ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme January 2001

GCE

Physics A

Unit PA02

Marking Scheme

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.

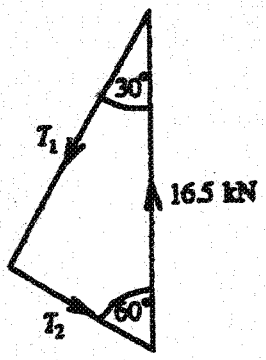
5 No penalties should be imposed for incorrect or omitted units at intermediate stages in a calculation or which are contained in brackets in the marking scheme. Penalties for unit errors (incorrect or omitted units) are imposed only at the stage when the final answer to a calculation is considered. 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.

UNIT PA02

1(a) resultant force = zero
(or the forces can be represented in magnitude and direction by the three sides of a triangle taken in order) ✓ *(1)*

(b)



scale drawing :
sensible scale used and stated ✓
arrows shown correctly ✓
one length measurement correctly stated ✓
both scale conversions correct to give $T_1 = 14$ kN, $T_2 = 8$ kN ✓

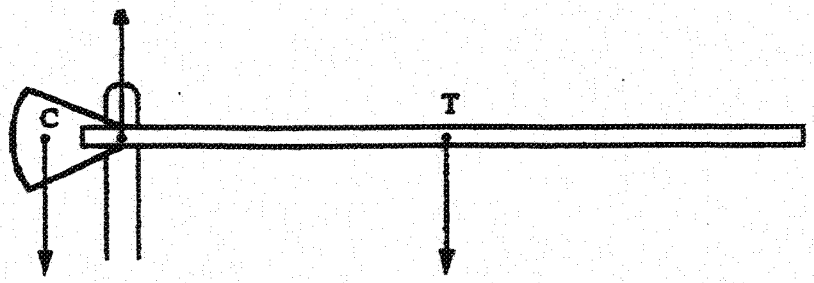
[**or** by calculation: $T_1 = 16.5 \sin 60$ ✓ $= 14.3$ kN ✓
$T_2 = 16.5 \cos 60$ ✓ $= 8.3$ kN ✓]

[**or** by resolving forces vertically and horizontally:
$T_1 \sin 30 = T_2 \sin 60$ ✓
$T_1 \cos 30 + T_2 \cos 60 = 16.5$ (kN) ✓
gives $T_1 = 14.3$ kN ✓ and $T_2 = 8.3$ kN ✓] *(4)*
(5)

2(a)(i) a force multiplied by a distance ✓
perpendicular distance from line of action of the force to the point P ✓
(stated or from diagram)

(ii) N m ✓ *(3)*

(b)(i) force up at pivot ✓
two downward forces at correct points ✓



(ii) weight of tube ($= mg$) $= 12.0 \times 9.81 = 118$ N ✓

(iii) moments about pivot equated ✓
$118 \times 1.6 = W \times 0.3$ gives $W = 629$ (N) ✓ (allow e.c.f. for weight in (ii))

mass $= \frac{629}{9.81} = 64.1$ kg ✓ (allow e.c.f. for W) max (5)

(8)

3(a)(i) **region A**: uniform acceleration
(or (free-fall) acceleration = g (= 9.8(1) m s^{-2})) ✓
force acting on parachutist is entirely his weight
(or other forces are very small) ✓

(ii) **region B**: speed is still increasing
acceleration is decreasing ✓ ✓ (any two)
because frictional (drag) forces become significant (at higher speeds)

(iii) **region C**: uniform speed (50 m s^{-1})
because resultant force on parachutist is zero ✓ ✓ (any two)
weight balanced exactly by resistive force upwards (6)

(b) deceleration is gradient of the graph (at t = 13s) ✓
(e.g. 20/1 or 40/2) = 20 m s^{-2} ✓ (2)

(c) distance = area under graph ✓
suitable method used to determine area (e.g. counting squares) ✓
with a suitable scaling factor (e.g. area of each square = 5 m^2) ✓
distance = 335 m (±15 m) ✓ (4)

(d)(i) speed = $\sqrt{(5.0^2 + 3.0^2)} = 5.8$ m s^{-1} ✓

(ii) $\tan\theta = \frac{3}{5}$ gives $\theta = 31°$ ✓ (2)

(14)

4(a) $F \cos 20 = 300$ gives $F = 319$ N ✓ (1)

(b)(i) work done = force × distance moved in direction of force ✓
F is not in the direction of motion ✓

(ii) work done = force × distance = $300 \times 8000 = 2.4 \times 10^6$ J ✓

(iii) power $= \frac{\text{work done}}{\text{time taken}}$ ✓
$= \frac{2.4 \times 10^6}{5.0 \times (60 \times 60)}$ ✓ (allow e.c.f. for work done in (ii))
= 133 W ✓ (allow e.c.f. for incorrect time conversion) (6)

(c) on the level, work is done only against friction ✓
uphill, more work must be done to increase in potential energy ✓
sensible conclusion drawn

(e.g. increased work at constant power requires longer time) ✓ (3)

(10)

5(a) momentum before collision = momentum after collision ✓
provided no external force acts ✓ (2)

(b)(i) $p = mv$ ✓
$10 \times 10^{-3} \times 200 = 2.(0)$ ✓ $\quad kg\,m\,s^{-1}$ (N s) ✓

(ii) total mass after collision = 0.40 kg ✓
$0.40\,v = 2.0$ gives $v = 5.(0)\,m\,s^{-1}$ ✓ (allow e.c.f. from (i)) max(4)

(c)(i) kinetic energy = $\frac{1}{2}mv^2$ ✓
$= \frac{10 \times 10^{-3} \times 200^2}{2}$ ✓ (= 200 J)

(ii) kinetic energy = $\frac{0.40 \times 5.0^2}{2}$ ✓ (= 5.0 J)

(iii) $\Delta Q = 200 - 5 = 195$ (J) $= mc\Delta\theta$ ✓
$\Delta\theta = \frac{195}{10 \times 10^{-3} \times 250} = 78$ K ✓ (allow e.c.f. for incorrect ΔQ) (5)

(d) kinetic energy lost (= potential energy gained) = mgh ✓
$h = \frac{5}{0.40 \times 9.8} = 1.3$ m ✓ (2)

(13)

6(a) number of molecules in a gas is very large
duration of collision much less than time between collisions
total volume of molecules small compared with gas volume
molecules are in random motion
collisions are (perfectly) elastic
there are no forces between molecules ✓ ✓ ✓ ✓ (any four) (4)

(b)(i) heat (energy) transferred to gas from warmer air outside
mean kinetic energy of gas molecules increases
or molecules move faster
momentum of molecules increases
more collisions per second
each collision (with container walls) transfers more momentum
force (per unit area) on container wall increases ✓ ✓ ✓ ✓ (any four)

(ii) $T = 273 + 27 = 300$ K ✓
mean kinetic energy = $\frac{3}{2}kT$
$= 1.5 \times 1.38 \times 10^{-23} \times 300 = 6.2 \times 10^{-21}$ J ✓

(allow e.c.f. for incorrect T) *(6)*

(10)

The Quality of Written Communication marks were awarded primarily for the quality of answers to Q3(a) and Q6(b)(i).