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PHYSICS **9702/23**

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

MARK SCHEME

Maximum Mark: 60

Published

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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]

(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) 8.35×10^{-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]

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 15×11.25 — 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 π / 3 rad — A1 [1]

(ii) ratio = $[3.4/2.2]^2$ — C1

= 2.4 (2.39) — A1 [2]

8 **(a)** α-particle is 2 protons and 2 neutrons; β^+-particle is positive electron/positron
α-particle has charge +2*e*; 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]