

MARK SCHEME for the May/June 2014 series

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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2014 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

Page 2	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2014	9702	21

- 1 (a) (i) *either* rate of change of displacement
or (change in) displacement/time (taken) B1 [1]
- (ii) speed has magnitude only B1
velocity has magnitude and direction B1 [2]
- (b) (i) idea of area under graph / use of $s = \frac{(u+v)}{2} \times t$ C1
 $s = \frac{(18+32)}{2} \times 2.5$ C1
 $= 62.5 \text{ m}$ A1 [3]
- (ii) $a = (18 - 32)/2.5 (= -5.6)$ C1
 $F = ma$ C1
 $F = 1500 \times (-) 5.6 = (-) 8400 \text{ N}$ A1 [3]
- (c) arrow labelled A and arrow labelled F both to the left B1 [1]
- 2 (a) (i) work (done)/time (taken) B1 [1]
- (ii) work = force $\times$ displacement (in direction of force) B1
power = force $\times$ displacement/time (taken) = force $\times$ velocity B1 [2]
- (b) (i) weight = mg C1
 $P = Fv = 2500 \times 9.81 \times \sin 9^\circ \times 8.5$ (or use $\cos 81^\circ$) C1
 $= 33$ (32.6) kW A1 [3]
- (ii) no gain or loss of KE B1
no work (done) against air resistance B1 [2]
- 3 (a) (i) resultant force is zero B1
weight of plank + weight of man = $F_A + F_B$
or $200 \text{ (N)} + 880 \text{ (N)}$ or $1080 = F_A + F_B$ B1 [2]
- (ii) principle of moments used C1
(anticlockwise moments) $F_B \times 5.0$ C1
(clockwise moments) $880 \times 0.5 + 200 \times 2.5$ C1
 $F_B = (440 + 500)/5.0 = 188 \text{ N}$ A1 [4]
- (b) straight line with positive gradient (allow freehand) M1
start point (0, 100) A1
finish point (5, 980) A1 [3]

Page 3	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2014	9702	21

- 4 (a) kinetic energy = $\frac{1}{2}mv^2$
 $= \frac{1}{2} \times 0.040 \times (2.8)^2 = 0.157 \text{ J or } 0.16 \text{ J}$ C1
A1 [2]
- (b) (i) $k = F/x$ or $F = kx$ C1
 $X_B = 14/800$
 $= 0.0175 \text{ m}$ A1 [2]
- (ii) area under graph = elastic potential energy stored C1
or $\frac{1}{2}kx^2$ or $\frac{1}{2}Fx$
(energy stored =) 0.1225 J less than KE (of 0.16 J) A1 [2]
- 5 (a) (i) displacement is the distance from the
equilibrium position / undisturbed position / midpoint / rest position B1
amplitude is the maximum displacement B1 [2]
- (ii) frequency is the number of wavefronts / crests passing a point
per unit time / number of oscillations per unit time B1
time period is the time between adjacent wavefronts
or time for one oscillation B1 [2]
- (b) (i) 1. amplitude = 1.5 mm A1 [1]
2. wavelength = $25/6$ C1
 $= 4.2 \text{ cm or } 4.2 \times 10^{-2} \text{ m}$ A1 [2]
- (ii) $v = \lambda/T$ or $v = f\lambda$ and $T = 1/f$ C1
 $T = 4.2/7.5 = 0.56 \text{ s}$ A1 [2]
- (c) (i) progressive M0
wavefront / crests moving / energy is transferred by the waves A1 [1]
- (ii) transverse M0
the vibration is perpendicular to the direction of energy transfer / wave velocity
or travel of the wave / wavefronts A1 [1]
- 6 (a) e.m.f.: energy converted from chemical / other forms to electrical
per unit charge B1
p.d.: energy converted from electrical to other forms per unit charge B1 [2]
- (b) (i) the p.d. across the lamp is less than 12 V
or there are lost volts / power / energy in the battery / internal resistance B1 [1]
- (ii) $R = V^2/P$ (or $V = RI$ and $P = VI$) C1
 $= 144/48$
 $= 3.0 \Omega$ A1 [2]

Page 4	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2014	9702	21

(iii) $I = E/(R_T + r)$
 $= 12/2.0$
 $= 6.0\text{A}$

C1
A1 [2]

