N99/430/H(2)M

INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

MARKSCHEME

November 1999

PHYSICS

Higher Level

Paper 2

17 pages

SECTION A

A1. (a) 5.6×10^{14} Hz *[1]*

Accept (5.4 → 5.8) $\times 10^{14}$ Hz

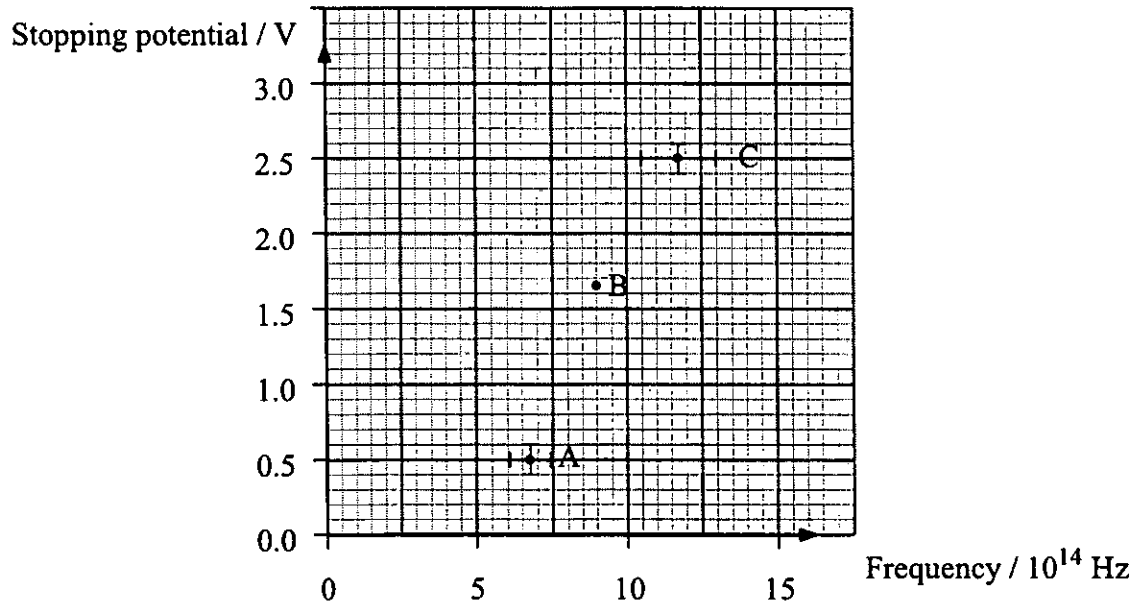
Reject 5.5 Hz

(b) Correct values for stopping potential error bars for A and C (0.5±0.1V, 2.5±0.1V) *[1]*

Correct values for frequency bars for point A 6.75±0.68 *[1]*

Correct values for frequency bars for point C 11.75±1.18 *[1]*

Correct answer is



(c) Use of Einstein's photoelectric equation *[1]*

Identifying the gradient of line = h / e *[1]*

i.e. $h = gradient \times 1.6 \times 10^{-19}$

Correct evaluation of gradient of candidate's line *[1]*

e.g. gradient = 4.0×10^{-15} V s (ignore units)

