

**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**  
GCE Advanced Subsidiary Level and GCE Advanced Level

## **MARK SCHEME for the May/June 2008 question paper**

### **9702 PHYSICS**

**9702/04**

Paper 4 (A2 Structured Questions), maximum raw mark 100

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.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the May/June 2008 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.



Page 2	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – May/June 2008	9702	04

## Section A

- 1 (a) (i) angle (subtended) at centre of circle  
by an arc equal in length to the radius (of the circle) B1  
B1 [2]
- (ii) angle swept out per unit time / rate of change of angle  
by the string M1  
A1 [2]
- (b) friction provides / equals the centripetal force B1  
 $0.72 W = md\omega^2$  C1  
 $0.72 mg = m \times 0.35\omega^2$   
 $\omega = 4.49 \text{ (rad s}^{-1}\text{)}$  C1  
 $n = (\omega/2\pi) \times 60$  B1  
 $= 43 \text{ min}^{-1} \text{ (allow 42)}$  A1 [5]
- (c) *either* centripetal force increases as  $r$  increases  
*or* centripetal force larger at edge M1  
so flies off at edge first A1 [2]  
( $F = mr\omega^2$  so edge first – treat as special case and allow one mark)
- 2 (a) molecule(s) rebound from wall of vessel / hits walls B1  
change in momentum gives rise to impulse / force B1  
*either* (many impulses) averaged to give constant force / pressure  
*or* the molecules are in random motion B1 [3]
- (b) (i)  $p = \frac{1}{3}\rho\langle c^2 \rangle$  C1  
 $1.02 \times 10^5 = \frac{1}{3} \times 0.900 \times \langle c^2 \rangle$   
 $\langle c^2 \rangle = 3.4 \times 10^5$  C1  
 $c_{\text{RMS}} = 580 \text{ m s}^{-1}$  A1 [3]
- (ii) *either*  $\langle c^2 \rangle \propto T$  *or*  $\langle c^2 \rangle = 2 \times 3.4 \times 10^5$  C1  
 $c_{\text{RMS}} = 830 \text{ m s}^{-1} \text{ (allow 820)}$  A1 [2]
- (c)  $c_{\text{RMS}}$  depends on temperature (alone) B1  
so no effect B1 [2]

Page 3	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – May/June 2008	9702	04
3	(a) (i) amplitude = 0.5 cm		A1 [1]
	(ii) period = 0.8 s		A1 [1]
	(b) (i) $\omega = 2\pi / T$ = 7.85 rad s <sup>-1</sup> correct use of $v = \omega \sqrt{(x_0^2 - x^2)}$ = 7.85 × √{(0.5 × 10 <sup>-2</sup> ) <sup>2</sup> - (0.2 × 10 <sup>-2</sup> ) <sup>2</sup> } = 3.6 cm s <sup>-1</sup> (if tangent drawn or clearly implied (B1) 3.6 ± 0.3 cm s <sup>-1</sup> (A2) but allow 1 mark for > ±0.3 but ≤ ±0.6 cm s <sup>-1</sup> )		C1 B1 A1 [3]
	(ii) d = 15.8 cm		A1 [1]
	(c) (i) (continuous) loss of energy / reduction in amplitude (from the oscillating system) caused by force acting in opposite direction to the motion / friction / viscous forces		B1 B1 [2]
	(ii) same period / small increase in period line displacement always less than that on Fig.3.2 (ignore first T/4) peak progressively smaller		B1 M1 A1 [3]
4	(a) work done moving unit positive charge from infinity to the point		M1 A1 [2]
	(b) (i) x = 18 cm		A1 [1]
	(ii) $V_A + V_B = 0$ (3.6 × 10 <sup>-9</sup> ) / (4πε <sub>0</sub> × 18 × 10 <sup>-2</sup> ) + q / (4πε <sub>0</sub> × 12 × 10 <sup>-2</sup> ) = 0 q = -2.4 × 10 <sup>-9</sup> C (use of $V_A = V_B$ giving 2.4 × 10 <sup>-9</sup> C scores one mark)		C1 C1 A1 [3]
	(c) field strength = (-) gradient of graph force = charge × gradient / field strength or force ∝ gradient force largest at x = 27 cm		B1 B1 B1 [3]
5	(a) at t = 1.0 s, V = 2.5 V energy = ½CV <sup>2</sup> 0.13 = ½ × C × (8.0 <sup>2</sup> - 2.5 <sup>2</sup> ) C = 4500 μF		C1 C1 M1 A0 [3]
	(b) use of two capacitors in series in all branches of combination connected into correct parallel arrangement		M1 A1 [2]

Page 4	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – May/June 2008	9702	04

