UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level

MARK SCHEME for the October/November 2011 question paper for the guidance of teachers

8780 PHYSICAL SCIENCE

8780/03 Paper 3, maximum raw mark 80

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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International Examinations

1 **(a)** 8.0 – 9.5 (°C) ; [1]

(b) reversed scale [1]
non-linear, high numbers closer, at least 4 and scale easy to use [1]

[Total: 3]

2 **(a)** +3/3/III allow *3+* [1]

(b) moles CO_2 produced = <u>15</u> [1]

$V = nRT/p \quad = \dfrac{(15 \times 8.31 \times 298)}{100 \times 10^3}$ correct conversion and substitution [1]

0.37(1) m^3 [1]

[Total: 4]

3 **(a)** W = 17 200 N, F = 17 200 N [1]
(must use g = 9.81 or 9.8 Nkg^{-1})

(b) **(i)** <u>use of</u> force/area $\rightarrow$ 17 200/(2.4 × 1.0) [1]

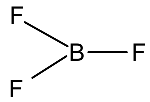
7200 Pa (accept ecf) [1]

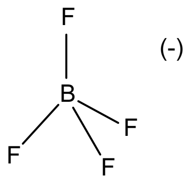
(ii) <u>use of</u> $p = \rho g \Delta h$ [1]
Δh = 7200/(1080 × 100) $\rightarrow$ Δh = 0.67 m (accept ecf) [1]

(c) mass of water displaced = 0.68 × 1.0 × 2.4 × 1080 = 1760 kg [1]

[Total: 6]

4 **(a)** **(i)** BF_3 drawn as trigonal planar BF_4^- drawn as tetrahedral





[2]

allow [1] if two fully-correct dot-and-cross diagrams given in place of both structures

BF_3 named as trigonal planar [1]

BF_4^- angle = 109(½)° [1]

(ii) <u>equal</u> repulsion between 3 bonding pairs [1]

(b) **(i)** dative/coordinate [1]

(ii) lone pair donated from F^- to B allow to BF_3 [1]

[Total: 7]

5 **(a)** **(i)** 1 mm – 1 m [1]

(ii) recognition that it is a diffraction effect [1]
radio waves wavelength much longer than microwaves / microwaves wavelength much less than size of mountain / radio waves wavelength similar to mountain [1]

(b) **(i)** path difference for contributions from slits = *n* wavelengths [1]
so waves in phase (and add)/constructive interference [1]

(ii) path difference for contributions from slits = [*n* + ½] wavelengths [1]
so waves out of phase (and subtract/cancel) / destructive interference [1]

(iii) amplitude = maximum amplitude ÷√2 [1]

(iv) **1.** maxima and minima/fringes move further apart [1]
2. maxima and minima/fringes move closer [1]

[Total: 10]

6 **(a)** $CH_4 + H_2O \rightarrow CO + 3H_2$ [1]

(b) **(i)** quotes/refers to data showing decreased yield as temp. increases [1]
high temp. favours endothermic direction so forwards = exothermic [1]

(ii) fewer molecules/moles on right, high pressure favours direction producing fewer molecules ($\therefore$ higher yield) [1]

(iii) pressure is compromise between rate/yield and cost of maintaining high pressure [1]
allow: pressure used is the maximum economic pressure / is the highest economically viable pressure

(c) **(i)** N_2 and H_2 have only (weak) induced dipole-induced dipole/van der Waal forces of attraction, (strong) hydrogen bonding present between NH_3 molecules [1]
hydrogen bonding much stronger than induced dipole-induced dipole/ van der Waal forces (so more energy/higher temperature needed to separate molecules) [1]

(ii) <u>cooling</u> the mixture allows ammonia to be removed as a <u>liquid</u> [1]
allow a specific statement to the effect that ammonia is removed by condensation

(d) $\Delta H_f = [(-414.5) + 2(-81.0)] - [(-287.0) + (-320.5)]$ [1]
$= 31\,kJ\,mol^{-1}$ [1]

[Total: 10]

7 **(a)** the hydrogen nucleus has less charge / smaller (not less mass) / lower speed [1]