Correct evaluation of h *[1]*

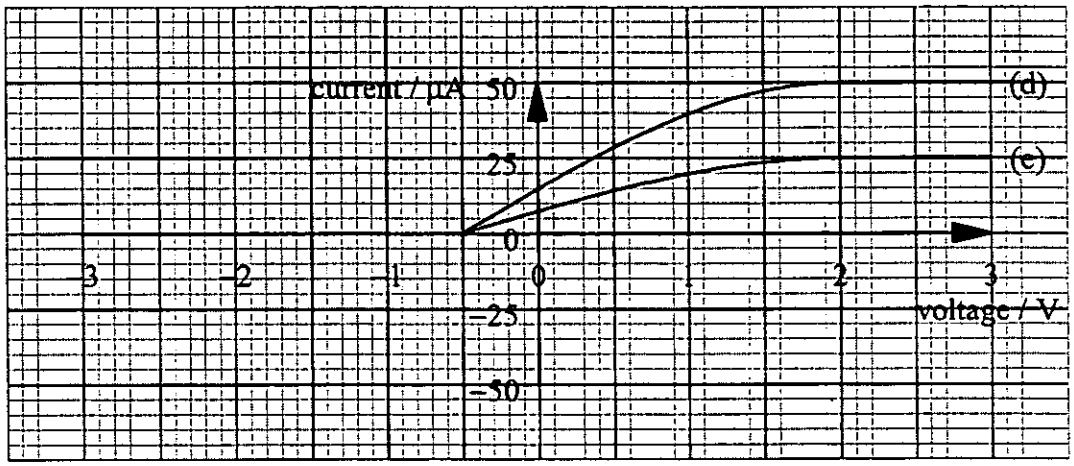
e.g. $h = 4.0 \times 10^{-15} \times 1.6 \times 10^{-19} = 6.4 \times 10^{-34}$ J s

Accept 5.8 → 7.0×10^{-34} J s

Substitution of single value is maximum three out of four.

(d) Top section *i.e.* flat from +2 V and on *[1]*
Stopping potential correctly shown (≈0.5 V). Accept 0.1 → 1.0 V *[1]*
Any line between the above two sections *[1]*
Good shape *[1]*

Answer is



(e) Same stopping potential as above *[1]*
half the maximum current *i.e.* 25 μA *[1]*

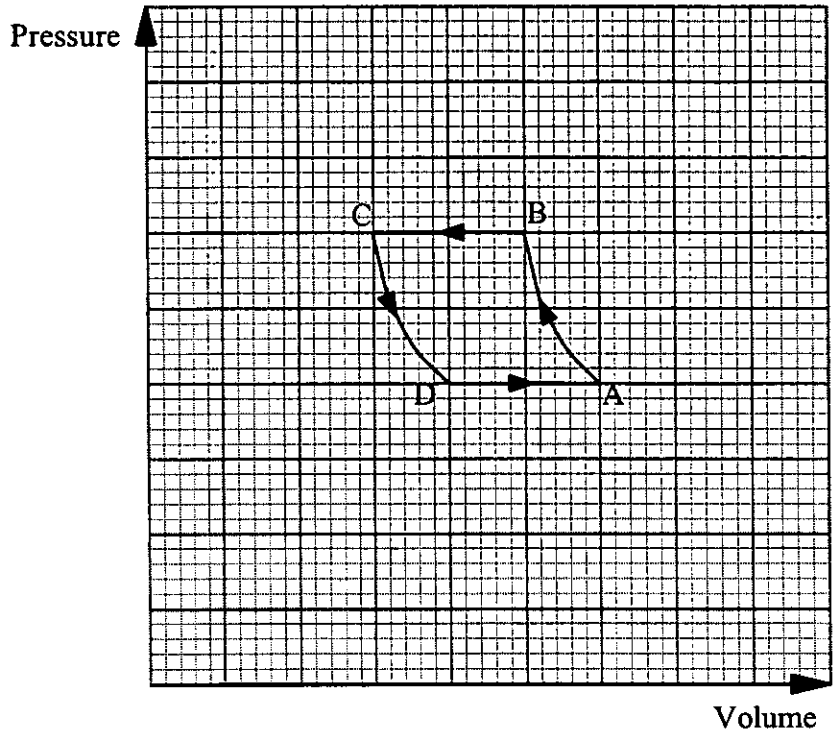
A2. (a) (i) Weight DOWN *[1]*
Tension (tensions) UP (*do not allow friction*) *[1]*

(ii) Vertical pair - Weight DOWN + reaction(s) from ground UP *[1]*
Horizontal pair - Thrust / force from engine RIGHT
- Friction / wind resistance LEFT *[1]*

(iii) Tension ALONG STRING *[1]*
Weight DOWN *[1]*
N.B. Extra (incorrect) forces reduce total awarded by ***[1 mark]*** each

(b) Sensible discussion for (i) - realisation that resultant force = zero *[1]*
Sensible discussion (ii) - realisation that resultant force = zero *[1]*
Sensible discussion (iii) - realisation that resultant force = CPF *[1]*
- idea of where resultant comes from *[1]*
i.e. component of T.