- 6 (a) parallel (to the field) B1 [1]
- (b) (i) torque =  $F \times d$   
 $2.1 \times 10^{-3} = F \times 2.8 \times 10^{-2}$   
 $F = 0.075 \text{ N}$   
*(use of 4.5 cm scores no marks)* C1  
A1 [2]
- (ii) zero A1 [1]
- (c)  $F = BILN(\sin\theta)$  C1  
 $0.075 = B \times 0.170 \times 4.5 \times 10^{-2} \times 140$  M1  
 $B = 7.0 \times 10^{-2} \text{ T} = 70 \text{ mT}$  A0 [2]
- (d) (i) (induced) e.m.f. is proportional to / equal to rate of change of (magnetic) flux (linkage) M1  
A1 [2]
- (ii) change in flux linkage =  $BAN$   
 $= 0.070 \times 4.5 \times 10^{-2} \times 2.8 \times 10^{-2} \times 140$  C1  
 $= 0.0123 \text{ Wb turns}$   
induced e.m.f =  $0.0123 / 0.14$  C1  
 $= 88 \text{ mV}$  A1 [3]  
*(Note: This is a simplified treatment. A full treatment would involve the averaging of  $B \cos\theta$  leading to a  $\sqrt{2}$  factor)*
- 7 (a) charge is quantised / discrete quantities B1 [1]
- (b) (i) parallel so that the electric field is uniform / constant B1  
horizontal so that *either* oil drop will not drift sideways  
*or* field is vertical  
*or* electric force is equal to weight B1 [2]
- (ii)  $qE = mg$  C1  
 $q \times 850 / (5.4 \times 10^{-3}) = 7.7 \times 10^{-15} \times 9.8$  C1  
 $q = 4.8 \times 10^{-19} \text{ C}$  and is negative A1 [3]
- (c) charge changes by  $1.6 \times 10^{-19} \text{ C}$  between droplets / integral multiples M1  
so charge on electron is  $1.6 \times 10^{-19} \text{ C}$  A0 [1]
- 8 (a) since momentum before combining is zero B1  
momenta must be equal and opposite after B1  
equal momenta so photon energies equal B1 [3]
- (b)  $E = mc^2$  C1  
 $= 9.1 \times 10^{-31} \times (3.0 \times 10^8)^2$   
 $= 8.19 \times 10^{-14} \text{ (J)}$  C1  
 $= (8.19 \times 10^{-14}) / (1.6 \times 10^{-13})$   
 $= 0.51 \text{ MeV}$  A1 [3]

Page 5	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – May/June 2008	9702	04

## Section B

- 9 (a) blocks labelled sensing device / sensor / transducer B1  
processor / processing unit / signal conditioning B1 [2]
- (b) (i) two LEDs with opposite polarities (*ignore any series resistors*) M1  
correctly identified as red and green A1 [2]
- (ii) correct polarity for diode to conduct identified M1  
hence red LED conducts when input (+)ve or *vice versa* A0 [1]
- 10 large / strong (constant) magnetic field B1  
nuclei rotate about direction of field / precess (1)  
radio frequency / r.f. pulse B1  
causes resonance in nuclei , nuclei absorb energy (1)  
(pulse) is at the Larmor frequency (1)  
on relaxation / nuclei de-excite emit (pulse of) r.f. B1  
detected and processed B1  
non-uniform field (superimposed) B1  
allows for position of nuclei to be determined B1  
and for location of detection to be changed (1)  
(B6 plus any two extra details, 1 each, max 2) B2 [8]
- 11 (a) (i) frequency of carrier wave varies M1  
in synchrony with displacement of information signal A1 [2]
- (ii) 1. zero (accept constant) B1 [1]  
2. upper limit 530 kHz B1  
lower limit 470 kHz B1  
changes upper limit → lower limit → upper limit at 8000 s<sup>-1</sup> B1 [3]
- (b) e.g. more radio stations required / shorter range  
more complex electronics  
larger bandwidth required  
(any two sensible suggestions, 1 each) B2 [2]
- 12 (a) (i) picking up of signal in one cable M1  
from a second (nearby) cable A1 [2]
- (ii) random (unwanted) signal / power B1  
that masks / added to / interferes with / distorts transmitted signal B1 [2]  
(allow this mark in (i) or (ii))
- (b) if  $P$  is power at receiver,  
 $30 = 10\lg(P / (6.5 \times 10^{-6}))$  C1  
 $P = 6.5 \times 10^{-3} \text{ W}$  C1  
loss along cable =  $10\lg(\{26 \times 10^{-3}\} / \{6.5 \times 10^{-3}\})$  C1  
= 6.0 dB C1  
length =  $6.0 / 0.2 = 30 \text{ km}$  A1 [5]