ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme January 2002

GCE

Physics B

Unit PHB4

NOTES

Letters are used to distinguish between different types of marks in the scheme.

M indicates OBLIGATORY METHOD MARK
This is usually awarded for the physical principles involved, or for a particular point in the argument or definition. It is followed by one or more accuracy marks which cannot be scored unless the M mark has already been scored.

C indicates COMPENSATION METHOD MARK
This is awarded for the correct method or physical principle. In this case the method can be seen or implied by a correct answer or other correct subsequent steps. In this way an answer might score full marks even if *some* working has been omitted.

A indicates ACCURACY MARK
These marks are awarded for correct calculation or further detail. They follow an M mark or a C mark.

B indicates INDEPENDENT MARK
This is a mark which is independent of M and C marks.

e.c.f. is used to indicate that marks can be awarded if an error has been carried forward. This is also referred to as a 'transferred error' or 'consequential marking'.

Where a correct answer only (c.a.o.) is required, this means that the answer must be as in the Marking Scheme, including significant figures and units.

c.n.a.o. is used to indicate that the answer must be numerically correct but the unit is only penalised if it is the first error or omission in the section (see below).

Where an error carried forward (e.c.f.) is allowed by the Marking Scheme for an incorrect answer, e.c.f. must be written on the script if an error has been carried forward.

Only **one** unit penalty (u.p.) in **Section A** and **one** unit penalty in **Section B** of this paper.

Only **one** significant figure penalty (s.f.) in **Section A** and **one** significant figure penalty in **Section B** of this paper. Allow 2 or 3 s.f. unless otherwise stated.
Significant figure penalties include recurring figures and fractions for answers

Question 1

(a)		Max to zero to max with zero at 0 displacement and correct amplitude correct shape drawn with reasonable attempt to keep total energy constant, crossing at 1 x 10^{-2}J	M1 A1	**2**
(b)	(i)	0.044 m	B1	**1**
	(ii)	x = 0.044 cos 2π3.5t (0.044 cos 22t) or x = 0.044 sin 2π3.5t etc ecf for A	B1	**1**
	(iii)	a_{max} = (2 π 3.5)^2 0.044 21 (21.3) m s^{-2} ecf for A and incorrect 2πf from (ii) (0.042 gives 20.3; 0.04 gives 19.4)	C1 A1	**2**
				6

Question 2

(a)		The force per unit area at which the material extends considerably/a lot/plastically/ or strain increases considerably etc NOT doesn't return to its original shape/permanently deformed for no (or a small) increase in) force/stress	B1 B1 B1	**3**
(b)	(i)	strain = 8.4 x 10^{-4} (1.3x10^{-3}/1.55 seen) (allow if in E =$FL/A\Delta L$) or area of cross section = 2..54 x 10^{-6} or π (0.9 x 10^{-3})^2 stress = E x strain (explicit or numerically) and stress =F/A or E = $FL/A\Delta L$ force = 440 – 450 N(cao)	B1 C1 A1	**3**
	(ii)	Energy = ½ F Δl or ½ stress x strain x volume 0.29 J ecf for F from (b)(i)	C1 A1	**2**
				8

Question 3

(a)		the frequency needed to liberate an electron (electrons) from the surface of a material or minimum frequency to cause photoelectric effect	C1	
		the minimum frequency of the radiation/light/photon needed to liberate an electron (electrons) from (the surface of) a material or from the surface	A1	**2**
(b)		the rate increases or more electrons per second	M1	
		there are more photons striking the surface each second no change in rate if frequency is below threshold frequency -Allow 1	A1	**2**
(c)	(i)	Calculation using hc/E for (4.7 or 1.5 or 3.2)x 10^{-19} J	C1	
		use of 1.5 leads to 1.32 x 10^{-6} ; use of 3.2 leads to 6.2 x 10^{-7} 4.2 x 10^{-7} m	A1	**2**
	(ii)	use of 1.5 x 10^{-19}J	B1	
		$p = \sqrt{(2mE)}$ and $\lambda = h/p$ or $E = ½ mv^2$ and $\lambda = h/mv$ correct answer for their energy	C1	
		1.26 x 10^{-9} m for 1.5 x 10^{-19} J 1.2 x 10^{-9} m for 1.7 x 10^{-19} J 0.86 x 10^{-9} m for 3.2 x 10^{-19} J 0.71x 10^{-9} m for 4.7 x 10^{-19} J	A1	**3**
				9

Question 4

(a)		Time constant = 1.5 ms (allow 2.2 x 680 condoning powers of 10 ; may be seen in equation below)	C1	
		2.2 = 5.0 $e^{-t/(\text{their timeconstant})}$ or alternative using Q	C1	
		1.2 or 1.23 ms (cao)	A1	**3**
(b)	(i)	Calculation on one energy correctly (2.75(2.8) x 10^{-5} J or 5.3 x 10^{-6} J) (condone any suggestion that their one energy is the energy loss)	C1	
		2.1 to 2.3 x 10^{-5} J e.c.f. for same incorrect power of 10 as in (a)	A1	**2**
	(ii)	in the resistor	B1	
		Internal energy of the resistor or (eventually) internal energy of the surroundings) (but not heat in the resistor etc)	B1	**2**
(c)	(i)	Quotes or uses correct formula ($1/C = 1/C_1 + 1/C_2$)	C1	
		1.32 μF	A1	**2**
	(ii)	The change would not have the desired effect	M0	
		because The capacitor would discharge quicker so in the longer contact time the final p.d.would be lower or too low to measure accurately	A1	
		or To have a similar final voltage a larger time constant is needed; the suggested adjustment gives a lower time constant		**1**
				10