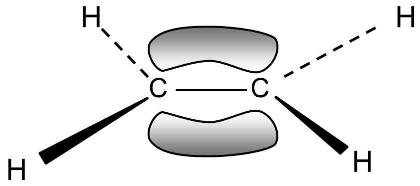
(b) **(i)** attempted use of momentum equation $\rightarrow 5 \times 0.4 = 3 \times 0.4 + 8m$ [1]
$\rightarrow 2 \times 0.4 = 8m_B \rightarrow m = 0.10$ kg [1]

(ii) KE before = $\frac{1}{2} \times 0.4 \times 5^2$ =5.0 J OR KE after = $\frac{1}{2} \times 0.4 \times 5^2 + 1/2 \times 0.1 \times 8^2$ [1]
correct calculation for both (= 5 J) [1]
statement that <u>kinetic</u> energy before = <u>kinetic</u> energy after [1]

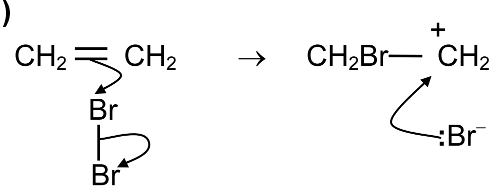
[Total: 6]

8 **(a)** **(i)** σ bonding involves end-on overlap of orbitals / clear diagram [1]
π bonding involves sideways overlap (of 'p' orbitals) / clear diagram [1]

(ii) diagram of ethene showing planar shape and π bond clearly drawn, e.g. [1]



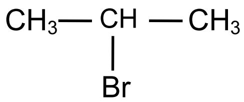
(b) **(i)**



3 curly arrows correctly positioned [1]
correct intermediate bromocarbocation [1]
1,2-dibromoethane [1]

(ii) induced dipole on Br_2, caused by high electron density on C=C bond [1]

(c) **(i)** correct structure for 2-bromopropane – displayed formula expected but allow below as minimum detail: [1]



(ii) alcohol [1]

(iii) H^+ **and** $K_2Cr_2O_7$ **and** heat [1]

(iv) propanone [1]

[Total: 11]

9 **(a)** positive background dough [1]
electrons embedded [1]

(b) mark **(i)** and **(ii)** as one entity
α-particle fired at gold foil [1]

three points, including at least one observation and one linked conclusion, from:
foil very thin/leaf
most go straight through*
* leads to mostly empty space
(very) small percentage deflected through large angles**
** leads to very small/massive nucleus [max 3]

(c) **(i)** two from:
electrons in allowed orbits (accept orbitals/shells)
orbits 'radiationless'
fixed numbers in each orbit [max 2]

(ii) group numbers = number of outer shell electrons [1]
period = number of shells [1]

[Total: 10]

10 **(a)** **(i)** $2I_2 - 8I_3 - 0 \times I_1 = 0 \rightarrow I_3 = 4I_2$ [1]

(ii) I_2 = 1.6 A, I_3 = 0.4 A [1]

(b) ($1 - I_1 - I_2 = 0 \rightarrow 1 - I_1 - 1.6 = 0 \rightarrow$ =) – 0.6 A (or could be done at point **G**) [1]

(c) <u>use of</u> Kirchhoff's 2nd law around suitable loop [1]
E = 13.2 V [1]

[Total: 5]

11 (a) (i) simplest ratio of atoms of each element in a compound/molecule [1]

(ii)

<u>Na</u>	<u>Cl</u>	<u>O</u>	
$\frac{21.6}{23}$	$\frac{33.3}{35.5}$	$\frac{45.1}{16}$	[1]
0.939	0.938	2.82	

= 1 : 1 : 3
= $NaClO_3$ [1]

(b) (i) moles HCl = 21.70 × 0.263/1000 = 5.71 × 10^{-3} (mol) [1]
moles Q_2CO_3 = 0.571/2 = 2.85 × 10^{-3} (mol) [1]
$M_r(Q_2CO_3)$ = 0.394/2.85 × 10^{-3} = 138 [1]

(ii) $A_r(Q)$ = [138 – 60]/2, mark is for 60 [1]
= 39 so Q= K/potassium [1]

[Total: 8]