Rewarding Learning

ADVANCED
General Certificate of Education
2018

Physics

Assessment Unit A2 1

assessing

Momentum, Thermal Physics, Circular Motion, Oscillations and Atomic and Nuclear Physics

[AY211]

MONDAY 4 JUNE, AFTERNOON

MARK SCHEME

Subject-specific Instructions

In numerical problems, the marks for the intermediate steps shown in the mark scheme are for the benefit of candidates who do not obtain the final correct answer. A correct answer and unit, if obtained from a valid starting-point, gets full credit, even if all the intermediate steps are not shown. It is not necessary to quote correct units for intermediate numerical quantities.

Note that this "correct answer" rule does not apply for formal proofs and derivations, which must be valid in all stages to obtain full credit.

Do not reward wrong physics. No credit is given for consistent substitution of numerical data, or subsequent arithmetic, **in a physically incorrect equation**. However, answers to subsequent stages of questions that are consistent with an earlier incorrect numerical answer, and are based on physically correct equation, must gain full credit. Designate this by writing **ECF** (Error Carried Forward) by your text marks.

The normal penalty for an arithmetical and/or unit error is to lose the mark(s) for the answer/unit line. Substitution errors lose both the substitution and answer marks, but 10^n errors (e.g. writing 550 nm as 550×10^{-6} m) count only as arithmetical slips and lose the answer mark.

						AVAILABLE MARKS
1	**(a)**		Momentum before collision = momentum after	[1]		
			Closed system/no external forces act	[1]	[2]	
	(b)	**(i)**	p = mv or subs	[1]		
			$v = 19.4\ m\ s^{-1}$	[1]		
			$0.8(mgh) = \frac{1}{2}mv^2$	[1]		
			24 m (ecf from v)	[1]	[4]	
			SE 100% efficiency ans = 19 m scores [3]/[4]			
		(ii)	$2450 - 114 \times 7.5$	[1]		
			$= 114 \times 4.6 + 126\ v$	[1]		
			$8.5\ m\ s^{-1}$	[1]	[3]	9
2	**(a)**	**(i)**	Volume of air trapped and scale to measure V/l	[1]		
			Pressure gauge	[1]		
			Pump/means of applying pressure	[1]	[3]	
		(ii)	Fixed mass of gas/no. of moles	[1]		
			Constant temperature	[1]	[2]	
		(iii)	P is inversely proportional to V		[1]	
	(b)	**(i)**	pV = nRT	[1]		
			n = 355430	[1]		
			1423 kg (ecf no K conversion m = 29170 kg scores [2]/[3])	[1]	[3]	
		(ii)	Subs into $\frac{1}{2}m\langle c^2\rangle = 3/2\ kT$ or $pV = 1/3\ Nm\langle c^2\rangle$	[1]		
			$\langle c^2\rangle = 1787000$	[1]		
			1337	[1]	[3]	12
3	**(a)**	**(i)**	Energy to change temperature of 1 kg by 1 degree		[1]	
		(ii)	Pumice			
			Lower SHC – Idea of less heat energy		[1]	
	(b)	**(i)**	$Q = 750 \times 4.187 \times 82$ (ecf $\Delta\theta$) or Q = 257500	[1]		
			t = E/P or subs (ecf Q)	[1]		
			t = 95.4 s (ecf Q)	[1]	[3]	
		(ii)	Energy losses/not 100% efficient		[1]	6

						AVAILABLE MARKS
4	**(a)**	**(i)**	Rate of change of velocity	[1]		
			velocity changes since direction is changing	[1]		
			$F = ma$	[1]	[3]	
		(ii)	$F = mr\omega^2$ or $F = mv^2/r$	[1]		
			$\omega = 0.15$ rad s^{-1} or $v = 0.90$ m s^{-1}	[1]		
			$F = 18.4$ N	[1]	[3]	
	(b)	**(i)**	$mg = mv^2/r$ or $v^2 = gr$	[1]		
			$v = 13.7$ m s^{-1}	[1]	[2]	
			SE: use of d giving 19.3 m s^{-1} [1]/[2]			
		(ii)	Lose contact with track		[1]	
		(iii)	No change		[1]	10
5	**(a)**		$T = 0.87$ s or $f = 1.15$ Hz	[1]		
			$\omega = 7.23$ (ecf f)	[1]		
			$x = 0.03 \cos (7.23)(12.5)$	[1]		
			–0.022 m	[1]		
			above equilibrium position	[1]	[5]	
			SE -6.5×10^{-4} (using degrees) scores [4]/[5]			
	(b)		Draw a tangent where displacement = 0	[1]		
			Gradient of tangent	[1]	[2]	
	(c)	**(i)**	Forced/driver frequency equal to natural frequency		[1]	
		(ii)	Maximum amplitude		[1]	9
6	**(a)**		subs into $r = r_0 A^{\frac{1}{3}}$	[1]		
			7.0×10^{-15} m	[1]	[2]	
	(b)	**(i)**	moveable microscope	[1]		
			fluorescent screen	[1]	[2]	
		(ii)	P opposite source		[1]	
		(iii)	No air particles for alpha particles to collide with/to cause ionisation		[1]	
	(c)		more curve,	[1]		
			starting earlier	[1]	[2]	8
7	**(a)**		Uses points from a large triangle to find the gradient	[1]		
			Gradient = (–)0.072	[1]		
			Half-life = 9.6 mins (ecf gradient)	[1]	[3]	
	(b)		$0.46 = A_0 e^{-0.072(120)}$ (ecf λ)	[1]		
			2600 Bq	[1]	[2]	5

					AVAILABLE MARKS
8	**(a)**	y-axis 1, 2, 3…. x-axis 10, 20, 30…	[1] [1]	[2]	
	(b)	Energy is released when binding energy per nucleon increases Description of fission Description of fusion Nuclei to right of peak undergo fusion to move up curve Nuclei to right of peak undergo fission to move up curve	[1] [1] [1] [1] [1]	[5]	
		Quality of written communication		[2]	9
9	**(a)**	Moderator, Graphite/Water/Beryllium Control Rods, Boron/Cadmium/Indium/Silver	[1] [1]	[2]	
	(b)	**(i)** 2		[1]	
		(ii) Mass diff = 0.1857 u conversion to kg 3.083×10^{-28} (ecf mass diff) E = 2.774×10^{-11} (ecf m) Number = 3.604×10^{10} (ecf E)	[1] [1] [1] [1]	[4]	7
10	**(a)**	e.g. Cathode ray tube, X-ray tube, diode, fluorescent bulb		[1]	
	(b)	**(i)** $v^2 = \frac{2hf}{m} - \frac{2W}{m}$ Clear mapping to y = mx + c	[1] [1]	[2]	
		(ii) Heading $m^2\ s^{-2}$ Values ($\times 10^{10}$) to 3 s.f.: 3.28, 8.24, 13.2, 17.0, 19.8 10^n correct	[1] [1] [1]	[3]	
		(iii) y-axis labelled and scaled Points correct ([–1] each incorrect) Best fit line	[1] [2] [1]	[4]	
		(iv) Uses a large triangle to calculate gradient Gradient quality $1.5 \pm 0.1 \times 10^{-3}$ (10^n ecf from y-axis values) Subs gradient and point from bfl into equation Calculation of W in J from their values (guide 3.49×10^{-19}) J–eV conversion, guide 2.18 eV	[1] [1] [1] [1] [1]	[5]	15
				Total	**90**