A3. (a) Any closed cycle *[1]*
Shape correct *[1]*
Correct labelling of corners *[1]*



(b) (i) D→A *[1]*
(ii) B→C *[1]*

(c) Any statement of second law *[1]*
Correct and appropriate discussion *[1]*

(d) Use of coefficient of performance = T_{cold} / Temp difference *[1]*
Conversion of temperatures into Kelvin *[1]*
x / 150 = 273 / 25 *[1]*
so x = 1638 = 1.6 kW *[1]*

SECTION B

B1. (a) The alpha particles ionise the air molecules *[1]*
The potential difference across the chamber will cause the ions to migrate *[1]*
Thereby creating a current *[1]*

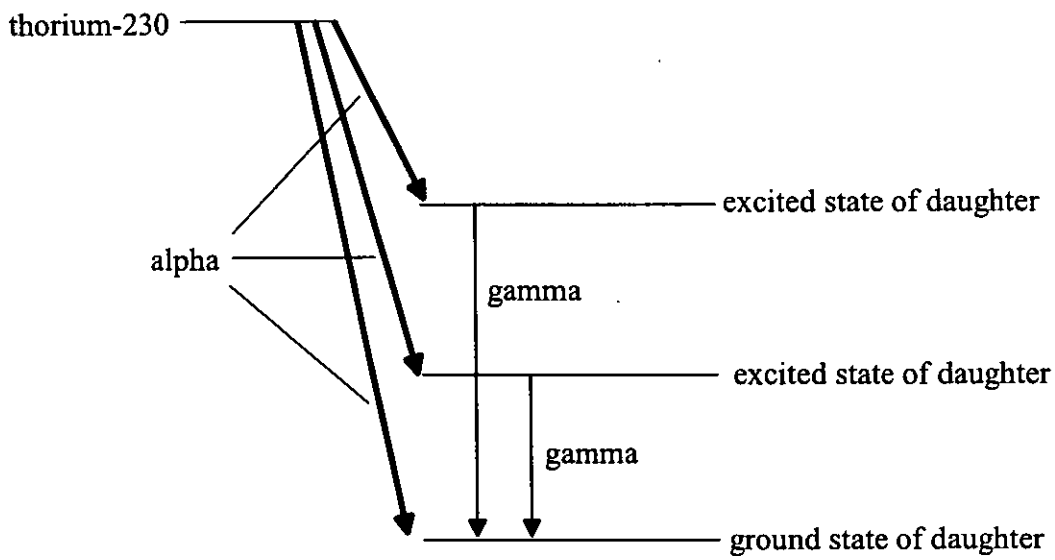
(b) Any assumption *e.g. no recombinations, singly ionised etc.* *[1]*
Number of ionisation events = current / charge from ionisation *[1]*
$= 50 \times 10^{-12} / 1.6 \times 10^{-19}$ *[1]*
$\approx 3 \times 10^{8}$ *[1]*

N.B. do not penalise a candidate that thinks each ionisation contributes 3.2×10^{-19} C and so gets an answer of 1.5×10^{8}

(c) (i) Number of ionisations $= 3 \times 10^{8} / 1500$ *[1]*
$= 2 \times 10^{5}$ *[1]*

(ii) Energy of $\alpha = 2 \times 10^{5} \times 23$ eV *[1]*
= 4.6 MeV *[1]*

(d)



3 energy levels of daughter *[1]*
1 energy level of parent *[1]*
Alpha spectra *[1]*
Gamma spectra *[1]*
Good diagram *[1]*

