

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2014 series

9702 PHYSICS

9702/41

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, 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 October/November 2014 series for most Cambridge IGCSE[®], Cambridge International A and AS Level components and some Cambridge O Level components.

® IGCSE is the registered trademark of Cambridge International Examinations.



CAMBRIDGE
International Examinations

Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	41

Section A

- 1 (a) $g = GM/R^2$
 $= (6.67 \times 10^{-11} \times 6.4 \times 10^{23}) / (3.4 \times 10^6)^2 = 3.7 \text{ N kg}^{-1}$ C1
A1 [2]
- (b) $\Delta E_P = mg\Delta h$
because $\Delta h \ll R$ (or $1800 \text{ m} \ll 3.4 \times 10^6 \text{ m}$) g is constant B1
 $\Delta E_P = 2.4 \times 3.7 \times 1800$ C1
 $= 1.6 \times 10^4 \text{ J}$ A1 [3]
(use of $g = 9.8 \text{ m s}^{-2}$ max. 1 for explanation)
- (c) gravitational potential energy $= (-)GMm/x$ C1
 $v^2 = 2GM/x$ C1
 $x = 4D = 4 \times 6.8 \times 10^6$ C1
 $v^2 = (2 \times 6.67 \times 10^{-11} \times 6.4 \times 10^{23}) / (4 \times 6.8 \times 10^6)$
 $= 3.14 \times 10^6$
 $v = 1.8 \times 10^3 \text{ m s}^{-1}$ A1 [4]
(use of 3.5D giving $1.9 \times 10^3 \text{ m s}^{-1}$, allow max. 3)
- 2 (a) (i) $F = R \cos \theta$ M1
 $W = R \sin \theta$ M1
dividing, $W = F \tan \theta$ A0 [2]
(max. 1 if derivation to final line not shown)
- (ii) provides the centripetal force B1 [1]
- (b) either $F = mv^2/r$ and $W = mg$
or $v^2 = rg/\tan \theta$ C1
 $v^2 = (14 \times 10^{-2} \times 9.8) / \tan 28^\circ$ C1
 $= 2.58$
 $v = 1.6 \text{ m s}^{-1}$ A1 [3]
- 3 (a) obeys the equation $pV/T = \text{constant}$ B1 [1]
(accept $pV = nRT$)
- (b) (i) $pV = nRT$ C1
 $5.0 \times 10^7 \times 3.0 \times 10^{-4} = n \times 8.31 \times 296$ giving $n = 6.1 \text{ mol}$ A1 [2]
- (ii) pressure $\propto$ amount of substance
loss $= 0.40/100 \times 6.1 \text{ mol} = 0.0244 \text{ mol}$ C1
 $= 0.0244 \times 6.02 \times 10^{23}$ (atoms) C1
 $= 1.47 \times 10^{22}$ atoms C1
rate $= (1.47 \times 10^{22}) / (35 \times 24 \times 60 \times 60)$
 $= 4.9 \times 10^{15} \text{ s}^{-1}$ A1 [4]

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	41

- 4 (a) acceleration / force proportional to displacement (from a fixed point) M1
either acceleration and displacement in opposite directions A1 [2]
or acceleration always directed towards a fixed point
- (b) (i) g and r are constant so a is proportional to x B1
negative sign shows a and x are in opposite directions B1 [2]
- (ii) $\omega^2 = g/r$ and $\omega = 2\pi/T$ C1
 $\omega^2 = 9.8/0.28$
 $= 35$ C1
 $T = 2\pi/\sqrt{35} = 1.06 \text{ s}$
time interval $\tau = 0.53 \text{ s}$ A1 [3]
- (c) sketch: time period constant (or increases very slightly) M1
drawn line always 'inside' given loops A1
successive decrease in peak height A1 [3]
- 5 (a) work done in moving unit positive charge M1
from infinity (to the point) A1 [2]
- (b) (i) inside the sphere, the potential would be constant B1 [1]
- (ii) for point charge, V_x is constant B1
co-ordinates clear and determines two values of V_x at least 4 cm apart M1
conclusion made clear A1 [3]
- (c) $q = 4\pi\epsilon_0 V_x$
 $q = 4\pi \times 8.85 \times 10^{-12} \times 180 \times 1.0 \times 10^{-2}$ M1
 $= 2.0 \times 10^{-10} \text{ C}$ A1 [2]
- 6 (a) $F = BIL \sin \theta$ C1
 $= 2.6 \times 10^{-3} \times 5.4 \times 4.7 \times 10^{-2} \times \sin 34^\circ$
 $= 3.69 \times 10^{-4} \text{ N}$ A1 [2]
(allow 1 mark for use of $\cos 34^\circ$)
- (b) peak current $= 1.7 \times \sqrt{2}$ C1
 $= 2.4 \text{ A}$
- max. force $= 2.6 \times 10^{-3} \times 2.4 \times 4.7 \times 10^{-2} \times \sin 34^\circ$
 $= 1.64 \times 10^{-4} \text{ N}$ C1
- variation $= 2 \times 1.64 \times 10^{-4}$
 $= 3.3 \times 10^{-4} \text{ N}$ A1 [3]

