s}^{-1}$ A1

$v_B = 430$ (433) m s^{-1} A1 [3]

Page 4	Mark Scheme	Syllabus	Paper
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- 6 (a) ohm is volt per ampere or volt/ampere B1 [1]
- (b) (i) $R = \rho l / A$ B1
- $R_P = 4\rho(2l) / \pi d^2$ or $8\rho l / \pi d^2$ or $R_Q = \rho l / \pi d^2$
or
ratio idea e.g. length is halved hence R halved and diameter is halved hence R is 1/4 C1
- $R_Q (= 4\rho l / \pi 4d^2) = \rho l / \pi d^2$
 $= R_P / 8$
 $(= 12/8) = 1.5 \Omega$ A1 [3]
- (ii) power = $I^2 R$ or V^2 / R or VI C1
- $= (1.25)^2 \times 12 + (10)^2 \times 1.5$ or $(15)^2 / 12 + (15)^2 / 1.5$ or 15×11.25 C1
- $= (18.75 + 150) = 170$ (168.75) W A1 [3]
- (iii) $I_P = (15 / 12) = 1.25$ (A) and $I_Q = (15 / 1.5) = 10$ (A) C1
- $v_P / v_Q = I_P n A_Q e / I_Q n A_P e$ or $(1.25 \times \pi d^2) / (10 \times \pi d^2 / 4)$ C1
- $= 0.5$ A1 [3]
- 7 (a) (i) alter distance from vibrator to pulley
alter frequency of generator
(change tension in string by) changing value of the masses
- any two B2 [2]
- (ii) points on string have amplitudes varying from maximum to zero/minimum B1 [1]
- (b) (i) 60° or $\pi/3$ rad A1 [1]
- (ii) ratio = $[3.4 / 2.2]^2$ C1
- $= 2.4$ (2.39) A1 [2]

Page 5	Mark Scheme	Syllabus	Paper
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- 8 (a) α -particle is 2 protons and 2 neutrons; β^+ -particle is positive electron/positron
 α -particle has charge $+2e$; β^+ -particle has $+e$ charge
 α -particle has mass $4u$; β -particle has mass $(1/2000)u$
 α -particle made up of hadrons; β^+ -particle a lepton
- any three* B3 [3]
- (b) ${}^1_1\text{p} \rightarrow {}^1_0\text{n} + {}^0_1\beta + {}^0_0\nu$
- all terms correct M1
- all numerical values correct (ignore missing values on ν) A1 [2]
- (c) (i) 1. proton: up, up, down/uud B1
2. neutron: up, down, down/udd B1 [2]
- (ii) up quark has charge $+2/3$ (e) and down quark has charge $-1/3$ (e)
total is $+1$ (e) B1 [1]