Version 1.0: 0807

ASSESSMENT and QUALIFICATIONS ALLIANCE

## General Certificate of Education

# Physics 5451

*Specification A*

## PA02 Mechanics and Molecular Kinetic Theory

# Mark Scheme

*2007 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.



Set and published by the Assessment and Qualifications Alliance.

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*Dr Michael Cresswell Director General*

## 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).

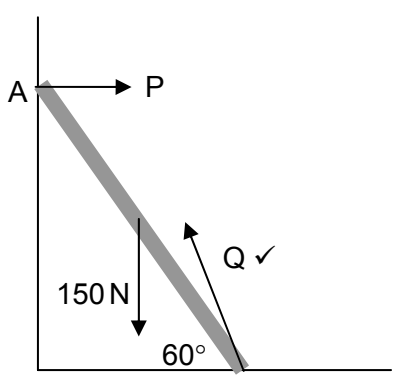
**4** With regard to incorrect use of significant figures, normally two, three or four significant figures will be acceptable. Exceptions to this rule occur if the data in the question is given to, for example, five significant figures as in values of wavelength or frequency in questions dealing with 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) | gradient (or slope or steepness) is changing ✓<br>**or** graph a curve (**or** not a straight line) | **1** |
| (b) | $25 \pm 3$ m ✓ | **1** |
| (c) | (use of *speed* = *distance* ÷ *time* gives)<br>speed = 100 ÷ 11<br>speed = $9.1 \pm 0.2$ m s$^{-1}$ ✓ | **1** |
| (d) (i) | constant acceleration ✓<br>**or** acceleration stays the same<br>**or** velocity increases uniformly with time | **3** |
| (ii) | (use of $s = ut + \frac{1}{2} at^2$ gives)<br>$a = 2 \times 100 \div (11^2)$ ✓<br>$a = 1.7$ m s$^{-2}$ ✓ | |
| | **Total** | **6** |

| Question 2 | | | |
|---|---|---|---|
| (a) | (i) | to balance (**or** oppose) the weight ✓<br>**or** stop ladder moving downwards | **2** |
| | (ii) | to balance P ✓ **or** stop slipping or stop ladder moving right | |
| (b) | |  <br>correct arrow ✓ | **1** |
| (c) | (i) | 43 N ✓ | **2** |
| | (ii) | 150 N ✓ | |
| (d) | | increases (in magnitude) ✓<br>as greater downward force (**or** vertical component increase) ✓<br>direction moves closer to vertical ✓ | **3** |
| | | **Total** | **8** |

| Question 3 | | |
|---|---|---|
| (a) (i) | (use of $pV = nRT$ gives)<br>$4.2 \times 10^5 \times 8.2 \times 10^{-3} = n \times 8.31 \times 295$ ✓<br>$n = 1.4$ (moles) ✓ | **3** |
| (ii) | (use of $E_k = 3/2kT$ gives)<br>average $E_k = 3/2 \times 1.38 \times 10^{-23} \times 295 = 6.1 \times 10^{-21}$ J ✓ | |
| (b) (i) | mean (square) speed decreases ✓<br>since mean $E_k$ decreases ✓ | **4** |
| (ii) | decreases ✓<br>since molecular collisions with walls less frequent ✓<br>**or** rate of change of momentum is less | |
| (c) | as same number of molecules (**or** moles) ✓<br>(and) same increase or change in (average) $E_k$ ✓ | **2** |
| | **Total** | **9** |

| Question 4 | | |
|---|---|---|
| (a) (i) | (use of $\Delta Q = mc\Delta\theta$ gives)<br>thermal energy = $.022 \times 2100 \times 12$ ✓<br>thermal energy = 55(4) J ✓ | **3** |
| (ii) | (use of $\Delta Q = mL$ gives)<br>thermal energy = $0.022 \times 3.3 \times 10^5$ = 7260 J | |
| (b) (i) | (use of $\Delta Q = mc\Delta\theta$ gives)<br>$m \times 4200 \times (22 - 8)$ ✓ = 7260 + 554 + $0.022 \times 4200 \times 8$ ✓<br>$m$ = 8553.2 ÷ 58800 = 0.14(5) kg ✓ | **4** |
| (ii) | no heat loss/gain from surroundings ✓<br>**or** no heat transferred to cup<br>**or** all ice melted<br>**or** all water in cup at 8 °C<br>**or** heat lost by water is equal to heat gained by ice | |
| | **Total** | **7** |

| Question 5 | | |
|---|---|---|
| (i) | find students weight (**or** mass) ✓<br>measure (vertical) height (of stairs) ✓<br>time (how long it takes student to run up stairs) ✓ | **8** |
| (ii) | using $E_p = mgh$ ✓<br>link measurements to quantities used to calculate $E_p$ ✓<br>divide gain in $E_p$ (**or** work) by time to get power ✓ | |
| (iii) | not all work done goes to $E_p$ ✓<br>ignoring gain in $E_k$ ✓<br>**or** ignoring movement<br>**or** ignoring fiction<br>**or** athlete gets hot<br>**or** body not 100% efficient | |
| | **Total** | **8** |

| Question 6 | | | |
|---|---|---|---|
| (a) | | for a body in equilibrium (or for a stationary body) ✓<br>the sum of the clockwise moments **about any point** is equal to the sum of the anti-clockwise moments ✓ (about the same point) | **2** |
| (b) | (i) | weight of object A/N: 0.40 ✓ \| weight of object B/N: 0.40 ✓ \| weight of object C/N: 0.70 ✓ \| weight of object D/N: 0.10 | **5** |
| | (ii) | (use of $F_1 \times d_1 = F_2 \times d_2$ gives)<br>$0.70 \times d = 0.10 \times 0.08$ ✓<br>$d = 0.011\,\text{m}$ ✓ | |
| | (iii) | T = 0.40 + 0.40 = 0.80 N ✓ | |
| (c) | (i) | beam (holding B) turns clockwise ✓<br>**or** beam tips right<br>**or** moves up | **3** |
| | (ii) | beams falls ✓ | |
| | (iii) | (main) beam rotates clockwise ✓<br>**or** beam tips right<br>all due to because of unbalanced moment ✓<br>(explanation can be attached to any answer)<br>(all three rotations correct 2 max, two rotations correct 1 mark) | |
| | | **Total** | **10** |

| Quality of Written Communication: Q2(d) and/or Q3(b) | **2** |
|---|---|