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	41

- 7 (a) (i) *either* heating effect in a resistor $\propto$ (current)² B1
square of value of an alternating current is always positive B1
so heating effect A0
or current moves in opposite directions in resistor during half-cycles (B1)
heating effect is independent of direction (B1) [2]
- (ii) that value of the direct current M1
producing the same heating effect (as the alternating current) in a resistor A1 [2]
- (b) (i) induced e.m.f. proportional to the rate M1
of change of (magnetic) flux (linkage) A1 [2]
- (ii) flux in core is in phase with current in the primary coil B1
(induced) e.m.f. in secondary because coil cuts the flux B1
flux and rate of change of flux are not in phase B1 [3]
- 8 (a) photon ‘absorbed’ by electron B1
photon has energy equal to difference in energy of two energy levels B1
electron de-excites emitting photon (of same energy) in any direction B1 [3]
- (b) (i) $E = hc/\lambda$ C1
 $= (6.63 \times 10^{-34} \times 3 \times 10^8)/(435 \times 10^{-9})$ C1
 $= 4.57 \times 10^{-19} \text{ J (allow 2 s.f.)}$ C1
 $= (4.57 \times 10^{-19})/(1.6 \times 10^{-19}) \text{ (eV)}$
 $= 2.86 \text{ eV (allow 2 s.f.)}$ A1 [4]
- (ii) arrow pointing in either direction between -3.41 eV and -0.55 eV B1 [1]
- 9 (a) ‘light’ nuclei combine to form ‘heavier’ nuclei B1 [1]
- (b) (i) *either* energy $= c^2 \Delta m$
or energy $= (3.00 \times 10^8)^2 \times 1.66 \times 10^{-27}$ C1
energy $= 1.494 \times 10^{-10} \text{ J}$ C1
 $= (1.494 \times 10^{-10})/(1.60 \times 10^{-13})$
 $= 934 \text{ MeV (3 s.f.)}$ A1 [3]
- (ii) $\Delta m = (2.01356 + 3.01551) - (4.00151 + 1.00867)$
 $= 5.02907 - 5.01018$
 $= 0.01889 \text{ u}$ C1
energy $= 0.01889 \times 934$
 $= 17.6 \text{ MeV (allow 2 s.f.)}$ A1 [2]
- (iii) high temperature means high speeds/kinetic energy of nuclei B1
D and T nuclei collide despite repelling one another B1 [2]

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	41

Section B

- 10 (a)** e.g. zero output resistance / impedance
infinite bandwidth
infinite slew rate
1 mark each, max. 3 B3 [3]
- (b) (i)** at 1.0 °C, thermistor resistance is 3.7 kΩ B1
amplifier gain = $-R/740 = -3700/740$ (negative sign essential) C1
= -5.0 C1

