Mark scheme
June 2003

GCE

Physics B

Unit PHB4

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Question 1

(a)(i)	Unchanged		B1
(ii)	½ OWTTE		B1

(iii) $T = 2\pi\sqrt{(M/k)}$ — B1
$T^2 = 4\pi^2 \times M/k$ (square and re-arrange) — B1

(iv) $T = 1/0.91$ [= 1.1 s] — C1
$1.1^2 \times 190000 / 4\pi^2$ — A1
So $m_{platform}$ = (cand ans for M −5300) leading to correctly evaluated answer — B1

(b) *v* shape correct   [*cos* graph] — B2
or *v* shape inverted   [-*cos* graph] — B1

k.e. always +ve — M1
k.e. freq doubles — M1
k.e. shape acceptable — A1

(c) **max 4 from:**
mention of forced oscillation
platform frequency always matches lorry's frequency
mention of resonance
small amplitude when well away from resonant frequency
large amplitude at resonance   [do not infer small amp point from this]
resonant freq close to 0.91 Hz — B4   **16**

Question 2

(a) $35 \times 10^3 \times 4200 \times 24$ — C1
$= 3.53 \times 10^9$ W — A1

(b) $3.53 \times 10^9/2.4 \times 10^6$ [ecf; ans to (a)/ 2.4×10^6] — C1
$= 1.47 \times 10^3$ kg s^{-1} [allow kg] — A1

(c) 800 MW/sensible power — C1
$= 0.8/(3.53 + 0.8) = 0.185$ or 18.5 %   [ecf from ai] — A1   **6**

Question 3

(a)(i) 15 rev/s = 30π rad/s **or** $v = 51/52$ m s^{-1} [could appear in subst]   B1
$F = mw^2r$ [or mv^2/r & $v = \omega r$]   B1
appropriate sub leading to 7.33 kN   [2+sf evaluation mandatory]   B1

(ii) to centre of rotor OWTTE   B1

(iii) *stress = F/A*   B1
correct substitution from ai   B1

(iv) $0.55 \times 2.09 \times 10^7/6 \times 10^{10}$ [or $\varepsilon = 3.3 \times 10^{-4}$]   C1
= 0.192 mm   A1

(v) ½ x 7.32 x 10^3 x 1.92 x 10^{-4} [ecf]   C1
= 0.702 J   A1

(b)(i) volume pushed down [per second] = Av [mass = ρ × volume]   B1
Change of momentum [per second] = mass pushed down per second   B1
× *v*

(ii) Upward force = 900 N OWTTE   [penalise use of 900*g*]   C1
OR area swept out by blades = $\pi \times 0.55^2$
$900 = (0.55)^2\pi 1.3v^2$ C1
= 27 m s^{-1} A1   **15**

Question 4

(a)(i) $= 0.35 \times 0.45 \times 6 \times 8.9 \times 10^{-12}/ 3 \times 10^{-3}$ C1
= 2.8 x 10^{-9} F   A1

(ii) 12/10 [× 10^3]   C1
= 1.2 mA   A1

(iii) 10^4 x 2.8 x 10^{-9} = 2.8 x 10^{-5} s   B1

(iv) correct curvature, goes thru I_0, not asymptotic to *I* axis   M1
value about 1/3 after 1 time constant [between 0.3 and 0.4]   A1
evidence of attempt to make ratios same at equal time intervals   B1

(v) capacitance increases   B1
justification for *C* change (expect $C \propto 1/d$; inversely prop, or equ^n)   B1
current increases   B1
justification for current increase   B1

Use of physics terms is accurate, the answer is fluent/well argued
with few errors in spelling, punctuation and grammar
and gains at least 3 marks for physics   B2

Use of physics terms is accurate but the answer lacks coherence or
the spelling, punctuation and grammar are poor
and gains at least 1 mark for physics   B1

Use of physics terms is inaccurate, the answer is disjointed with
significant errors in spelling, punctuation and grammar   B0   **14**

Question 5

(a)   Use of 4×10^{14} C1
         Use of $c = f\lambda$ C1
         7.5 x 10^{-7} m   A1

(b)   line parallel to first intersecting x-axis at twice threshold freq   B1

    (i)   gradient is h so unchanged   B1

    (ii)   intersection with x-axis is double because $hf = \varphi$ at zero ke for e⁻   B1   **6**

Question 6

(a) $1.8/1.81 \times 10^{-11}$ m   B1

(b)   circular bands of light on diagram   B1
         diffraction/interference effect **or** electron $\lambda \approx$ atomic spacing in
         graphite   B1

(c)   state correct and appropriate particulate aspect   B1
         quote evidence *from this expt* that shows electrons possess aspect   B1   **5**

         e.g.
         electrons carry momentum/kinetic energy to screen
         excite other electrons in atoms/cause emission of energy/light
         or
         electrons carry charge
         can be accelerated by electric field/p.d.
         etc

Question 7

(a)(i)   use of $pV=$ constant or $p_1 V_1 = p_2 V_2$ C1
         $p = 99 \times 3.50/4.15$ C1
         $= 83.5$ kPa   A1

(ii)   change occurs quickly so cannot remain in thermal equilibrium
        or no time for heat to be lost; gas does work as it
        expands/adiabatic   B1

(b)   99 [$\times 10^3$]$\times 3.5 \times 10^{-4}$/8.31 $\times$ **291**   C1
        = 1.4(3) x 10^{-2} moles   A1

(c)   molecules/particles have momentum   B1
        momentum change at wall   B1
        momentum change at wall/collisions at wall leads to force
        [allow impulse arguments]   B1

        less air so fewer molecules   B1
        so change in momentum **per second** /rate of change is less [*or*
        per unit time]   B1

        use of physics terms is accurate, the answer is fluent/well
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        Use of physics terms is accurate but the answer lacks
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        and gains at least 1 mark for physics   B1

        Use of physics terms is inaccurate, the answer is disjointed
        with significant errors in spelling, punctuation and grammar   B0   **13**