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PHYSICS **9702/22**

Paper 2 AS Level Structured Questions **May/June 2016**

MARK SCHEME

Maximum Mark: 60

Published

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1 **(a)** acceleration = change in velocity / time (taken) or rate of change of velocity B1 [1]

(b) **(i)** $v = 0 + at$ or $v = at$ C1

($a = 36/19 =$) 1.9 (1.8947) $m\,s^{-2}$ A1 [2]

(ii) $s = \frac{1}{2}(u + v)t$ or $s = v^2/2a$ or $s = \frac{1}{2}at^2$

$= \frac{1}{2} \times 36 \times 19$ $= 36^2/(2 \times 1.89)$ $= \frac{1}{2} \times 1.89 \times 19^2$

= 340 m (342 m / 343 m / 341 m) M1 [1]

(iii) **1.** (ΔKE =) $\frac{1}{2} \times 95 \times (36)^2$ C1

= 62 000 (61 560) J A1 [2]

2. (ΔPE =) $95 \times 9.81 \times 340 \sin 40°$ or $95 \times 9.81 \times 218.5$ C1

= 200 000 J A1 [2]

(iv) work done (by frictional force) = ΔPE – ΔKE
or
work done = 200 000 – 62 000 (values from **1b(iii) 1.** and **2.**) C1

(frictional force = 138 000 / 340 =) 410 (406) N [420 N if full figures used] A1 [2]

(v) $-ma = mg \sin 20° - f$ or $ma = -mg \sin 20° + f$ C1

$-95 \times 3.0 = 95 \times 3.36 - f$

f = 600 (604) N A1 [2]

2 **(a)** $p = F/A$ M1

use of $m = \rho V$ and use of $V = Ah$ and use of $F = mg$ M1

correct substitution to obtain $p = \rho gh$ A1 [3]

(b) **(i)** (when h is zero the pressure is not zero due to) <u>pressure</u> from the air/atmosphere B1 [1]

(ii) gradient = ρg or $P - 1.0 \times 10^5 = \rho gh$ C1

e.g. $\rho g = 1.0 \times 10^5 / 0.75$ (= 133333)

ρ = 133 333 / 9.81

= 14 000 (13 592) $kg\,m^{-3}$ A1 [2]

3 **(a)** Young modulus = stress / strain B1 [1]

(b) **(i)** $E = (F \times l)/(A \times e)$ or $e = (F \times l)/(A \times E)$ B1

$e \propto 1/E$
or
ratio $e_C/e_S = E_S/E_C$ or $(1.9 \times 10^{11})/(1.2 \times 10^{11})$ or 19 / 12 C1

(ratio =) 1.6 (1.58) A1 [3]

(ii) two straight lines from (0,0) with **S** having the steepest gradient B1 [1]

4 **(a)** longitudinal: vibrations/oscillations (of the particles/wave) are parallel to the direction **or** in the same direction (of the propagation of energy) B1

transverse: vibrations/oscillations (of the particles/wave) are perpendicular to the direction (of the propagation of energy) B1 [2]

(b) LHS: intensity = power / area units: $kg\,m\,s^{-2} \times m \times s^{-1} \times m^{-2}$ or $kg\,m^2s^{-3} \times m^{-2}$ B1

RHS: units: $m\,s^{-1} \times kg\,m^{-3} \times s^{-2} \times m^2$ M1

LHS and RHS both $kg\,s^{-3}$ A1 [3]

(c) **(i)** change/difference in the observed/apparent frequency when the source is moving (relative to the observer) B1 [1]

(ii) wavelength increases/frequency decreases/red shift B1 [1]

(d) observed frequency = $vf_S/(v - v_S)$ C1

$550 = (340 \times 510)/(340 - v_S)$ C1

v_S = 25 (24.7) $m\,s^{-1}$ A1 [3]