potential = $1.0/-5.0 = -0.20$ V A1 [4]
- (ii)** at 15 °C, $R = 2.15$ kΩ (allow ± 0.05 kΩ) C1
reading = $(2150/740) \times 0.2$
= 0.58 V (0.59 V → 0.57 V) A1 [2]
- (c) (i)** 0.68 V A1 [1]
- (ii)** resistance (of thermistor) does not change linearly with temperature B1 [1]
- 11 (a)** X-ray beam contains many wavelengths B1
aluminium filter absorbs long wavelength X-ray radiation M1
that would be absorbed by the body (and not contribute to the image) A1 [3]
- (b)** CT scan consists of (many) X-ray images of a slice M1
and there are many slices A1
X-ray image is a single exposure B1
(so much) greater exposure with CT scan B1 [4]
- 12 (a) (i)** e.g. satellite communication, mobile phones, line of sight communication, wifi B1 [1]
- (ii)** e.g. connection of TV to aerial, loudspeaker, microphone (if clearly identified) B1 [1]
- (iii)** e.g. a.f. amplifier to loudspeaker, landline for phone B1 [1]
- (b) (i)** attenuation/dB = $10 \lg (P_2/P_1)$ C1
 $-190 = 10 \lg (P_2/3.1)$
 $P_2 = 3.1 \times 10^{-19}$ kW A1 [2]
- (ii)** signal is amplified M1
frequency is changed M1
to prevent swamping of up-link signal by down-link (signal) A1 [3]

Page 6	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	41

- 13 (a) *either* for transmission and reception of signal
or switching between transmitted and received signals M1
either so that one aerial may be used
or so that transmission and reception can occur in quick succession A1 [2]
- (b) gives large signal for one (input) frequency M1
(and) rejects /very small signal for all other frequencies A1 [2]

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2014 series

9702 PHYSICS

9702/42

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, 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 October/November 2014 series for most Cambridge IGCSE[®], Cambridge International A and AS Level components and some Cambridge O Level components.

® IGCSE is the registered trademark of Cambridge International Examinations.

Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	42

Section A

- 1 (a) $g = GM/R^2$
 $= (6.67 \times 10^{-11} \times 6.4 \times 10^{23}) / (3.4 \times 10^6)^2 = 3.7 \text{ N kg}^{-1}$ C1
A1 [2]
- (b) $\Delta E_P = mg\Delta h$
because $\Delta h \ll R$ (or $1800 \text{ m} \ll 3.4 \times 10^6 \text{ m}$) g is constant B1
 $\Delta E_P = 2.4 \times 3.7 \times 1800$ C1
 $= 1.6 \times 10^4 \text{ J}$ A1 [3]
(use of $g = 9.8 \text{ m s}^{-2}$ max. 1 for explanation)
- (c) gravitational potential energy $= (-)GMm/x$ C1
 $v^2 = 2GM/x$ C1
 $x = 4D = 4 \times 6.8 \times 10^6$ C1
- $v^2 = (2 \times 6.67 \times 10^{-11} \times 6.4 \times 10^{23}) / (4 \times 6.8 \times 10^6)$
 $= 3.14 \times 10^6$
 $v = 1.8 \times 10^3 \text{ m s}^{-1}$ A1 [4]
(use of $3.5D$ giving $1.9 \times 10^3 \text{ m s}^{-1}$, allow max. 3)
- 2 (a) (i) $F = R \cos \theta$ M1
 $W = R \sin \theta$ M1
dividing, $W = F \tan \theta$ A0 [2]
(max. 1 if derivation to final line not shown)
- (ii) provides the centripetal force B1 [1]
- (b) either $F = mv^2/r$ and $W = mg$
or $v^2 = rg/\tan \theta$ C1
 $v^2 = (14 \times 10^{-2} \times 9.8) / \tan 28^\circ$ C1
 $= 2.58$
 $v = 1.6 \text{ m s}^{-1}$ A1 [3]
- 3 (a) obeys the equation $pV/T = \text{constant}$ B1 [1]
(accept $pV = nRT$)
- (b) (i) $pV = nRT$ C1
 $5.0 \times 10^7 \times 3.0 \times 10^{-4} = n \times 8.31 \times 296$ giving $n = 6.1 \text{ mol}$ A1 [2]
- (ii) pressure $\propto$ amount of substance
loss $= 0.40/100 \times 6.1 \text{ mol} = 0.0244 \text{ mol}$ C1
 $= 0.0244 \times 6.02 \times 10^{23}$ (atoms) C1
 $= 1.47 \times 10^{22}$ atoms C1
- rate $= (1.47 \times 10^{22}) / (35 \times 24 \times 60 \times 60)$
 $= 4.9 \times 10^{15} \text{ s}^{-1}$ A1 [4]