(iv) power of each lamp $= I^2 R$
 $= (3.0)^2 \times 3.0$
 $= 27\text{W}$

C1
A1 [2]

(c) less resistance (in circuit)/more current
more lost volts/less p.d. across battery

M1
A1 [2]

7 (a) α : helium nucleus

β : electron

γ : electromagnetic radiation / wave / ray or photon

three correct 2/2, two correct 1/2

B2 [2]

(b) (i) atomic number / proton number / $Z - 2$, nucleon / mass number / $A - 4$

B1 [1]

(ii) atomic number / proton number / $Z + 1$
nucleon / mass number / A no change

B1 [1]

(iii) no change in proton or mass number
or “no change”

B1 [1]

MARK SCHEME for the May/June 2014 series

9702 PHYSICS

9702/22

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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2014 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

Page 2	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2014	9702	22

- 1 (a) power = energy/time or work done/time B1
force: kg m s^{-2} (including from mg in mgh or Fv)
or kinetic energy ($\frac{1}{2}mv^2$): $\text{kg (m s}^{-1})^2$ B1
(distance: m and (time) $^{-1}$: s^{-1}) and hence power: $\text{kg m s}^{-2} \text{ m s}^{-1} = \text{kg m}^2 \text{ s}^{-3}$ B1 [3]
- (b) Q/t : $\text{kg m}^2 \text{ s}^{-3}$ C1
A: m^2 and x: m and T: K C1
correct substitution into $C = (Qx)/tAT$ or equivalent, or with cancellation C1
units of C: $\text{kg m s}^{-3} \text{ K}^{-1}$ A1 [4]
- 2 (a) $\rho = m/V$ C1
 $V = (\pi d^2/4) \times t = 7.67 \times 10^{-7} \text{ m}^3$
 $\rho = (9.6 \times 10^{-3})/[\pi(22.1/2 \times 10^{-3})^2 \times 2.00 \times 10^{-3}]$ C1
 $\rho = 12513 \text{ kg m}^{-3}$ (allow 2 or more s.f.) A1 [3]
- (b) (i) $\Delta\rho/\rho = \Delta m/m + \Delta t/t + 2\Delta d/d$ C1
 $= 5.21\% + 0.50\% + 0.905\%$ [or correct fractional uncertainties] C1
 $= 6.6\%$ (6.61%) A1 [3]
- (ii) $\rho = 12500 \pm 800 \text{ kg m}^{-3}$ A1 [1]
- 3 (a) a body/mass/object continues (at rest or) at constant/uniform velocity unless acted on by a resultant force B1 [1]
- (b) (i) weight vertically down B1
normal/reaction/contact (force) perpendicular/normal to the slope B1 [2]
- (ii) 1. acceleration = gradient or $(v - u)/t$ or $\Delta v/t$ C1
 $= (6.0 - 0.8)/(2.0 - 0.0) = 2.6 \text{ ms}^{-2}$ M1 [2]
2. $F = ma$
 $= 65 \times 2.6$
 $= 169 \text{ N}$ (allow to 2 or 3 s.f.) A1 [1]
3. weight component seen: $mg \sin \theta$ (218 N) C1
 $218 - R = 169$ C1
 $R = 49 \text{ N}$ (require 2 s.f.) A1 [3]

Page 3	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2014	9702	22

- 4 (a) GPE: energy of a mass due to its position in a gravitational field B1
KE: energy (a mass has) due to its motion/speed/velocity B1 [2]
- (b) (i) 1. $KE = \frac{1}{2} mv^2$ C1
 $= \frac{1}{2} \times 0.4 \times (30)^2$ C1
 $= 180 \text{ J}$ A1 [3]
2. $s = 0 + \frac{1}{2} \times 9.81 \times (2.16)^2$ or $s = (30 \sin 45^\circ)^2 / (2 \times 9.81)$ C1
 $= 22.88 \text{ (22.9) m}$ $= 22.94 \text{ (22.9) m}$ A1 [2]
3. $GPE = mgh$ C1
 $= 0.4 \times 9.81 \times 22.88 = 89.8 \text{ (90) J}$ A1 [2]
- (ii) 1. $KE = \text{initial KE} - GPE = 180 - 90 = 90 \text{ J}$ A1 [1]
2. (horizontal) velocity is not zero/(object) is still moving/answer explained in terms of conservation of energy B1 [1]
- 5 (a) (Young modulus/ E =) stress/strain B1 [1]
- (b) (i) stress = F/A
or = $F/(\pi d^2/4)$
or = $F/(\pi d^2)$ M1
ratio = 4 (or 4:1) A1 [2]
- (ii) E is the same for both wires (as same material) [e.g. $E_P = E_Q$] M1
strain = stress/ E
ratio = 4 (or 4:1) [*must be same as (i)*] A1 [2]
- 6 (a) there are no lost volts/energy lost in the battery
or there are no lost volts/energy lost in the internal resistance B1 [1]
- (b) the current/ I decreases (as R increases) M1
p.d. decreases (as R increases) A1
or
the parallel resistance (of X and R) increases M1
p.d. across parallel resistors increases, so p.d. (across Y) decreases A1 [2]

