ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme June 2002

GCE

Physics A

Unit PA02

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Unit 2: Mechanics and Molecular Kinetic Theory

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. 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 who fail to reach the threshold for the award of one mark.

3 An arithmetical error in an answer should be marked A.E. 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 C.E. (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 S.F. and, in addition, write S.F. 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.

1(a) AB: (uniform) acceleration ✓
BC: constant velocity/speed or zero acceleration ✓
CD: negative acceleration or deceleration or decreasing speed/velocity ✓
DE: stationary or zero velocity ✓
EF ; (uniform) acceleration in opposite direction ✓ (*5*)

(b) area under the graph ✓ (*1*)

(c) distance is a scalar and thus is the total area under the graph
[or the idea that the train travels in the opposite direction] ✓
displacement is a vector and therefore the areas cancel ✓ (*2*)
(*8*)

2(a) p: pressure and V: volume ✓
N: number of molecules ✓
m: mass of one molecule/particle/atom ✓

$\overline{c^2}$:mean square speed ✓ (*4*)

(b)(i) molecules have a range of speeds ✓
they have no preferred direction of movement ✓

(ii) elastic collisions
intermolecular forces are negligible (except during collisions)
volume of molecules negligible (compared to volume of container)
time of collisions negligible (compared to time between collisions)
all molecules identical
laws of statistics apply or large number of molecules
Newtonian laws apply
any two ✓ ✓ max(*3*)

(c) molecules collide (with the walls) ✓
walls exert a force on the molecules ✓
molecules exert an (equal) force (on the walls) ✓
creating pressure ✓
molecule momentum changes max(*4*)
(*11*)

3(a) adequate scale ✓
points plotted correctly ✓
best fit line (at least a point to right and left of line) ✓ (*3*)

(b) use of triangle for at least half line ✓
gradient $\left(=\frac{11.6}{208}\right) = 0.056 \pm 0.004$ (°C/s) ✓ (*2*)

(c) $\left(P = \frac{Q}{t} = \frac{mc\Delta T}{t}\right)$ gives $48 = c \times (1.0) \times 0.056$ ✓
$c = 860 \pm 60$ J kg^{-1} K^{-1} (or J kg^{-1} °C^{-1}) ✓ (*2*)

(d) (use of $E_{th} = ml$ gives) $48 \times 200 = 32 \times 10^{-3} \times l$ ✓
$l = 3.0 \times 10^5$ J kg^{-1} ✓
sensible assumption, e.g. no heat lost to surroundings or temperature
does not change or heat is transferred to ice ✓ (*3*)
(*10*)

4(a)(i) length of card
[or distance travelled by trolley A] ✓
time at which first light gate is obscured
[or time taken to travel the distance] ✓

(ii) time at which second light gate is obscured
[or distance travelled after collision and time taken] ✓ (*3*)

(b) momentum = mass × velocity ✓
mass of each trolley ✓
(check whether) $p_{initial} = p_{final}$ ✓ max(*2*)

(c) incline the ramps ✓
until component of weight balances friction ✓
[or identify where the friction occurs ✓
sensible method of reducing ✓] (*2*)
(*7*)

5(a) (use of $F = ma$ gives) $F = 1.3 \times 10^3 \times 2.5$ ✓
$= 3250$ N ✓(3.25×10^3) (*2*)

(b)(i) driving force = 3250 + 410 = 3660 N ✓
(allow C.E. from (a))

(ii) (use of $P = Fv$ gives) $P = 3660 \times 2.2$ ✓
(allow C.E. from(i))
$= 8100$ W ✓ (8.1×10^3) (*3*)

(c) (component of) car's weight opposes motion
[or overcomes gravity
or more work is done as car gains potential energy] ✓ (*1*)
(*6*)

6(a) (rate of change of horizontal) displacement is constant ✓
hence (horizontal) velocity is constant ✓
thus no (horizontal) force acting ✓ max(*2*)

(b) there is a vertical force
[or weight/force of gravity acting on ball] ✓
ball therefore accelerates (in vertical direction) ✓
acceleration is constant ✓ max(*2*)

(c)(i) (horizontal) displacement would be less ✓

(ii) (vertical) displacement or acceleration would be less ✓
effect would increase with time ✓
[or air resistance increases with speed until equals weight ✓
hence reaches terminal velocity/speed ✓] (*3*)
(*7*)

7(a)(i) $E_p = mg\Delta h$ ✓
$= 5.8 \times 10^{-2} \times 9.8(1) \times 1.5 = 0.85$ J ✓

(ii) 0.85 J ✓
(allow C.E. for value of E_p from (i))

(iii) (use of $E_k = \frac{1}{2}mv^2$ gives) $0.85 = 0.5 \times 5.8 \times 10^{-2} \times v^2$ ✓
(allow C.E. for answer from (ii))
($v^2 = 29.3$) $v = 5.4$ m s^{-1} ✓

(iv) (use of $p = mv$ gives) $p = 5.8 \times 10^{-2} \times 5.4$ ✓
(allow C.E. for value of v from (iii))
$= 0.31$ N s ✓ (*7*)

(b) $\left(\text{use of } F = \frac{\Delta(mv)}{\Delta t} \text{ gives}\right)$ $F = \frac{0.31}{0.010}$ ✓
(allow C.E. for value of p from (iv))
$= 31$ N ✓

[or $a = \frac{5.4}{0.010} = 540$ (m s^{-2}) ✓
$F = 5.8 \times 10^{-2} \times 540 = 31$ N ✓] (*2*)

(c) egg effectively stopped in a longer distance ✓
hence greater time and therefore less force on egg ✓
[or takes longer to stop
hence force is smaller as $F = \frac{\Delta(mv)}{t}$]
[or acceleration reduced as it takes longer to stop
thus force will be smaller]

[or some energy is absorbed by container
less absorbed by egg] (*2*)
(*11*)

The Quality of Written Communication marks are awarded primarily for the quality of answers to Q6(a)(b) and Q2(c).