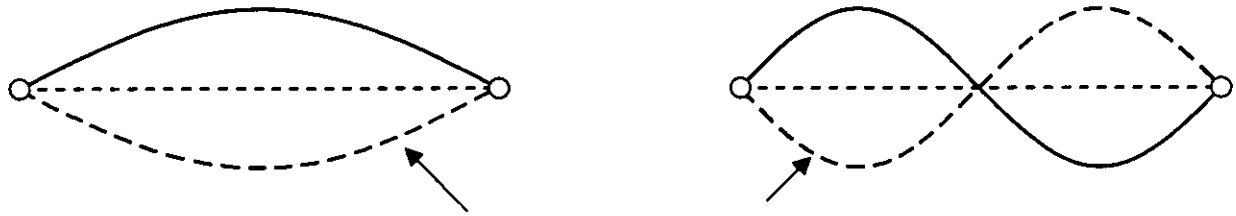
(e) (i) No *[1]*
since long half life means decay rate effectively constant *[1]*

(ii) Use of $\lambda = \ln 2 / t_{1/2}$ *[1]*
$= .693 / 8.0 \times 10^4 \times 3.2 \times 10^7$ *[1]*
$= 2.7 \times 10^{-13}\ s^{-1}$ *[1]*

(ii) Use of $dN/dt = -\lambda N$ *[1]*
so 1500 $= 2.7 \times 10^{-13}\ N$ *[1]*
to give N $= 5.5 \times 10^{15}$ atoms *[1]*
Mass = number of moles $\times$ 230 g *[1]*
$= (5.5 \times 10^{15} / 6.0 \times 10^{23}) \times 230$ *[1]*
$= 2\ \mu g$ *[1]*

(f) Mention of binding energy **or** forces between protons *[1]*
Mention of $E = m c^2$ *[1]*
Good explanation of mass deficiency in terms of energy needed to put the nucleus together *[1]*

B2. (a) Appropriate diagrams here ***[1 mark]*** each *[2]*
e.g.



Fundamental *The candiate does not need to show this dotted line for a mark* Harmonic

(b) l = half wavelength, therefore wavelength = 0.800 m *[1]*
watch for 'ecf'

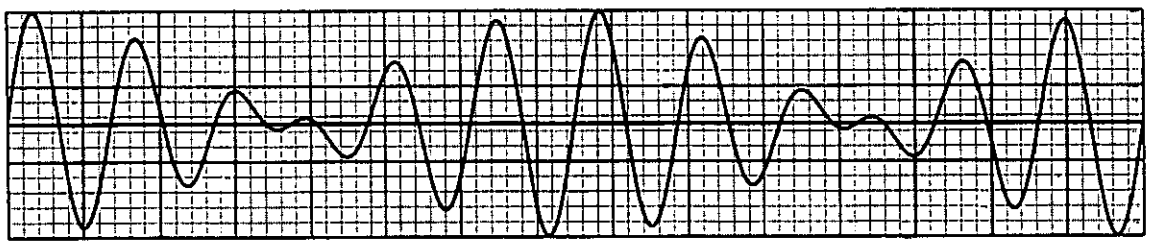
(c) As appropriate: 2 **or** 3 × fundamental *[1]*

(d) use of c = f λ to get c = 352 ms^{-1} *[1]*

Use of $v = \sqrt{\frac{T}{\mu}}$ to get $T = \frac{mv^2}{l}$ *[1]*

$= 0.001 \times 352^2 / 0.4 = 309.76$ N = 310 N *[1]*

(e) Speed constant explicit **or** implied from ratio calculation *[1]*
New wavelength = $0.8 \times 440 / 524 = 0.672$ m *[1]*
New string length = half of this figure, *i.e.* 0.336 m therefore finger placed 6.4 cm from end *[1]*
*(Bald 0.336 m gets **[3 marks]**)*



(f) Sound whose amplitude rises and falls periodically *[1]*
Produced by superposition of two waves of <u>similar</u> frequency *[1]*
At some moment the two waves interfere constructively,
producing constructive interference / loud sound *[1]*
Later the two waves interfere destructively,
producing destructive interference / cancellation of sound *[1]*
Any additional detail / quality gets ***[1 mark]*** each up to a maximum of ***[2 marks]***
e.g. correct diagram for the superposition of the waves; identifying constructive interference section of diagram; knowing that beat frequency = frequency difference etc.

