RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced GCE **G494**

Rise and Fall of the Clockwork Universe

Mark Scheme for June 2010

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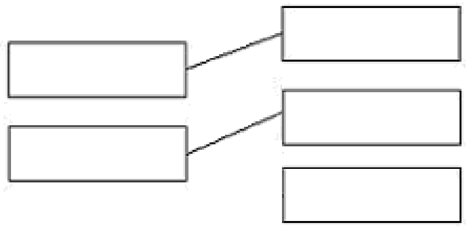
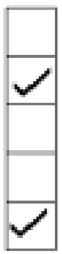
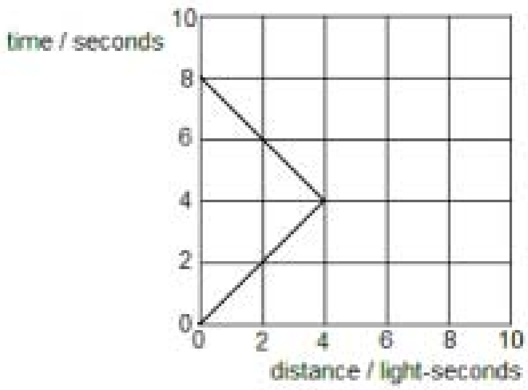
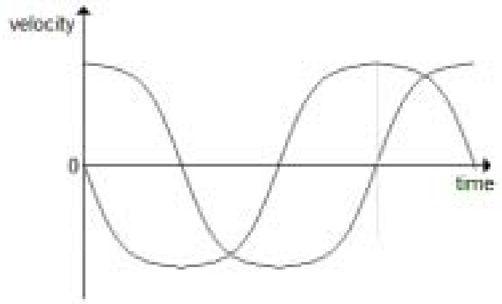
Question	expected answer	mark	Additional guidance
1a	N kg^{-1}	1	
1b	J kg^{-1} K^{-1}	1	
2a	$E = 0.5CV^2 = 1.2(15)\times10^{-3}$ J	1	**ignore** anything more than two sig. figs e.g 1.21×10^{-3} for [1]
2b	(current is) flow of charge (off capacitor, through circuit);	1	**ignore** references to discharging **not** just charge on capacitor decreases **accept** electrons as charge **accept** $I = Q/t$ or wtte for [1]
	EITHER p.d. across capacitor/resistor decreases (as capacitor loses charge) OR rate of charge release proportional to charge (on capacitor)	1	
3a	$D = \frac{Nm}{V} = (\frac{3p}{\overline{c^2}})$	1	look for $D = Nm/V$ $N = 1$ earns [0]
3b	$\sqrt{\overline{c^2}} = \sqrt{\frac{3p}{D}} = 500$ m s^{-1}	1	
3c	gas particles change direction;	1	**ignore** references to random
	because they collide (with other particles);	1	**ignore** description of random walk
4a	$N = \frac{A}{\lambda} = \frac{1.6\times10^5}{7.6\times10^{-10}} = 2.1\times10^{14}$	1	
4b	$A = A_0\, e^{-\lambda t} = 4.7\times10^4$ Bq	1	$N = 2.11\times10^{14}$ gives 4.75×10^4 Bq for [1] **ignore** sign of answer

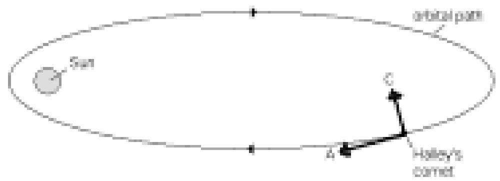
5	EITHER C and D OR D and C	2	each correct response for [1] remember **D**on't **C**are
6a 6b	$N = \frac{pV}{kT} = 3.1\times10^{24}$ $NkT = 1.2\times10^{4}$ J	1 1	look for at least two sig. figs in their answer, rounding to 3.1×10^{24} accept correct reverse calculation $3NkT/2$ gives 1.8×10^{4} J for [1] $5NkT/2$ gives 2.9×10^{4} J or 3.0×10^{4} J for [1]
7		1	correct pattern for [1]
8		1 1	correct pattern for [2] one mistake for [1] a mistake is an extra tick, a missing tick or a tick in the wrong place
9	A C D	2	only one mistake for [1] remember **A**ll **C**an **D**o

10a	particles bounce off ground; momentum of particles/ground changes; EITHER force on ground is its rate of change of momentum OR momentum change of particle requires a force, so equal and opposite force on the ground	1 1 1	**accept** collide/hit QWC mark - must use correct terms for third marking point
10bi	$p = (N/V)C$ where $C = kT$ = constant	1	
10bii	probability of a particle at h is $e^{-\frac{\varepsilon}{kT}}$; where $\varepsilon = mgh$ is gravitational/potential energy of particle;	1 1	**accept** fraction/proportion for probablility **accept** GPE
10biii	7.9×10^4 Pa	1	**accept** more than 2 sig. fig.

