UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2010 question paper

for the guidance of teachers

9702 PHYSICS

9702/21 Paper 2 (AS Structured Questions), maximum raw mark 60

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.

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1 10^{-9} B1
c B1
mega B1
tera ..... B1 [4]

2 **(a)** scalar B1
scalar B1
vector ..... B1 [3]

(b) **(i)** **1** gradient (of graph) is the speed/velocity (*can be scored here or in* ***2***)..... B1
initial gradient is zero ..... B1 [2]

2 gradient (of line/graph) becomes constant ..... B1 [1]

(ii) speed = (2.8 ± 0.1) m s^{-1} ..... A2 [2]
(*if answer* > ± 0.1 *but* $\leq \pm 0.2$, *then award 1 mark*)

(iii) curved line never below given line and starts from zero B1
continuous curve with increasing gradient B1
line never vertical or straight ..... B1 [3]

3 **(a)** *either* energy (stored)/work done represented by area under graph
or energy = average force × extension B1
energy = ½ × 180 × 4.0 × 10^{-2} C1
= 3.6 J ..... A1 [3]

(b) **(i)** *either* momentum before release is zero M1
so sum of momenta (of trolleys) after release is zero A1
or force = rate of change of momentum (M1)
force on trolleys equal and opposite (A1)
or impulse = change in momentum (M1)
impulse on each equal and opposite (A1) [2]

(ii) **1** $M_1V_1 = M_2V_2$ ..... B1 [1]

2 $E = \frac{1}{2} M_1V_1^2 + \frac{1}{2} M_2V_2^2$ ..... B1 [1]

(iii) **1** $E_K = \frac{1}{2}mv^2$ and $p = mv$ combined to give M1
$E_K = p^2 / 2m$ ..... A0 [1]

2 m smaller, E_K is larger because p is the same/constant M1
so trolley B ..... A0 [1]

4 **(a)** when a wave (front) passes by/incident on an edge/slit ……
wave bends/spreads (into the geometrical shadow) …… A

(b) $\tan\theta = \frac{38}{165}$

$\theta = 13°$ …… C1
$d \sin\theta = n\lambda$ …… C1
$d = 2.82 \times 10^{-6}$ …… C1
number = $(1/d =) 3.6 \times 10^{5}$ …… A1 [4]

(c) P remains in same position …… B1
X and Y rotate through 90° …… B1 [2]

(d) *either* screen not parallel to grating
or grating not normal to (incident) light …… B1 [1]

5 **(a)** region/area where a charge experiences a force …… B1 [1]

(b) **(i)** left-hand sphere (+), right-hand sphere (–) …… B1 [1]

(ii) **1** correct region labelled C within 10 mm of central part of plate
otherwise within 5 mm of plate …… B1 [1]

2 correct region labelled D area of field not included for **(b)(ii)1** …… B1 [1]

(c) **(i)** arrows through P and N in correct directions …… B1 [1]

(ii) torque = force × perpendicular distance (between forces) …… C1
$= 1.6 \times 10^{-19} \times 5.0 \times 10^{4} \times 2.8 \times 10^{-10} \times \sin 30$
$= 1.1 \times 10^{-24}$ N m …… A1 [2]

6 **(a)** **(i)** $P = VI$ …… C1
$60 = 12 \times I$
$I = 5.(0)$ A …… A1 [2]

(ii) *either* $V = IR$ *or* $P = I^2R$ or $P = V^2 / R$ …… C1
either $12 = 5 \times R$ *or* $60 = 5^2 \times R$ or $60 = 12^2/R$ …… M1
$R = 2.4\ \Omega$ …… A0 [2]

(b) $R = \rho L/A$ …… C1
$A = \pi \times (0.4 \times 10^{-3})^2$ $(= 5.03 \times 10^{-7})$ …… C1
$L = (2.4 \times 5.03 \times 10^{-7})/(1.0 \times 10^{-6})$
$= 1.2$ m …… A1 [3]

(c) resistance is halved …… M1
either current is doubled *or* power $\propto 1/R$ …… M1
power is doubled …… A1 [3]

7 **(a)** nuclei/atoms with same proton number/atomic number B1
nuclei/atoms contain different numbers of neutrons/different atomic mass B1

(b) **(i)** 92 ..... A1 [1]

(ii) 146 ..... A1 [1]

(c) **(i)** mass = $238 \times 1.66 \times 10^{-27}$ C1
$= 3.95 \times 10^{-25}$ kg ..... A1 [2]

(ii) volume = $\frac{4}{3}\pi \times (8.9 \times 10^{-15})^3$ $(= 2.95 \times 10^{-42})$ C1
density = $(3.95 \times 10^{-25})/(2.95 \times 10^{-42})$
$= 1.3 \times 10^{17}$ kg m^{-3} ..... A1 [2]

(d) nucleus contains <u>most</u> of mass of atom B1
either nuclear diameter/volume <u>very much</u> less than that of atom
or atom is mostly (empty) space ..... B1 [2]