AQA

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

General Certificate of Education

Physics 5451
Specification A

PA02   Mechanics and Molecular Kinetic Theory

Mark Scheme

2007 examination - January 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)	(i)	(use of $N = nN_A$) $N = 0.40 \times 6.02 \times 10^{23} = 2.4 \times 10^{23}$	✓	
	(ii)	(use of $E_k = 3/2kT$) average $E_k = 3/2 \times 1.38 \times 10^{-23} \times 300 = 6.21 \times 10^{-21}$ J	✓✓	**4**
	(iii)	(c.e. from (i) and (ii)) total $E_k = 2.4 \times 10^{23} \times 6.21 \times 10^{-21} = 1500$ J (1490)	✓	
(b)	(i)	mean square speed increases as temperature causes an increase in the (mean) kinetic energy	✓✓	**4**
	(ii)	increases as collisions are more frequent **or** increase rate of change of momentum	✓✓	
			Total	**8**

Question 2			
(a)	(i)	(use of $a = (v - u) \div t$ gives) acceleration $= 29 \div 2.0 = 14.5$ m s^{-2}	✓	
	(ii)	(use of $s = ut + \frac{1}{2}at^2$) $s = \frac{1}{2} \times 14.5 \times 2^2$ $s = 29$ m	✓✓	**4**
	(iii)	(use of $distance = speed \times time$ gives) $s = 29 \times 15 = 435$ m	✓	
(b)	(i)	 reaction time acceleration over 2.0 s constant speed	✓✓✓	**6**
	(ii)	(use of distance = average speed × time distance travelled by antelope $= 2 \times 12.5 + 14.5 \times 25 = 387.5$ ✓	✓✓	
	(iii)	distance $= 100 + 387.5 - 464 = 23$ m ✓ (23.5)	✓	
			Total	**10**

Question 3				
(a)	(i)	(use of $F_H = F \cos \theta$ gives) resultant force = 2 × 6500 cos 35 resultant force = 11 000 N (10 649) (1 out of 2 if only one component given)	✓✓	**4**
	(ii)	(use of work = force × distance gives) work = 11 000 × 1.5 × 60 work = 990 000 J (958 408) (if use 10 649 then 960 000 J)	✓✓	
(b)		there is an opposing force **or** mention of friction/drag work is done on this force **or** overall resultant force is zero	✓✓	**2**
(c)		initially accelerates as horizontal component increases (so) forward force now larger than drag **or** resultant force no longer zero **or** now a resultant forward force eventually reaches new higher constant speed	✓✓✓	**max 3**
			Total	**9**

Question 4				
(a)	(i)	(use of *energy = power × time* gives) energy = 400 × 6 = 2400 J	✓	**4**
	(ii)	energy absorbed = 0.80 × 2400 = 1900 J (c.e. from (i))	✓	
	(iii)	(use of $\Delta Q = mc\Delta\theta$ gives) 1900 = 3.0 × 10^{-2} × 4200 × $\Delta\theta$ (c.e. from (ii)) $\Delta\theta$ = 15 K	✓✓	
(b)		smaller temperature rise as collector only absorbs 400 W when radiation is incident at right angles (absorbs less at other angles) **or** panel absorbs less energy/radiation at different times of day	✓✓	**max 2**
			Total	**6**

Question 5				
(a)		the product of force ✓ and perpendicular distance from a point	✓✓	**2**
(b)	(i)	(use of *moment = force × perpendicular distance* gives) 46 = F × 0.25 cos 40 F = 240 N	✓✓	**4**
	(ii)	increases to a maximum (when shaft is horizontal) and then decreases because the perpendicular distance changes	✓✓	
			Total	**6**

Question 6				
(a)		momentum is a vector quantity hence the momentum of one trolley is positive and the other negative **or** momenta cancel	✓✓	**2**
(b)	(i)	momentum is conserved **or** correct use on Newton 3 (hence A must have the same magnitude of velocity after the collision as B but in opposite direction) since masses equal	✓✓	**4**
	(ii)	collision is not likely to be elastic hence there is a decreases in E_k **or** energy lost to other forms (such as heat)	✓✓	
(c)		time how long it takes trolley to travel a measured distance divide distance by time	✓✓✓	**3**
			Total	**9**

Quality of Written Communication: Q3 (c) and/or Q6 (c)	**2**