Cambridge International Examinations
Cambridge Pre-U Certificate

PHYSICS **9792/02**

Paper 2 Written Paper **May/June 2016**

MARK SCHEME

Maximum Mark: 100

Published

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1 (a) (i) uses $m = \rho V$ [1]
(weight = $)\rho hAg$ [1] [2]

(ii) uses $p = F/A = \rho hAg/A$ $(= h\rho g)$ [1] [1]

(b) (i) $(p = h\rho g = 10.9 \times 1030 \times 9.81 =) 1.10 \times 10^5$ (Pa) [1] [1]

(ii) any **two** rows from: [4] [4]

reason	**explanation**
density greater at greater depths	pressure greater / water compressed
density greater at greater depths	temperature less / water contracts
density different at greater depths	salt concentration different
g value different further down	distance from centre different / water above
atmosphere exerts force on surface / exerts pressure	added to water pressure

[8]

2 (a) (kinetic energy =) work done on body **or** Fx [1]
(acceleration =) F/m [1]
(use of $v^2 = u^2 + 2ax$ gives) $v^2 = 2(F/m)x$ which rearranges (to $\frac{1}{2}mv^2$) [1] [3]

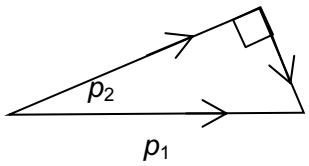
(b) (i) **1.** $(\frac{1}{2} \times 1040 \times 28^2 =) 4.08 \times 10^5$ (J) [1]
2. (F =) P/v [1]
$(= 36\,000/28 =)$ 1290 (N) [1] [3]

(ii) $(P =)\ mgh/t$ [1]
$(h/t =) 28/17$ **or** 1.647 ($m\,s^{-1}$) **or** 16 800 (W) [1]
$(P = 36\,000 + 1040 \times 9.81 \times 28/17 = 36\,000 + 16\,800 =) 52\,800$ (W) [1] [3]

(c) $(F =)\ \mu_k R$ [1]
$0.35 \times 40\,000 \times 9.81$ [1]
1.37×10^5 (N) [1] [3]

[12]

3 (a)



or with p_2 and p_3 beneath p_1

correct triangle **and** labels [1]
correct triangle **and** directions [1] [2]

(b) (i) (E_3 =) $E_1 - E_2$ [1] [1]

(ii) $v^2 = (1.30 \times 10^7)^2 - (1.20 \times 10^7)^2$ [1]
($v = \sqrt{(2.5 \times 10^{13})}$ =) 5.00×10^6 (m s^{-1}) [1] [2]

(c) (conservation of kinetic energy ensures) [initial speed of X]^2 = v^2 + [final speed of X]^2
(all the masses cancel) [1]
[initial speed of X]^2 = v^2 + [final speed of X]^2 **and** this is a Pythagorean triangle [1] [2]

[7]

4 (a) ($I = P/V$ = 24.0 / 12.0 =) 2.00 (A) **or** (P =)V^2/R [1]
($R = V/I$ = 12.0 / 2.00 =) 6.00 (Ω) [1] [2]

(b) (i) first column correct [1]
second column correct [1]
third column correct [1] [3]

R / Ω	total resistance / Ω	current / A	output power / W
0	6.0	2.00	24.0
3.0	9.0	1.33	10.7
6.0	12.0	1.00	6.0
9.0	15.0	0.80	3.8
12.0	18.0	0.67	2.7

(ii) slower increase of R (with angle at first makes the control more even) [1]
power decreases rapidly at first / unevenly (as resistance increases) **or** power varies more evenly (with angle) for **Fig. 4.2** resistor [1] [2]

[7]

5 **(a)** rainbow **or** dispersion / splits into colours in prisms **or** chromatic aberration in lens [1] [1]

(b) **(i)** (c =)$\sin^{-1}(1/n)$ **or** (n =)1.59 / 1.52 **or** (n =) 1.05 [1]
72.9(°) [1] [2]

(ii) ($v = c/n = 3.00 \times 10^8 / 1.59$ =) 1.89×10^8 (m s^{-1}) [1] [1]

(c) **(i)** (length of zigzag path =) 50 000 / sin88(°) **or** 50 030.5 (m) [1]
(time on axis =) 50 000 / 1.89×10^8 **or** 2.6500×10^{-4} (s) **or** 30.5 (m) length of zigzag path = 50 000 / sin 88 = 50 030.5 m [1]
(time for zigzag path =) 50 030.5 / 1.89×10^8 = 2.6516×10^{-4} (s)
or 30.5 / 1.89×10^8 [1]
(time delay =) 1.61×10^{-7} (s) [1] [4]

(ii) absorption by the fibre **or** attenuation of signal [1]
different paths / angles take different times which spreads out the signal [1] [2]

(d) **(i)** path curves towards centre line signal travels faster away from axis [1]
or
reduced path length longer paths have higher average speed [1] [2]

(ii) (very) narrow core / fibre [1] [1]

[13]

6 **(a)** **(i)** (e.g. 2 / 13 × 2π =) 0.96 to 1.12 [1]
rad(ians) **or** ^{c} [1] [2]

