CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the March 2016 series

9702 PHYSICS

9702/22 Paper 2 (AS Level Structured Questions), maximum raw mark 60

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1 (a) metre rule / tape measure — B1

(b) (i) $v = [(1.8 \times 126 \times 10^{-2}) / 5.1 \times 10^{-3}]^{1/2}$ — C1
$= 21.1\,(\text{m s}^{-1})$ — A1

(ii) percentage uncertainty = 4% **or** fractional uncertainty = 0.04 — C1
$\Delta v = 0.04 \times 21.1$
$= 0.84$ — C1
$v = 21.1 \pm 0.8\,(\text{m s}^{-1})$ — A1

2 (a) change in velocity / time (taken) **or** rate of change of velocity — B1

(b) (i) $v_X = (24 / 1.5) = 16\,(\text{m s}^{-1})$ — A1

(ii) $\tan 28° = v_Y / v_X$ *or* $v_X = v \cos 28°$ *and* $v_Y = v \sin 28°$ — C1
$v_Y = 16 \tan 28°$ *or* $v_Y = 16 \times (\sin 28° / \cos 28°)$ so $v_Y = 8.5\,(\text{m s}^{-1})$ — A1

(iii) $v = u + at$ — C1
$t = (0 – 8.5) / (–9.81)$
$= 0.87\,(\text{s})$ — A1

(iv) straight line from positive v_Y at $t = 0$ to negative v_Y at $t = 1.5\,\text{s}$ — M1
line starts at (0, 8.5) and crosses t-axis at (0.87, 0) and does not go beyond $t = 1.5\,\text{s}$. — A1

(c) (i) ($v^2 = u^2 + 2as$) $0 = 8.5^2 + 2(–9.81)s$
or ($s = ut + ½at^2$) $s = 8.5×0.87 + ½ \times (–9.81) \times 0.87^2$
or ($s = vt – ½at^2$) $s = 0 – ½×(–9.81)×0.87^2$
or ($s = ½(u + v)t$ or area under graph) $s = 0.5 \times 8.5 \times 0.87$ — C1

$s = 3.7\,(\text{m})$ — A1

(ii) $\Delta E_P = mg\Delta h$ (*allow* $E = mgh$) — C1
$m = 22 / (9.81 × 3.7)$
$= 0.61\,(\text{kg})$ — A1

(d) acceleration (of freefall) is unchanged / not dependent on mass, and so no effect (on maximum height)
or *explanation in terms of energy:*
(initial) KE ∝ mass, (Δ)KE = (Δ)PE, (max) PE ∝ mass, and so
no effect (on maximum height) — B1

3 (a) (i) (work =) force × distance moved in the direction of the force. — B1

(ii) the energy stored (in an object) due to extension / compression / change of shape — B1

(b) (i) $E_K = ½mv^2$ — C1
$= 0.5 \times 0.40 \times 0.30^2$
$= 1.8 \times 10^{-2}\,(\text{J})$ — A1

(ii) (change in) kinetic energy = work done on spring / (change in) elastic potential energy C1
$1.8 \times 10^{-2} = ½ \times F \times 0.080$ C1
$F_{MAX} = 0.45$ (N) A1

(iii) $a = F / m = 0.45 / 0.40$
$= 1.1$ ($m s^{-2}$) A1

(iv) **1.** constant velocity / resultant force is zero, so in equilibrium B1

2. decelerating / resultant force is not zero, so not in equilibrium B1

(c) curved line from the origin M1
with decreasing gradient A1

4 (a) (i) Displacement of particles perpendicular to direction of energy propagation B1

(ii) waves meet / overlap (at a point) B1
(resultant) displacement is sum of the individual displacements B1

(b) (i) $\lambda = vT$ **or** $\lambda = v / f$ and $f = 1 / T$ C1
$\lambda = 4.0 \times 1.5$
$\lambda = 6.0$ (cm) A1

(ii) path difference [= (44 cm – 29 cm) / 6 cm] = 2.5λ M1

either waves have path difference = $(n + ½)\lambda$
or waves have phase difference = 180° M1

so destructive interference A1

(c) (i) intensity $\propto$ (amplitude)^2 C1
ratio = $(0.60^2 / 0.90^2) = 0.44$ A1

(ii) phase difference = 90° A1

5 (a) (i) movement / flow of charge carriers B1

(ii) $\dfrac{\text{work (done) or energy (transformed)(from electrical to other forms)}}{\text{charge}}$ B1

(b) (i) p.d. across one lamp = 2.5 V C1
resistance = [(8.7 – 7.5) / 0.3] / 2 = 2.0 (Ω) A1

(ii) straight line through the origin M1
with gradient of 0.5 A1

(iii) $P = I^2R$ **or** $P = VI$ and $V = IR$ **or** $P = V^2 / R$ and $V = IR$ C1
$= 0.30^2 \times 2.0$ $= 0.60 \times 0.30$ $= 0.60^2 / 2.0$
$= 0.18$ (W) A1

(iv) **1** $R = \rho l/A$ C1
$l = (2.0 \times 0.40 \times 10^{-6}) / 1.7 \times 10^{-8}$
$= 47$ (m) A1

2 $I = Anvq$
$v = 0.30 / (0.40 \times 10^{-6} \times 8.5 \times 10^{28} \times 1.6 \times 10^{-19})$ C1
$= 5.5 \times 10^{-5}$ (m s^{-1}) A1

6 **(a)** ${}^{1}_{1}\text{p}$ B1
${}^{0}_{-1}\beta^{-}$ and ${}^{0}_{0}\bar{\nu}$ B1

(b) an (electron) antineutrino B1

(c) lepton(s) B1

(d) **(i)** down, down, up / ddu B1

(ii) a down / d (quark) changes to an up / u (quark) **or** ddu → uud B1