(g) (i) Suitable source *[1]*
*(e.g. single narrow slit **or** distant straight filament)*
Double slit *[1]*
Screen **or** suitable eyepiece *[1]*
*(e.g. travelling microscope **or** micrometer eyepiece)*
Sensible layout with reasonable distances seen / implied *[1]*
N.B.** Use of a laser on a double slit is not correct - award a maximum of **[2 marks]

(ii) Appropriate pattern consisting of fringes *[1]*
Approximately equally spaced *[1]*
Any further quality / detail *[1]*
e.g. correct attempt to sketch intensity distribution etc.

(iii) The two sources are coherent *[1]*
Idea that light arrives at the screen with a phase difference that depends on the path length difference. *[1]*
Bright fringes appear where distances of screen to S_1 and S_2 differ by an integral number of wavelengths (**or** explanation of dark fringes) *[1]*

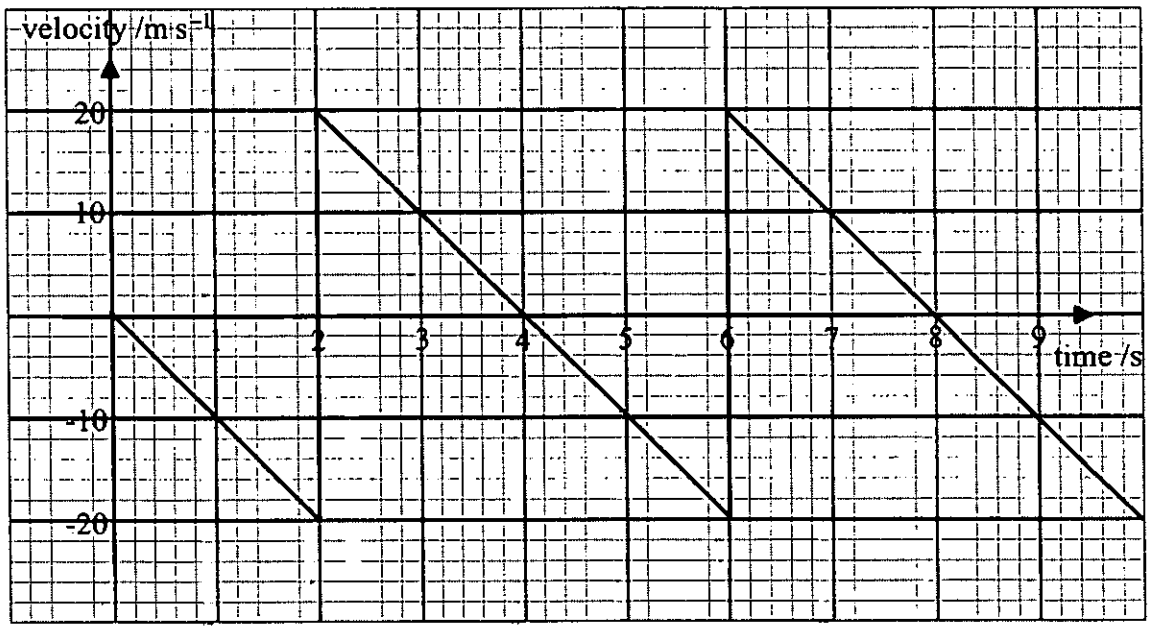
(iv) Central image white *[1]*
Fringes appear multicoloured *[1]*
Since wavelength different *etc.* *[1]*
Any correct extra detail *[1]*
e.g. red (high wavelength) edge further out than blue one.

B3. (a) (i) use of $s = ut + \frac{1}{2} a t^2$ **or** similar plus correct substitution *[1]*
Proper rearrangement to get $t = 2s$ *[1]*
*(**N.B.** watch for t = distance / g!! - award **[0 marks]**)*

(ii) Use of $v = u + at$ **or** similar *[1]*
Proper rearrangement *[1]*
Again - care with student versions!

