Cambridge International AS & A Level

**Cambridge International Examinations**
Cambridge International Advanced Subsidiary and Advanced Level

**PHYSICS** **9702/23**

Paper 2 AS Level Structured Questions **May/June 2016**

MARK SCHEME

Maximum Mark: 60

**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2016 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

® IGCSE is the registered trademark of Cambridge International Examinations.



© UCLES 2016

**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 m s$^{-1}$ A1 [1]

**2.** resultant displacement (= [120$^2$ + 80$^2$]$^{1/2}$) = 144 (m) C1

average velocity (= 144 / 27) = 5.3(3) m s$^{-1}$ A1

direction (= tan$^{-1}$ 80 / 120) = 34° (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) m A1 [3]

**(ii)** $a = (v - u) / t$ or gradient of line C1

= (7.8 – 3.9) / 0.4 = 9.8 (9.75) m s$^{-2}$ (allow ± $\frac{1}{2}$ small square in readings) A1 [2]

© Cambridge International Examinations 2016

**(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 × distance (moved) or *Fd* or *Fx* or *mgh* or *mgd* or *mgx* M1

= 1.5 × 9.8 × 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 $V = 5.0 \times 13 \times 10^{-6}$ ($m^3$) 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 <u>total</u> 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 <u>total</u> 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) × $10^{-25}$ N s A1 [1]

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

**2.** $mv_A \sin 60° + mv_B \sin 30°$ B1 [2]

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

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

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

© Cambridge International Examinations 2016

**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 Ω A1 [3]

**(ii)** power = $I^2R$ 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 $15 \times 11.25$ 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

$v_P / v_Q$ = $I_P nA_Q e / I_Q nA_P e$ 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 <u>amplitudes</u> 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]

© Cambridge International Examinations 2016

**8** **(a)** $\alpha$-particle is 2 protons and 2 neutrons; $\beta^+$-particle is positive electron/positron
$\alpha$-particle has charge +2*e*; $\beta^+$-particle has +*e* charge
$\alpha$-particle has mass 4u; $\beta$-particle has mass (1/2000)u
$\alpha$-particle made up of hadrons; $\beta^+$-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 $\nu$) 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]

© Cambridge International Examinations 2016