AQA

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 5451
Specification A

PA02 Mechanics and Molecular Kinetic Theory

Mark Scheme

2005 examination – June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Instructions to Examiners

1   Give due credit to alternative treatments which are correct. Give marks for what is correct; do not deduct marks because the attempt falls short of some ideal answer. Where marks are to be deducted for particular errors specific instructions are given in the marking scheme.

2   Do not deduct marks for poor written communication. Refer the script to the Awards meeting if poor presentation forbids a proper assessment. In each paper candidates may be awarded up to two marks for the Quality of Written Communication in cases of required explanation or description. Use the following criteria to award marks:

    2 marks: Candidates write legibly with accurate spelling, grammar and punctuation; the answer containing information that bears some relevance to the question and being organised clearly and coherently. The vocabulary should be appropriate to the topic being examined.

    1 mark: Candidates write with reasonably accurate spelling, grammar and punctuation; the answer containing some information that bears some relevance to the question and being reasonably well organised. Some of the vocabulary should be appropriate to the topic being examined.

    0 marks: Candidates who fail to reach the threshold for the award of one mark.

3   An arithmetical error in an answer should be marked AE thus causing the candidate to lose one mark. The candidate's incorrect value should be carried through all subsequent calculations for the question and, if there are no subsequent errors, the candidate can score all remaining marks (indicated by ticks). These subsequent ticks should be marked CE (consequential error).

4   With regard to incorrect use of significant figures, normally two, three or four significant figures will be acceptable. Exceptions to this rule occur if the data in the question is given to, for example, five significant figures as in values of wavelength or frequency in questions dealing with the Doppler effect, or in atomic data. In these cases up to two further significant figures will be acceptable. The maximum penalty for an error in significant figures is **one mark per paper**. When the penalty is imposed, indicate the error in the script by SF and, in addition, write SF opposite the mark for that question on the front cover of the paper to obviate imposing the penalty more than once per paper.

5   No penalties should be imposed for incorrect or omitted units at intermediate stages in a calculation or which are contained in brackets in the marking scheme. Penalties for unit errors (incorrect or omitted units) are imposed only at the stage when the final answer to a calculation is considered. The maximum penalty is **one mark per question**.

6   All other procedures, including the entering of marks, transferring marks to the front cover and referrals of scripts (other than those mentioned above) will be clarified at the standardising meeting of examiners.

PA02 Mechanics and Molecular Kinetic Theory

Question 1			
(a)		curve A below original, curve B above original ✓ both curves correct shape ✓	**2**
(b)	(i)	(use of $pV = nRT$ gives) $130 \times 10^3 \times 0.20 = n \times 8.31 \times 290$ ✓ $n = 11$ (mol) ✓ (10.8 mol)	
	(ii)	(use of $E_k = {}^3/_2\, kT$ gives) $E_k = {}^3/_2 \times 1.38 \times 10^{-23} \times 290$ ✓ $= 6.0 \times 10^{-21}$ J ✓	**5**
	(iii)	(no. of molecules) $N = 6.02 \times 10^{23} \times 10.8\ (= 6.5 \times 10^{24})$ total k.e. $= 6.5 \times 10^{24} \times 6.0 \times 10^{-21} = 3.9 \times 10^4$ J ✓ (allow C.E. for value of n and E_k from (i) and (ii)) (use of $n = 11$ (mol) gives total k.e. $= 3.9\,(7) \times 10^4$ J)	

Question 2			
(a)	(i)	horizontal component $= 850 \times \cos 42$ ✓ $\qquad\qquad\qquad = 630$ N ✓ (632 N)	
	(ii)	vertical component $= 850 \times \sin 42 = 570$ N ✓ (569 N) (if mixed up sin and cos then CE in (ii))	**5**
	(iii)	weight of girder $= 2 \times 570 = 1100$ N ✓ (1142 N) (use of 569 N gives weight $= 1138$ N) (allow C.E. for value of vertical component in (ii))	
	(iv)	arrow drawn vertically downwards at centre of girder ✓	

Question 3			
(a)		weight/gravity causes raindrop to accelerate/move faster (initially) ✓ resistive forces/friction **increase(s)** with **speed** ✓ resistive force (eventually) equals weight ✓ [or upward forces equal downward forces] resultant force is now zero ✓ [or forces balance or in equilibrium] no more acceleration ✓ [or correct application of Newton's Laws] [if Newton's third law used, then may only score first two marks]	**Max 4**
(b)	(i)	$E_k\ (= \tfrac{1}{2}\, mv^2) = \tfrac{1}{2} \times 7.2 \times 10^{-9} \times 1.8^2$ ✓ $\qquad\qquad = 1.2 \times 10^{-8}$ J ✓ (1.17×10^{-8} J)	
	(ii)	work done $(= mgh) = 7.2 \times 10^{-9} \times 9.81 \times 4.5$ ✓ $\qquad\qquad\qquad = 3.2 \times 10^{-7}$ J ✓ (3.18×10^{-7} J)	**4**
(c)		$v_{\text{resultant}} = \sqrt{(1.8^2 + 1.4^2)}$ ✓ $= 2.2(8)$ m s^{-1} ✓ $\theta = \tan^{-1}(1.4/1.8) = 38°$ ✓ (37.9°) [or correct scale diagram]	**3**

Question 4			
(a)		lead particles fall and lose potential energy (as tube is inverted) ✓ this is converted to kinetic energy ✓ kinetic energy converted into heat energy on impact ✓	3
(b)	(i)	E_p (= mgh) = $0.025 \times 9.81 \times 1.2$ = 0.29(4) J ✓	
	(ii)	total change of energy (= 50×0.294) = 15 J ✓ (14.7 J) (use of 0.29 gives 14.(5) J) (allow C.E. for value of E_p from (i))	4
	(iii)	(use of $\Delta Q = mc\Delta\theta$ gives) $14.7 = 0.025 \times c \times 4.5$ ✓ c = 131 J kg^{-1} K^{-1} ✓ (130.7 J kg^{-1} K^{-1}) (use of 15 from (ii) gives 133 J kg^{-1} K^{-1}) (allow C.E. for value of energy from (ii))	

Question 5			
(a)	(i)	(change in momentum of A) = $-$ ✓ 25×10^3 ✓ kg m s^{-1} (or N s) ✓	4
	(ii)	(change in momentum of B) = 25×10^3 kg m s^{-1} ✓	

(b)						4

	initial vel/m s^{-1}	final vel/m s^{-1}	initial k.e./J	final k.e./J
truck A	2.5	1.25	62500	15600
truck B	0.67	1.5	6730	33750
	✓	✓	✓	✓

(c)		not elastic ✓ because kinetic energy not conserved ✓ kinetic energy is greater before the collision (or less after) ✓ [or justified by correct calculation]	3

Question 6		
(a)	component (parallel to ramp) = $7.2 \times 10^3 \times \sin 30$ ✓ (= 3.6×10^3 N)	1
(b)	mass = $\dfrac{7.2 \times 10^3}{9.81}$ = 734 (kg) ✓ $a = \dfrac{3600}{734}$ = 4.9(1) m s^{-2} ✓	2
(c)	(use of $v^2 = u^2 + 2as$ gives) $0 = 18^2 - (2 \times 4.9 \times s)$ ✓ s = 33(.1) m ✓ (allow C.E. for value of a from (b))	2
(d)	frictional forces are acting ✓ increasing resultant force [or opposing motion] ✓ hence higher deceleration [or car stops quicker] ✓ energy is lost as thermal energy/heat ✓	Max 2

Quality of Written Communication: Q3 (a) and/or Q4 (a)	2