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

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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 M1
wave bends/spreads (into the geometrical shadow) ..... A1 [2]

(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 [2]

(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]