(ii) they are (coherent) **and** constant phase difference [1] [1]

(b) **(i)** (θ =)$\sin^{-1}(5.00/14.0)$ **or** $\sin^{-1}(10.0/14.0)$ **or** $\sin(\theta) = 5.00/14.0$
or $\sin(\theta) = 10.0/14.0$ [1]
20.9(°) **and** 45.6(°) [1] [2]

(ii) central maximum [1]
zero intensity at ±20.9(°) and at ±45.6(°) [1]
lesser (<50% of central maximum) peaks between ±20.9(°) and ±45.6(°) [1] [3]

[8]

7 any **eight** points from: [8] [8]
mean background count = 0.4 (counts s^{-1})
background negligible **or** attempts to subtract background count rate
both axes labelled with quantity, unit **and** scale
all points correct to ± ½ small square **and** smooth curve that levels off
(at $t = 0$) $A_1 = 40 – 41$ (counts s^{-1})
(at $t = 0$) $A_2 = 195 – 196$ (counts s^{-1})
one half-life very much longer than18.0 hours **or** longer than other isotope
other half-life 2.2 – 2.4 hours
levels out because one isotope is used up **[8]**

8 **(a)** **(i)** ($E = hf = hc/\lambda =$) $6.63 \times\times 10^{-34} \times 3.00 \times 10^{8} / 3.80 \times 10^{-7}$ [1]
5.23×10^{-19} (J) [1] [2]

(ii) ($W_f = 5.23 \times 10^{-19} – 2.73 \times 10^{-19} =$) 2.50×10^{-19} (J) [1] [1]

(iii) ($2.50 \times 10^{-19} / 1.60 \times 10^{-19} =$)1.57 (eV) [1] [1]

(iv) ($f_{th} = W_f / h =$) $2.50 \times 10^{-19} / 6.63 \times 10^{-34}$ [1]
3.78×10^{14} (Hz) [1] [2]

(b) less intensity because fewer photons [1]
photons have the same energy **or** photon energy independent of intensity (of light) [1]
electromagnetic radiation is quantised **or** comes in photons **or** explained by quantum model [1] [3]

(c) **(i)** some photoelectrons do more work than the work function as they escape **or** photoelectrons do different amounts of work **or** collide [1] [1]

(ii) no wavelengths less than 380 nm **or** no ultraviolet light [1]
smaller wavelengths have greater photon energy [1] [2]

[12]

9 **(a)** **(i)** from GPE **and** to electrical (**ignore** intermediate kinetic) **or** rotational KE (of Earth) **and** to electrical (**ignore** intermediate kinetic) [1] [1]

(ii) any **two** of: [2] [2]
friction between water and pipe,
viscosity within water,
friction between moving parts,
resistive heating in coils, cables
eddy currents in transformer / generator

(b) **(i)** $GPE =$)ρVgh **or** $1.03 \times 10^{3} \times 2100 \times 9.81 \times 12.4$ [1]
2.63×10^{8} ($J\,s^{-1}$) [1] [2]

(ii) ($P = 0.905 \times 2.63 \times 10^{8} / 10^{6} =$) 238 (MW) [1] [1]

(iii) ($I = P/V = 2.38 \times 10^{8} / 225\,000 =$) 1.06×10^{3} (A) [1] [1]

(c) (i) $24 \times 10 \times 10^6 \times 365 \times 24$ **or** 2.1×10^6 (MWh) **or** 2.1×10^9 (kWh) **or** 2.1×10^{12} (Wh) [1]
$540\,000\,000 / 2.1 \times 10^9$ [1]
0.257 **or** 25.7 % [1] [3]

(ii) (there are times when) generation is less than the maximum level **or** when there is no generation at all [1]
when levels are not sufficiently different **or** levels are equal **or** no demand for electricity [1] [2]

(d) rotational energy of Earth **or** kinetic energy of Earth-Moon system [1]
(more) friction / force between Earth and moving water due to turbines [1]
slows rotation of Earth **or** increases Earth-Moon distance [1] [3]

(e) (i) $(F_M =) GMm/(r-R)^2 - GMm/r^2$ [1]
bring over a common denominator of $r^2(r-R)^2$ [1]
$r >> R$ **and** simplification leading to $2GMmR/r^3$ [1] [3]

(ii) **1.** $(F_M = 2GMmR/r^3 =)$
$2 \times 6.67 \times 10^{-11} \times 7.35 \times 10^{22} \times 1.00 \times 6.38 \times 10^6 / (3.84 \times 10^8)^3$ [1]
1.10×10^{-6} (N) [1] [2]

2. (ratio = $M_M r_E^3 / (M_S r_M^3) =$)
$7.35 \times 10^{22} \times (1.50 \times 10^{11})^3 / (1.99 \times 10^{30} \times (3.84 \times 10^8)^3)$ [1]
2.20 [1]
the effect of the Moon on the tides is 2.20 times than the Sun [1] [3]

(iii) Earth, Moon Sun in straight line [1]
tidal forces / bulges coincide / reinforce [1] [2]

[25]