10c	EITHER more energy in system so more particles get lucky and able to reach that height OR *T* = some value above 290 K (b)(iii) correctly recalculated OR increased KE/speed/velocity of particles increased collision rate OR increased momentum of particles increased momentum change per collision OR *kT* increases so $e^{-\frac{E}{kT}}$ / BF / $e^{-\frac{mgh}{kT}}$ increases	 1 1	**accept** *pV* = *nkT* so *p* increases with increasing *T* for [1] **accept** increase of $\overline{c^2}$ so $p = \rho\overline{c^2}/3$ increases for [1] **accept** (-)*E*/*kT* or (-)*mgh*/*kT* decreases (as *T* increases)

11ai	all lines at 45° from (0,0) changes direction at (?,4) and ends at (0,8) 	1 1	**accept** lines drawn freehand
11aii	time out = time back because speed of light is constant	1 1	**accept** one-way time is half total time **ignore** references to distance **accept** pulse travels at speed of light
11aiii	$s = 3.00\times10^8 \times4.00 = 1.20\times10^9$ m	1	**accept** 1.2×10^9 m
11bi	pulse-echo time is now 7.34 s less than before, (so reduced distance)	1 1	 **accept** pulse-echo time is reduced by 0.66 s for [2] **accept** calculation of new distance of 1.1×10^9 m for [2]
11bii	s at 950 s is 1.10×10^9 m $(1.20\text{-}1.10)\times10^9/946 = 1.1\times10^5$ m s^{-1}	1 1	**allow** ecf from incorrect bi and aiii **accept** $1.(0)\times10^5$ m s^{-1} **allow** ecf incorrect new distance to asteroid for [1]
11c	(measure) change of wavelength $\Delta\lambda$ apply $z = \Delta\lambda/\lambda = v/c$	1 1	**accept** increase or decrease of wavelength **accept** measure the red/blue shift for [1]

12ai	Sound energy produced (at expense of kinetic energy).	1	
12aii	$\Delta p = 2.0 \times (5 + 3.3) = 16.6$ Ns for hammer $p = 16.6$ Ns for mass $v = 16.6 / 10 = 1.7$ m s^{-1}	1 1 1	look for attempt at momentum conservation [1] correct substitution for [1] evaluation for [1] so 0.34 m s^{-1} for [2]
12b	correct shape and period correct phase  	1 1	over the whole time span, any constant amplitude
12ci	$a = -50 \times 0.21 = -10.5$ m s^{-2} $v = 0.85 - 10.5 \times 0.05 = 0.325$ m s^{-1} average speed = 0.5875 m s^{-1} $x = 0.21 + 0.59 \times 0.05 = 0.24$	1 1 1 1	allow ecf from one step to the next **accept** correct use of $s = ut + at^2/2$ for full marks **ignore** use of $x = A\cos(2\pi ft)$
12cii	(do two or more successive calculations) for shorter time intervals	1	

13a	[1] for each correct arrow 	2	mark the direction of the arrow if it doesn't pass through the comet
13bi	$E_k = 1/2mv^2$ so $E_k/m = v^2/2$ $E_k/m = (54.6\times10^3)^2/2 = \underline{1.49}\times10^9$ J kg^{-1}	1 1	
13bii	$E_g = -\frac{GMm}{r}$ so $\frac{E_g}{m} = -\frac{GM}{r}$ $(=V_g)$ $= -6.67\times10^{-11} \times 2.00\times10^{30} / 8.82\times10^{10}$ $= -1.5(1)\times10^9$ J kg $^{-1}$ $E_t = E_g + E_k = (-2\times10^7$ J kg$^{-1})$	1 1	**ignore** calculation of total energy, but **accept** -1.2×10^7 J kg^{-1}
13biii	$E_g = -\ 2.5\times10^7$ J kg^{-1} $E_k = -2.0\times10^7 - (-2.52\times10^7) = 5.2\times10^6$ J kg^{-1} so $v = \sqrt{2\times5.2\times10^6} = 3.2\times10^3$ m s^{-1}	1 1 1	calculate new value for E_g using $-GM/r$ for [1] ecf: calculate new E_k by E_t - E_g for [1] ecf: calculate v from E_k for [1] **accept** 2.3×10^3 m s^{-1} for [3]

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