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	42

- 4 (a) acceleration / force proportional to displacement (from a fixed point) M1
either acceleration and displacement in opposite directions A1 [2]
or acceleration always directed towards a fixed point
- (b) (i) g and r are constant so a is proportional to x B1
negative sign shows a and x are in opposite directions B1 [2]
- (ii) $\omega^2 = g/r$ and $\omega = 2\pi/T$ C1
 $\omega^2 = 9.8/0.28$
 $= 35$ C1
 $T = 2\pi/\sqrt{35} = 1.06 \text{ s}$
time interval $\tau = 0.53 \text{ s}$ A1 [3]
- (c) sketch: time period constant (or increases very slightly) M1
drawn line always 'inside' given loops A1
successive decrease in peak height A1 [3]
- 5 (a) work done in moving unit positive charge M1
from infinity (to the point) A1 [2]
- (b) (i) inside the sphere, the potential would be constant B1 [1]
- (ii) for point charge, V_x is constant B1
co-ordinates clear and determines two values of V_x at least 4 cm apart M1
conclusion made clear A1 [3]
- (c) $q = 4\pi\epsilon_0 V_x$
 $q = 4\pi \times 8.85 \times 10^{-12} \times 180 \times 1.0 \times 10^{-2}$ M1
 $= 2.0 \times 10^{-10} \text{ C}$ A1 [2]
- 6 (a) $F = BIL \sin \theta$ C1
 $= 2.6 \times 10^{-3} \times 5.4 \times 4.7 \times 10^{-2} \times \sin 34^\circ$
 $= 3.69 \times 10^{-4} \text{ N}$ A1 [2]
(allow 1 mark for use of $\cos 34^\circ$)
- (b) peak current $= 1.7 \times \sqrt{2}$ C1
 $= 2.4 \text{ A}$
- max. force $= 2.6 \times 10^{-3} \times 2.4 \times 4.7 \times 10^{-2} \times \sin 34^\circ$
 $= 1.64 \times 10^{-4} \text{ N}$ C1
- variation $= 2 \times 1.64 \times 10^{-4}$
 $= 3.3 \times 10^{-4} \text{ N}$ A1 [3]

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	42

- 7 (a) (i) *either* heating effect in a resistor $\propto$ (current)² B1
square of value of an alternating current is always positive B1
so heating effect A0
or current moves in opposite directions in resistor during half-cycles (B1)
heating effect is independent of direction (B1) [2]
- (ii) that value of the direct current M1
producing the same heating effect (as the alternating current) in a resistor A1 [2]
- (b) (i) induced e.m.f. proportional to the rate M1
of change of (magnetic) flux (linkage) A1 [2]
- (ii) flux in core is in phase with current in the primary coil B1
(induced) e.m.f. in secondary because coil cuts the flux B1
flux and rate of change of flux are not in phase B1 [3]
- 8 (a) photon ‘absorbed’ by electron B1
photon has energy equal to difference in energy of two energy levels B1
electron de-excites emitting photon (of same energy) in any direction B1 [3]
- (b) (i) $E = hc/\lambda$ C1
 $= (6.63 \times 10^{-34} \times 3 \times 10^8)/(435 \times 10^{-9})$ C1
 $= 4.57 \times 10^{-19} \text{ J (allow 2 s.f.)}$ C1
 $= (4.57 \times 10^{-19})/(1.6 \times 10^{-19}) \text{ (eV)}$
 $= 2.86 \text{ eV (allow 2 s.f.)}$ A1 [4]
- (ii) arrow pointing in either direction between -3.41 eV and -0.55 eV B1 [1]
- 9 (a) ‘light’ nuclei combine to form ‘heavier’ nuclei B1 [1]
- (b) (i) *either* energy $= c^2 \Delta m$
or energy $= (3.00 \times 10^8)^2 \times 1.66 \times 10^{-27}$ C1
energy $= 1.494 \times 10^{-10} \text{ J}$ C1
 $= (1.494 \times 10^{-10})/(1.60 \times 10^{-13})$
 $= 934 \text{ MeV (3 s.f.)}$ A1 [3]
- (ii) $\Delta m = (2.01356 + 3.01551) - (4.00151 + 1.00867)$
 $= 5.02907 - 5.01018$
 $= 0.01889 \text{ u}$ C1
energy $= 0.01889 \times 934$
 $= 17.6 \text{ MeV (allow 2 s.f.)}$ A1 [2]
- (iii) high temperature means high speeds/kinetic energy of nuclei B1
D and T nuclei collide despite repelling one another B1 [2]