Page 4	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2014	9702	22

- (c) (i) current = 2.4 (A) C1
p.d. across AB = $24 - 2.4 \times 6 = 9.6$ V M1
- or
- total resistance = $10\ \Omega$ (= $24\text{ V}/2.4\text{ A}$) C1
(parallel resistance = $4\ \Omega$), p.d. = $24 \times (4/10) = 9.6$ V M1 [2]
- (ii) $R(\text{AB}) = 9.6/2.4 = 4.0\ \Omega$ C1
 $1/6 + 1/X = 1/4$ [must correctly substitute for R] C1
 $X = 12\ \Omega$ A1
- or
- $I_R = 9.6/6.0 = 1.6$ (A) (C1)
 $I_X = 2.4 - 1.6 = 0.8$ (A) (C1)
 $X (= 9.6/0.8) = 12\ \Omega$ (A1) [3]
- (iii) power = VI or EI or V^2/R or E^2/R or I^2R C1
= 24×2.4 or $(24)^2/10$ or $(2.4)^2 \times 10$
= 57.6 W (allow 2 or more s.f.) A1 [2]
- (d) power decreases M0
- e.m.f. constant or power = $24 \times$ current, and current decreases
or e.m.f. constant or power = $24^2/\text{resistance}$, and resistance increases A1 [1]
- 7 (a) waves from the double slit are coherent/constant phase difference B1
- waves (from each slit) overlap/superpose/meet (**not** interfere) B1
- maximum/bright fringe where path difference is $n\lambda$
or phase difference is $n360^\circ/2\pi n$ rad
- or minimum/dark fringe where path difference is $(n + \frac{1}{2})\lambda$
or phase difference is $(2n + 1) 180^\circ/(2n + 1)\pi$ rad B1 [3]
- (b) $v = f\lambda$ C1
 $\lambda = (3 \times 10^8) / 670 \times 10^{12} = 448$ (or 450) (nm) M1 [2]
- (c) $w = 12 / 9$ C1
 $a (= D\lambda/w) = (2.8 \times 450 \times 10^{-9}) / (12 / 9 \times 10^{-3})$ [allow nm, mm] C1
= $9.5 \times 10^{-4}\text{ m}$ [$9.4 \times 10^{-4}\text{ m}$ using $\lambda = 448\text{ nm}$] A1 [3]
- (d) (red light has) larger/higher/longer wavelength (must be comparison) M1
fringes further apart/larger separation A1 [2]

MARK SCHEME for the May/June 2014 series

9702 PHYSICS

9702/23

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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2014 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

