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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 5451

Specification A

PA02 Mechanics and Molecular Kinetic Theory

Mark Scheme

2008 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.

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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.

GCE Physics, Specification A, PA02, Mechanics and Molecular Kinetic Theory

Question 1		
(a)	**resultant** force must be zero ✓ (**or** forces balance) **resultant** torque must be zero ✓ (**or** acm = cm **or** no turning effect) otherwise object will **accelerate** ✓ (or change direction) otherwise object would rotate/turn (with angular acceleration) ✓	**4**
(b) (i)	(use of $w_1 \times d_1 = w_2 \times d_2$) $U \times 1.1 = 200 \times 1.85$ ✓ $U = 340\,\text{N}$ ✓	**3**
(ii)	CE from (i) $D = 340 - 200 = 140\,\text{N}$ ✓ (or by moments)	
(c)	U must decrease ✓ because greater distance ✓ (means for same moment force can be less) change in D consistent with U ✓ (if U wrong max 1 mark) as U has decreased but weight of pole remained the same ✓ (or $U = D + 200$)	**max 3**
	Total	**10**

Question 2		
(a)	**resultant** force must be zero ✓ because sledge is moving at constant velocity ✓ (or zero acceleration)	**2**
(b)	parallel component = $4.5 \times 9.81 \times \sin 22 = 16.5\,\text{N}$ ✓ perpendicular component = $4.5 \times 9.81 \times \cos 22 = 41\,\text{N}$ ✓ (if components swapped -1) (if no g then 1 max but must have unit as kg)	**2**
(c)	same as (b) (i) e.g. 16.5 N ✓ same as (b) (ii) e.g. 41 N ✓ (ignore units)	**2**
		6

Question 3			
(a)		accelerates uniformly/constantly for first 20 s ✓ (quoting numerical value ok) travels at constant speed (of 15 m s^{-1}) ✓ decelerates (to rest) ✓ (**or** negative acceleration) (n.b. only need to see uniformly/constant once)	**3**
(b)	(i)	(use of $p = mv$) p = 1200 × 15 ✓ p = 18000 N s ✓	**4**
	(ii)	rate of change of momentum = 18000/20 = 900 N ✓	
	(iii)	(use of *distance* = *average speed* × *time*) distance = (15 + 0)/2 × 20 distance = 150 m ✓	
		Total	**7**

Question 4			
(a)	(i)	(use of $P \times t = mc\Delta\theta$) 2500 × t = 1.2 × 4200 × 80 ✓ t = 16(1) s ✓	**4**
	(ii)	(use of $P \times t = mL$) 2500 × t = 0.10 × 1.2 ✓ × 2.3 × 10^6 t = 110 s ✓	
(b)		some (thermal) energy/heat transferred to kettle ✓ heat is lost to the surroundings ✓ **or** kettle not 100% efficient/power not 2.5 kW **or** takes time for heat to be transferred to water **or** water may evaporate (before boiling)	**2**
		Total	**6**

Question 5			
(a)	(i)	(use of $pV = nRT$) V = 6.7 × 8.31 × (273 + 25)/110000 ✓ V = 0.15 m^3 ✓	**5**
	(ii)	(use of average kinetic energy = 3/2 kT) average kinetic energy = 3/2 × 1.38 × 10^{-23} × (273 + 25) = 6.2 × 10^{-21} J ✓ **if not** used Kelvin then no marks for (a) (i) or (ii)	
	(iii)	(if the average kinetic energy is doubled then) temperature is doubled ✓ (hence) pressure is doubled (as volume and amount of gas is constant) ✓ n.b. can be shown by calculation	
(b)	(i)	molecules have no preferred directions ✓ with a range of speeds ✓ (**or** different speeds) **or** average velocity = 0 **or** no forces between molecules (except during collisions)/molecules move freely	**3**
	(ii)	a collision in which (momentum and) kinetic energy is conserved ✓	
		Total	**8**

Question 6			
(a)		potential energy to kinetic energy ✓ (ignore mention of heat/sound)	**1**
(b)	(i)	gain of E_k = loss of E_p ½ mv^2 = mgh ½ × 250 × v^2 = 250 × 9.81 × 4.5 v^2 = 88.29 v = 9.4 m s^{-1} (if use g = 10 m s^{-2} then -1 (answer 1.06 m s^{-1}))	**4**
	(ii)	(use of p = mv) p = 250 × 9.4 = 2350 N s ✓ (if g = 10 m s^{-2} then get 2694 N)	
	(iii)	(use m_1u = m_2v) 2350 = (250 + 2000) v ✓ v = 1.0(4) m s^{-1} ✓ (if g = 10 m s^{-2} then get 1.06 m s^{-1}) **if** omit 250 kg then -1 (answer 1.18 m s^{-1})	
(c)	(i)	(use of E_k = ½mv^2) CE from (b) (iii) E_k = ½ × 2250 × 1.042 ✓ = 1200 J (1217 J) ✓	**4**
	(ii)	(use of *work done* = *force* × *distance*) (can use *force* = *mass* × *acceleration*) 1217 = F × 0.25 ✓ F = 4900 N ✓ if include loss of E_p then get 26940 N and full credit if use loss of E_p but ignore E_k then -1 mark	
(d)		resistive force from the ground will increase ✓ as pile gets deeper in the ground ✓	**2**
		Total	**11**

Quality of Written Communication Q1 (c) and/or Q3 (a)	**2**