Question 5

(a)		$Ft = \Delta(mv)$ or $F = ma$ **and** $a = (v\text{-}u)/t$ 3800 N	C1 A1	**2**
(b)		work done = change in KE or appropriate equation of motion for s or work done = Fs Calculation of one KE correctly or s calculated correctly (50 m) 1.9×10^5 J (condone N m) e.c.f. for F	C1 C1 A1	**3**
(c)		power = {force from (a)} x any velocity or power = change in KE/time 76 kW (kJ s^{-1}) ecf from (b) or ecf from (a) for use of $P = Fv$ *(their F x* 20)	C1 A1	**2**
(d)	(i)	(their (b)) = 4.8 (or 1.2) x 510 x $\Delta\theta$ (allow use of 1.2 instead of 4.8 for this mark) appreciation of 4 discs evident in the calculation 77.6 (78) K (or °C) or their (b)/2450	C1 C1 A1	**3**
	(ii)	temperature rise will be lower there will be air resistance some energy becomes internal energy of the air OR other components of the braking system (including answers involving friction of tyres with road) these will use some of the energy to increase temperature OR heat/energy transfer to the surroundings since surroundings at lower temperature or temperature or internal energy of surroundings rises	B1 B1 B1 B1	**2**
				12

Question 6

(a)	(i)	3.8×10^{-23}	B1	
		N s or kg m s^{-1} (nb this is an extra unit penalty)	B1	**2**
	(ii)	$F = mv^2/r$ or $F = mr\omega^2$	C1	
		$3.5\text{-}3.6 \times 10^{-14}$ N	A1	**2**
	(iii)	Shown clearly toward the centre of the circular path	B1	**1**
(b)		In an elastic collision kinetic energy in conserved or no change in KE)	B1	
		total KE is constant or KE of system is constant	B1	**2**
		reasonable sketch of energy levels (at least 4 levels), –13.6 eV as the lowest	B1	
		in ionisation the electron removes an electron from the atom **or** from the ground state by providing 13.6 eV of energy	B1	**2**
		to emit light		
		an electron is raised to one of the intermediate levels or to a higher level or the atom is excited	B1	
		light is emitted when the electron returns to a lower level (nb not de-excites)	B1	
		a photon is emitted	B1	
		light is emitted when the electron falls into the $n = 2$ level	B1	**max 2**
		the use of physics terms is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar. must gain **at least 3/6** for physics	2	
		the use of physics terms is accurate, the answer lacks coherence or the spelling, punctuation and grammar are poor. must gain **at least 2/6** for physics	1	
		the use of physics terms is inaccurate, the answer is disjointed with significant errors is spelling, punctuation and grammar are poor	0	**max 2**
				13

Question 7

(a)	(i)	$pV = nRT$	C1	
		0.078(3) (mol)	A1	**2**
	(ii)	7.2×10^{-3} (mol)	B1	**1**
	(iii)	1.6 to 1.7×10^5 Pa (allow ecf from (i) and (ii) [{(i) + (ii)}/(i) x 1.5×10^5 Pa]	B1	**1**
(b)		there is pressure because **:**		
		molecules move, or have KE, or have momentum	B1	
		when molecules collide with the walls there is a change in momentum of the molecules (this mark may imply the first	B1	
		a force is exerted on the molecules to change their momentum or $Ft = \Delta mv$	B1	
		(an equal and opposite**)** force is exerted on the wall during collision or molecules hit/collide with the wall and cause a force	B1	
		pressure = force/area	B1	**3 max**
		when more air is pushed into the tube pressure/force is greater because		
		more molecules collide with the wall /higher chance of collision with the wall	B1	
		there is a greater change in momentum each second	B1	**2**
		the use of physics terms is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar. must gain **at least 3/5** for physics	2	
		the use of physics terms is accurate, the answer lacks coherence or the spelling, punctuation and grammar are poor. must gain **at least 1/5 for physics and give further argument** on which to judge QoWC	1	
		the use of physics terms is inaccurate, the answer is disjointed with significant errors is spelling, punctuation and grammar are poor	0	**max 2**
(c)	(i)	knows that for isothermal change $pV = constant$	C1	
		uses data correctly from graph to show that pV is not constant	A1	**2**
	(ii)	any clear attempt to determine the area under the line (25 to 30 squares seen)	C1	
		total number of squares = 132 + 27 = 159 (allow 150 – 170)	A1	
		energy per square = 0.025 J	B1	
		or	B1	**4**
		clear attempt to use the trapezium rule	C1	
		correct use of trapezium rule to find area	A1	
		evidence that correct use of scales	B1	
		3.8 to 4.2 J (cao)		
		or		
		Mean pressure = 1.15 to 1.25×10^5 Pa	B1	
		Volume change = 0.33×10^{-4} m^3	B1	
		Work done = (mean) pressure x volume change	B1	
		3.8 to 4.1 J	B1	**17**