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	42

Section B

- 10 (a)** e.g. zero output resistance / impedance
infinite bandwidth
infinite slew rate
1 mark each, max. 3 B3 [3]
- (b) (i)** at 1.0 °C, thermistor resistance is 3.7 kΩ B1
amplifier gain = $-R/740 = -3700/740$ (negative sign essential) C1
= -5.0 C1

potential = $1.0/-5.0 = -0.20$ V A1 [4]
- (ii)** at 15 °C, $R = 2.15$ kΩ (allow ± 0.05 kΩ) C1
reading = $(2150/740) \times 0.2$
= 0.58 V (0.59 V → 0.57 V) A1 [2]
- (c) (i)** 0.68 V A1 [1]
- (ii)** resistance (of thermistor) does not change linearly with temperature B1 [1]
- 11 (a)** X-ray beam contains many wavelengths B1
aluminium filter absorbs long wavelength X-ray radiation M1
that would be absorbed by the body (and not contribute to the image) A1 [3]
- (b)** CT scan consists of (many) X-ray images of a slice M1
and there are many slices A1
X-ray image is a single exposure B1
(so much) greater exposure with CT scan B1 [4]
- 12 (a) (i)** e.g. satellite communication, mobile phones, line of sight communication, wifi B1 [1]
- (ii)** e.g. connection of TV to aerial, loudspeaker, microphone (if clearly identified) B1 [1]
- (iii)** e.g. a.f. amplifier to loudspeaker, landline for phone B1 [1]
- (b) (i)** attenuation/dB = $10 \lg (P_2/P_1)$ C1
 $-190 = 10 \lg (P_2/3.1)$
 $P_2 = 3.1 \times 10^{-19}$ kW A1 [2]
- (ii)** signal is amplified M1
frequency is changed M1
to prevent swamping of up-link signal by down-link (signal) A1 [3]

Page 6	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	42

- 13 (a) *either* for transmission and reception of signal
or switching between transmitted and received signals M1
either so that one aerial may be used
or so that transmission and reception can occur in quick succession A1 [2]
- (b) gives large signal for one (input) frequency M1
(and) rejects /very small signal for all other frequencies A1 [2]

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2014 series

9702 PHYSICS

9702/43

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, 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 October/November 2014 series for most Cambridge IGCSE[®], Cambridge International A and AS Level components and some Cambridge O Level components.

® IGCSE is the registered trademark of Cambridge International Examinations.

Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	43

- 1 (a) (i) *either* $\omega = 2\pi / T$ *or* $\omega = 2\pi f$ and $f = 1 / T$ C1
 $\omega = 2\pi / 0.30$
 $= 20.9 \text{ rad s}^{-1}$ (accept 2 s.f.) A1 [2]
- (ii) kinetic energy $= \frac{1}{2}m\omega^2 x_0^2$ *or* $v = \omega x_0$ and $\frac{1}{2}mv^2$ C1
 $= \frac{1}{2} \times 0.130 \times 20.9^2 \times (1.5 \times 10^{-2})^2 = 6.4 \times 10^{-3} \text{ J}$ A1 [2]
- (b) (i) as magnet moves, flux is cut by cup / aluminium giving rise to induced e.m.f. (in cup) B1
induced e.m.f. gives rise to currents and heating of the cup B1
thermal energy derived from oscillations of magnet so amplitude decreases B1
or
induced e.m.f. gives rise to currents which generate a magnetic field (B1)
the magnetic field opposes the motion of the magnet so amplitude decreases (B1) [3]
- (ii) *either* use of $\frac{1}{2}m\omega^2 x_0^2$ and $x_0 = 0.75 \text{ cm}$ *or* x_0 is halved so $\frac{1}{4}$ energy C1
to give new energy = 1.6 mJ
either loss in energy = $6.4 - 1.6$ *or* loss = $\frac{3}{4} \times 6.4$ giving loss = 4.8 mJ A1 [2]
- (c) $q = mc\Delta\theta$
 $4.8 \times 10^{-3} = 6.2 \times 10^{-3} \times 910 \times \Delta\theta$ C1
 $\Delta\theta = 8.5 \times 10^{-4} \text{ K}$ A1 [2]
- 2 (a) smooth curve with decreasing gradient, not starting at $x = 0$ M1
end of line not at $g = 0$ or horizontal A1 [2]
- (b) straight line with positive gradient M1
line starts at origin A1 [2]
- (c) sinusoidal shape B1
only positive values and peak/trough height constant B1
4 'loops' B1 [3]
- 3 (a) initially, $pV/T = (2.40 \times 10^5 \times 5.00 \times 10^{-4})/288 = 0.417$ M1
finally, $pV/T = (2.40 \times 10^5 \times 14.5 \times 10^{-4})/835 = 0.417$ M1
ideal gas because pV/T is constant A1 [3]
(allow 2 marks for two determinations of V/T and then 1 mark for V/T and p constant, so ideal)

