**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 = $(2.8 \pm 0.1)$ m s$^{-1}$ ..... A2 [2]
(*if answer* > $\pm 0.1$ *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]