Page 2	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2014	9702	23

- 1 (a) current, mass and temperature
two correct 2/2, one omission or error 1/2 A2 [2]
- (b) σ : no units, V : m^3 C1
 E_p : $\text{kg m}^2 \text{s}^{-2}$ C1
 C : $\text{kg m}^2 \text{s}^{-2} \times \text{m}^{-3} = \text{kg m}^{-1} \text{s}^{-2}$ A1 [3]
- 2 (a) scalar has magnitude only B1
vector has magnitude and direction B1 [2]
- (b) (i) $v^2 = 0 + 2 \times 9.81 \times 25$ (or using $\frac{1}{2} m v^2 = mgh$) C1
 $v = 22(.1) \text{ m s}^{-1}$ A1 [2]
- (ii) $22.1 = 0 + 9.81 \times t$ (or $25 = \frac{1}{2} \times 9.81 \times t^2$) M1
 $t (=22.1/9.81) = 2.26 \text{ s}$ or $t [= (5.097)^{1/2}] = 2.26 \text{ s}$ A0 [1]
- (iii) horizontal distance $= 15 \times t$
 $= 15 \times 2.257 = 33.86$ (allow $15 \times 2.3 = 34.5$) C1
(displacement) $^2 = (\text{horizontal distance})^2 + (\text{vertical distance})^2$ C1
 $= (25)^2 + (33.86)^2$ C1
displacement $= 42$ (42.08) m (allow 43 (42.6) m, allow 2 or more s.f.) A1 [4]
- (iv) distance is the actual (curved) path followed by ball B1
displacement is the straight line/minimum distance P to Q B1 [2]
- 3 (a) work done is the product of force and the distance moved in the direction of the force
or product of force and displacement in the direction of the force B1 [1]

Page 3	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2014	9702	23

- (b) (i) work done equals the decrease in GPE – gain in KE B1 [1]
- (ii) 1. distance = area under line C1
 $= (7.4 \times 2.5) / 2 = 9.3 \text{ m (9.25 m)}$ M1 [2]
- or
- acceleration from graph $a = 7.4 / 2.5 (= 2.96)$ (C1)
and equation of motion $(7.4)^2 = 2 \times 2.96 \times s$ gives $s = 9.3 \text{ (9.25) m}$ (A1)
2. kinetic energy $= \frac{1}{2} m v^2$ C1
 $= \frac{1}{2} \times 75 \times (7.4)^2$ C1
 $= 2100 \text{ J}$ A1 [3]
3. potential energy $= mgh$ C1
 $h = 9.3 \sin 30^\circ$ C1
 $PE = 75 \times 9.81 \times 9.3 \sin 30^\circ = 3400 \text{ J}$ A1 [3]
4. work done = energy loss C1
 $R = (3421 - 2054) / 9.3$ C1
 $= 150 \text{ (147) N}$ A1 [3]
- 4 (a) add small mass to cause extension then remove mass to see if spring returns to original length M1
repeat for larger masses and note maximum mass for which, when load is removed, the spring does return to original length A1 [2]
- (b) Hooke's law requires force proportional to extension B1
graph shows a straight line, hence obeys Hooke's law M1 [2]
- (c) $k = \text{force} / \text{extension}$ C1
 $= (0.42 \times 9.81) / [(30 - 21.2) \times 10^{-2}]$ C1
 $= 47 \text{ (46.8) N m}^{-1}$ A1 [3]
- 5 (a) lost volts/energy used within the cell/internal resistance B1
when cell supplies a current B1 [2]

Page 4	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2014	9702	23

- (b) (i) $E = I(R + r)$
 $4.5 = 0.65 (6.0 + r)$
 $r = 0.92 \Omega$ C1
A1 [2]
- (ii) $I = 0.65 \text{ (A)}$ and $V = IR$
 $V = 0.65 \times 6 = 3.9 \text{ V}$ C1
A1 [2]
- (iii) $P = V^2/R$ or $P = I^2R$ and $P = IV$
 $= (3.9)^2/6 = 2.5 \text{ W}$ C1
A1 [2]
- (iv) efficiency = power out/power in
 $= I^2R/I^2(R + r) = R/(R + r) = 6.0/(6.0 + 0.92) = 0.87$ C1
A1 [2]
- (c) (circuit) resistance decreases B1
current increases M1
more heating effect A1 [3]
- 6 (a) (i) progressive wave transfers energy, stationary wave no transfer of energy/
keeps energy within wave B1 [1]
- (ii) (progressive) wave/wave from loudspeaker reflects at end of tube B1
reflected wave overlaps (another) progressive wave B1
same frequency and speed hence stationary wave formed B1 [3]
- (iii) (side to side) along length of tube/along axis of tube B1 [1]
- (b) all three nodes clearly marked with N/clearly labelled at cross-over points B1 [1]
- (c) phase difference = 0 A1 [1]
- (d) (i) $v = f\lambda$
 $\lambda = 330/440 = 0.75 \text{ m}$ C1
A1 [2]
- (ii) $L = 5/4 \lambda$
 $= 5/4 \times 0.75 = 0.94 \text{ m}$ C1
A1 [2]