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	43

- (b) (i) work done $= p\Delta V$
 $= 2.40 \times 10^5 \times (14.5 - 5.00) \times 10^{-4}$
 $= 228 \text{ J (ignore sign, not 2 s.f.)}$ C1
A1 [2]
- (ii) $\Delta U = q + w = 569 - 228$
 $= 341 \text{ J}$ M1
increase A1 [2]
- 4 (a) acceleration / force proportional to displacement (from a fixed point) M1
either acceleration and displacement in opposite directions
or acceleration always directed towards a fixed point A1 [2]
- (b) (i) zero & 0.625 s or 0.625 s & 1.25 s or 1.25 s & 1.875 s or 1.875 s & 2.5 s A1 [1]
- (ii) 1. $\omega = 2\pi / T$ and $v_0 = \omega x_0$ C1
 $\omega = 2\pi / 1.25$
 $= 5.03 \text{ rad s}^{-1}$ C1
- $v_0 = 5.03 \times 3.2$
 $= 16.1 \text{ cm s}^{-1}$ (allow 2 s.f.) A1 [3]
2. $v = \omega \sqrt{(x_0^2 - x^2)}$
either $\frac{1}{2}\omega a = \omega \sqrt{(x_0^2 - x^2)}$ or $\frac{1}{2} \times 16.1 = 5.03 \sqrt{(3.2^2 - x^2)}$ C1
 $x_0^2 / 4 = x_0^2 - x^2$ $2.58 = 3.2^2 - x^2$
 $x = 2.8 \text{ cm}$ $x = 2.8 \text{ cm}$ A1 [2]
- (c) sketch: loop with origin at its centre M1
correct intercepts & shape based on (b)(ii) A1 [2]
- 5 (a) work done / energy in moving unit positive charge from infinity (to the point) M1
A1 [2]
- (b) (i) $V = q / 4\pi\epsilon_0 r$
at 16 kV, $q = 3.0 \times 10^{-8} \text{ C}$
- $r = (3.0 \times 10^{-8}) / (4\pi \times 8.85 \times 10^{-12} \times 16 \times 10^3)$ C1
 $= 1.69 \times 10^{-2} \text{ m (allow 2 s.f.)}$ A1 [2]
(allow any answer which rounds to 1.7×10^{-2})
- (ii) energy is / represented by area 'below' line C1
energy $= \frac{1}{2}qV$
 $= \frac{1}{2} \times 24 \times 10^3 \times 4.5 \times 10^{-8}$ C1
 $= 5.4 \times 10^{-4} \text{ J}$ A1 [3]
- (c) $V = q / 4\pi\epsilon_0 r$ and $E = q / 4\pi\epsilon_0 r^2$ giving $Er = V$ B1
 $2.0 \times 10^6 \times 1.7 \times 10^{-2} = V$ C1
 $V = 3.4 \times 10^4 \text{ V}$ A1 [3]

