ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme January 2002

GCE

Physics A

Unit PA02

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 Awardsmeeting 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. However, no candidate may be awarded more than the total mark for the paper. Use the following criteria to award marks:

2 marks: Candidates write with almost faultless accuracy (including grammar, spelling and appropriate punctuation); specialist terms are used confidently, accurately and with precision.
1 mark: Candidates write with reasonable and generally accurate expression (including grammar, spelling and appropriate punctuation); specialist terms are used with reasonable accuracy.
0 marks: Candidates 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 a penalty is imposed if the number of significant figures used by the candidate is one less, or two more, than the number of significant figures used in the data given in the question. 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.

Mechanics and Molecular Kinetic Theory

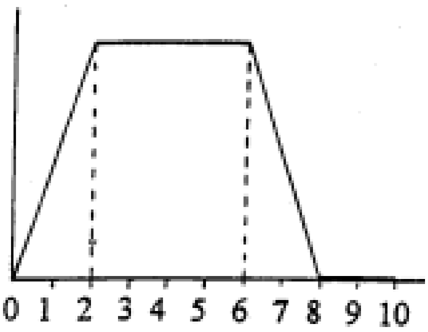
1(a)(i) rate of change of velocity
[or $a = \frac{\Delta v}{t}$] ✓

(ii) (acceleration) has (magnitude and) direction ✓ (*2*)

(b)(i) (acceleration) is the gradient (or slope) of the graph ✓

(ii) (displacement) is the area (under the graph) ✓ (*2*)

(c) velocity



graph to show:

(linear) increase to t = 2.0 ± 0.2 s ✓
uniform velocity between 2.0 s and 6.0 s✓
(linear) decrease from 6.0 ± 0.2 s to 8.0 s ✓
zero velocity after t = 8.0 s ✓

(*4*)
(*8*)

2(a)(i) graph:
scales (points spread over at least half graph paper, each) ✓
correct points (plotted within ½ square) ✓
best fit line (if origin shown, line must pass through it) ✓

E_k at 350 K = 7.22 × 10^{-21} J (accept 7.23 to 7.27) ✓

(ii) gradient (= $\frac{(8.28-6.21)\times10^{-21}}{400-300}$)
= 2.07 × 10^{-23} (J K^{-1}) (accept 2.00 to 2.15) ✓

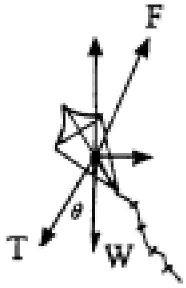
$\left(\text{use of } \frac{3}{2}kT = E_k \text{ gives}\right)$ gradient = $\frac{3}{2}k$ ✓ (accept C.E. for gradient)

$k = \left(\frac{2\times2.07\times10^{-23}}{3}\right)$ = 1.38 × 10^{-23} ✓ J K^{-1} ✓ (*8*) (b)(i) kinetic energy is conserved ✓

(ii) time of collision is negligible (compared to time between collisions)
[or large number of molecules,
volume negligible (compared to volume of container),
no intermolecular forces,
rapid random motion] ✓

(iii) temperature proportional to E_k ✓
at 0 K, E_k would be zero ✓
[or sketch graph of E_k vs T/K to give straight line through origin ✓
graph explained ✓] (*4*)
(*12*)

3(a)



components at right angles ✓
vertical component in line with weight ✓
(both components to start from the •)
(*2*)

(b)(i) (horizontal component) = 25 sin θ = 12 (or 13) N (12.5) ✓
(± 0.5 N if scale drawing)

(ii) (vertical component) = 25 cos θ = 22 N (21.7) ✓
(± 0.5 N if scale drawing) (*2*)

(c)(i) vertical component of F = 21.7 + 2.5 = 24 N (24.2)
[or 25 (24.5)] ✓ (allow C.E. from (b))

(ii) horizontal component of F.= 12 (or 13) N ✓ (12.5) (allow C.E. from (b))

(iii) $F = \sqrt{(12.5^2 + 24.2^2)}$ ✓ (allow C.E. from parts (I) and (ii))
= 27 N (27.2) [or 28 (28.2)] ✓ (26 N to 29 N if scale drawing)
[if θ measured on diagram and F cosθ used, ✓ ✓ (same tolerance)] (*4*)
(*8*)

4(a) sum of clockwise moments equals sum of anticlockwise moments ✓
for a body in equilibrium ✓ (*2*)

(b) point in the body through which the weight/mass (appears to) acts
[or point where resultant torque/moment is zero]
[or point where body would balance] ✓ (*1*)

(c)(i) towards A ✓

so that weight of ruler ✓
provides balancing moment ✓

(ii) (moments about pivot give) $1.0 \times (0.30 - d) = 0.50 \times d$ ✓
$1.5\,d = 0.30$ and $d = 0.20$ m ✓ (*5*)
(*8*)

5(a) decreases for the first four seconds ✓
zero for the remaining six seconds ✓ (*2*)

(b) $E_k = ½ \times 1.4 \times 10^3 \times 16^2$ ✓
$= 1.8 \times 10^5$ J ✓
(accept $v = 15$ m s^{-1} from misleading graph and $E_k = 1.6 \times 10^5$ J) (*2*)

(c) (use of $P = Fv$ gives) $20 \times 10^3 = F \times 30$ ✓
$F = 670$ N ✓ (*2*)
(*6*)

6(a) loss of potential energy = $m \times 9.81 \times 6.0$ ✓
gain in kinetic energy = loss of potential energy ✓
$½mv^2 = 58.9\,m$ gives $v = 10.8$ (m s^{-1}) (≈11 m s^{-1}) ✓ (*3*)

(b) loses potential energy (as it moves to B) ✓
gains kinetic energy (as it moves to B) ✓
regains some potential energy at the expense of kinetic energy as it moves from B to C ✓
some energy lost as heat (due to friction) ✓ (*4*)
(*7*)

7(a) ball bearing accelerates at first as resultant force is downwards ✓
resistive force increases with speed ✓
when resultant force on ball is zero, terminal velocity reached ✓ (*3*)

(b) show ball bearing takes same time ✓
to travel equal distances ✓
[or measure velocity at different points ✓with appropriate method ✓] (*2*)
(*5*)

8(a)(i) (use of $v^2 = u^2 + 2as$ gives) $0 = 25^2 - 2 \times 9.81 \times s$ ✓
$19.6\ s = 625$ and $s = 32$ m ✓

(ii) $t = \dfrac{25}{9.81} = 2.5$ s ✓

(iii) (use of $v^2 = u^2 + 2as$ gives) $v^2 = 25^2 - 2 \times 9.81 \times 16$ ✓
(allow C.E. from (a)(i))
and $v = 18\ \text{m s}^{-1}$ ✓ max(*4*)

(b) time to stop the ball is greater ✓
∴ rate of change of momentum is less ✓
[or work done on ball is the same but greater distance ✓∴ less force ✓] (*2*)
(*6*)

The Quality of Written Communication marks are awarded primarily for the quality of answers to Q6(b) and Q7(a).