5 **(a)** diffraction: spreading/diverging of waves/light (takes place) at (each) slit/ element/gap/aperture B1

interference: overlapping of waves (from coherent sources at each element) B1

path difference λ/phase difference of 360(°)/2π (produces the first order) B1 [3]

(b) $d \sin\theta = n\lambda$ or $\sin\theta = Nn\lambda$ C1

$d = (2 \times 486 \times 10^{-9})/\sin 29.7°$ $(= 1.962 \times 10^{-6})$ C1

number of lines = 510 (509.7) mm^{-1} A1 [3]

6 **(a)** at least six horizontal lines equally spaced and arrow to the right B1 [1]

(b) charge used $2e$ C1

gain in KE = $15 \times 1.6 \times 10^{-19} \times 10^{3} = 2 \times 1.6 \times 10^{-19} \times V$ (p.d.across plates)
or
F $(= W/d) = 15 \times 1.6 \times 10^{-19} \times 10^{3} / 16 \times 10^{-3}$ C1

(hence $V = 7500$ V or $F = 1.5 \times 10^{-13}$ N)

$E = V/d$ or $E = F/Q$ C1

$E = (7500 / 16 \times 10^{-3})$ or $E = (1.5 \times 10^{-13} / 3.2 \times 10^{-19})$

$E = 4.7 \times 10^{5}$ (468 750) V m^{-1} A1 [4]

or

KE $(= \frac{1}{2}mv^{2}) = 15 \times 10^{3} \times 1.6 \times 10^{-19}$

$v = [(2 \times 15 \times 10^{3} \times 1.6 \times 10^{-19}) / (6.68 \times 10^{-27})]^{1/2} = 8.5 \times 10^{5}$ m s^{-1} (C1)

a $(= v^{2}/2s) = (8.5 \times 10^{5})^{2} / 2 \times 16 \times 10^{-3} = 2.25 \times 10^{13}$ m s^{-2}

F $(= 6.68 \times 10^{-27} \times 2.25 \times 10^{-13}) = 1.5 \times 10^{-13}$ N

$E = F/Q$ (C1)

$Q = 2e$ (C1)

$E = 4.7 \times 10^{5}$ V m^{-1} (A1)

7 **(a)** charge exists only in discrete amounts B1 [1]

(b) **(i)** $E = I(R + r)$ or $V = IR$ C1

(total resistance =) 2.7 + 0.30 + 0.25 (= 3.25 Ω) M1

I = 9.0 / (2.7 + 0.30 + 0.25) or 9.0 / 3.25 = 2.8 A A1 [3]

(ii) $V = IR_{ext}$ C1
= 2.77 × 3.0 or 2.8 × 3.0

or

$V = E - Ir$ (C1)
= 9.0 – 2.77 × 0.25 or 9.0 – 2.8 × 0.25

V = 8.3 (8.31) V or 8.4 V A1 [2]

(c) **(i)** $I = nevA$

v = 2.77 / (8.5 × 10^{29} × 1.6 × 10^{-19} × 2.5 × 10^{-6}) M1

= 8.1 (8.147) × 10^{-6} m s^{-1} or 8.2 × 10^{-6} m s^{-1} A1 [2]

(ii) A reduces by a factor 4 (1/4 less) or resistance <u>of Z</u> goes up by 4× M1

current goes down but by <u>less than</u> a factor of 4 (as total resistance does not go up by a factor of 4) so drift speed goes up A1 [2]

8 **(a)** both electron and neutrino: lepton(s) B1

both neutron and proton: hadron(s)/baryon(s) B1 [2]

(b) **(i)** ${}^{1}_{1}\text{p} \rightarrow {}^{1}_{0}\text{n} + {}^{0}_{1}\beta + {}^{0}_{0}\nu$

correct symbols for particles M1

correct numerical values (allow no values on neutrino) A1 [2]

(ii) up up down or uud → up down down or udd B1 [1]

(iii) weak (nuclear) B1 [1]