(iii) Correct maximum value of velocity *[1]*
Correct time period *[1]*
Reversal of velocity *[1]*
Shape *[1]*

Answer is



Accept answer flipped in *x*-axis – *i.e.* positive velocities initially

(iv) Look for:
If the earth and the object are considered then momentum of the system is conserved *[1]*
Plus any other sensible points *[1]*
e.g. Vector nature of momentum
Momentum of object is not conserved — It is accelerated by the gravitational force of the earth *etc.*

(v) No *[1]*
Definition / detailed description of SHM *[1]*
Reason why this is not SHM *[1]*

(b) (i) $0.01 \times 300 = 2.00 \times v$ *[1]*
$v = 1.50 \text{ m s}^{-1}$ *[1]*

(ii) Realisation that work done = change in kinetic energy *[1]*
k.e. $= 1 \times (1.5)^2 = 2.25\text{J}$ *[1]*
Frictional force $= \mu R = 0.4 \times 2 \times 10 = 8.0 \text{ N}$ *[1]*
Work done against friction $= 8.0 \times d$ *[1]*
Therefore $d = 2.25/8 = 28 \text{ cm}$ *[1]*

(c) (i) $\omega = 0.5 \text{ rev /s} = \pi$ radians / s *[1]*
Ang mom $= I\omega$
$= 0.005 \times p = 0.016$ *[1]*
Correct units ($\text{kg m}^2 \text{ s}^{-1}$ **or** J s) *[1]*

(ii) Conservation of angular momentum (or words to that effect) *[1]*
Mention of no external torque *[1]*

(iii) Attempt to use the conservation of angular momentum *[1]*
Calculate of new moment of inertia
$I = 5 \times 10^{-3} \times 30 / 25$
$= 6 \times 10^{-3} \text{ kg m}^2$ *[1]*
Use of new I = old I + $m r^2$ *[1]*
So $r^2 = 0.001 / 0.05 = 0.02$ *[1]*
So $r = 0.141 \text{ m} = 14 \text{ cm}$ *[1]*

B4. (a) (i) Poles such that the field left to right *[2]*
*Essentially two or nothing, but **[1 mark]** possible if only one pole is marked!*

(ii) To reverse the current direction *[1]*
Every 180° / when coil is vertical *[1]*
So that rotation is maintained (or words to that effect) *[1]*

(b) (i) Voltmeter parallel *[1]*
Ammeter series *[1]*

(ii) Use of Power = voltage × current *[1]*
$P = 6V \times 0.50A$ *[1]*
$= 3.0\ W$ *[1]*

(iii) Work done $= 6.0 \times 10 \times 0.8 = 48\ J$ *[1]*
Therefore power $= \frac{48}{24}$ *[1]*
$= 2.0\ W$ *[1]*

(iv) Efficiency $= \frac{\text{Power OUT}}{\text{Power IN}}$ *[1]*
$= \frac{2}{3} = 67\%$ *[1]*

(c) (i) Idea that transformer is made up of two coils around an iron core explicit **or** implied *[1]*
Step-down transformer OR fewer turns on secondary *[1]*
a.c. therefore changing field due to primary *[1]*
Induces changing e.m.f in secondary *[1]*

(ii) Use of turns ratio = p.d. ratio *[1]*
Secondary turns $= (\frac{6}{230}) \times 690 = 18$ *[1]*

(d) (i) *Any three sensible points - **[1 mark]** each, up to maximum of **[3 marks]***
e.g. Remove battery.
Force the coil to rotate
Different connections to coil / replace commutator
Details of new connections *etc.*

(ii) Output sinusoidal *[1]*
Calculation that time period = 0.1 second *[1]*
Correct representation of time period on graph. *[1]*
Calculation of peak p.d for 1st set-up = 14.14 V *[1]*
Realisation that double speed means double the p.d. *[1]*
Correct peak value = 28.3 V *[1]*

N.B. with 'ecf' a graph of time period 0.1 s of peak value = 20 V gets ***[5 marks]***