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	43

- 6 (a) for the two capacitors in parallel, capacitance = $96 \mu\text{F}$
for complete arrangement, $1/C_T = 1/96 + 1/48$
 $C_T = 32 \mu\text{F}$ C1
A1 [2]
- (b) p.d. across parallel combination is one half p.d. across single capacitor
total p.d. = 9 V C1
A1 [2]
- 7 (a) *either* charge exists in discrete and equal quantities
or multiples of elementary charge / $e / 1.6 \times 10^{-19} \text{ C}$ B1 [1]
- (b) (i) force due to magnetic field must be upwards
B-field into the plane of the paper B1
B1 [2]
- (ii) sketch showing: deflection consistent with force in (b)(i)
reasonable curve B1
B1 [2]
- 8 (a) discrete amount / packet / quantum of energy
of electromagnetic radiation / EM radiation M1
A1 [2]
- (b) (i) $E = hc/\lambda$
 $= (6.63 \times 10^{-34} \times 3.0 \times 10^8) / (570 \times 10^{-9}) = 3.49 \times 10^{-19} \text{ J}$ A1 [1]
- (ii) 1. number = $(2.7 \times 10^{-3}) / (3.5 \times 10^{-19})$
 $= 7.7 \times 10^{15}$ C1
A1 [2]
2. momentum of photon = h/λ
 $= (6.63 \times 10^{-34}) / (570 \times 10^{-9})$
 $= 1.16 \times 10^{-27} \text{ kg m s}^{-1}$ C1
C1
- change in momentum = $1.16 \times 10^{-27} \times 7.7 \times 10^{15}$
 $= 8.96 \times 10^{-12} \text{ kg m s}^{-1}$ A1 [3]
- (allow $E = pc$ route to 9×10^{-12})
- (c) pressure = (change in momentum per second) / area
 $= (8.96 \times 10^{-12}) / (1.3 \times 10^{-5})$
 $= 6.9 \times 10^{-7} \text{ Pa}$ C1
A1 [2]
- 9 (a) activity = $(1.7 \times 10^{14}) / (2.5 \times 10^6)$
 $= 6.8 \times 10^7 \text{ Bq kg}^{-1}$ A1 [1]
- (b) (i) energy released per second in 1.0 kg of steel
 $= 6.8 \times 10^7 \times 0.067 \times 1.6 \times 10^{-13}$
 $= 7.3 \times 10^{-7} \text{ J}$ B1 [1]

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	43

(ii) this is a very small quantity of energy so steel will not be warm B1 [1]

(iii) $A = A_0 e^{-\lambda t}$ and $\lambda t_{1/2} = \ln 2$ C1
 $400 = (6.8 \times 10^7) \exp(-[\ln 2 \times t]/92)$ C1
 $t = 1600$ years A1

or

$A = A_0 / 2^n$ (C1)
 $n = 17.4$ (C1)
 $t = 17.4 \times 92 = 1600$ years (A1) [3]

Section B

10 (a) (i) thermistor/thermocouple B1 [1]

(ii) quartz crystal/piezoelectric crystal or transducer/microphone B1 [1]

(b) (i) $V_{OUT} = -5V$ A1
inverting input is positive or V_- is positive or $V_- > V_+$ so V_{OUT} is negative B1
op-amp has very large/infinite gain and so saturates B1 [3]

(ii) sketch: V_{OUT} switches from (+) to (–) when V_{IN} is zero B1
 V_{OUT} is +5V or –5V M1
 V_{OUT} is negative when V_{IN} is positive (or v.v.) A1 [3]

11 (a) product of density and speed M1
density of medium, speed of wave in medium A1 [2]
(not “speed of light”, 0/2)

(b) (i) $\alpha = (6.4 - 1.7)^2 / (6.4 + 1.7)^2$ C1
 $= 0.34$ A1 [2]

(ii) $I/I_0 = e^{-\mu x}$ C1
 $= \exp(-23 \times 3.4 \times 10^{-2})$ C1
 $= 0.46$ A1 [3]

(iii) $I_R/I = (0.46)^2 \times 0.34$ C1
 $= 0.072$ A1 [2]

12 (a) analogue: continuously variable B1
digital: two/distinct levels only or 1 s and 0 s or highs and lows B1 [2]

(b) (i) 5 A1 [1]

(ii) 1 1 0 1 A1 [1]

Page 6	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	43

- (c) greater number of voltage/signal levels B1
 smaller step heights in reproduced signal B1
 smaller voltage/signal changes can be seen B1 [3]

- 13 (a) same carrier frequencies can be re-used M1
 but not in neighbouring cells/possible to use more handsets A1 [2]

- (b) e.g. wavelength is short (M1)
 so aerial on mobile phone conveniently short (A1)
- e.g. limited range (M1)
 so low power/less interference between cells (A1)
- e.g. large number of channels/greater bandwidth (M1)
 so more simultaneous callers (A1) [4]