CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2015 series

8780 PHYSICAL SCIENCE

8780/03 Paper 3 (Structured Questions), maximum raw mark 80

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1 **(a)** positive background cloud with negative particles (electrons) embedded [1]

(b) **(i)** alpha (particles) incident on gold [1]
thin gold/foil/leaf/in a vacuum/detection system [1]

(ii) virtually all the alpha particles were not deflected/very small deflection [1]
remainder deflected through large angles [1]

(iii) positive nucleus [1]
nucleus is very small (compared with the atom) [1]
nucleus contains virtually all the mass (of the atom) [1]

[Total: 8]

2 **(a)** **(i)** $Na_2O + H_2O \rightarrow 2NaOH$ [1]
$SO_3 + H_2O \rightarrow H_2SO_4$ [1]

(ii) nature changes from basic on the left to acidic on the right
OR
sodium oxide is basic **and** sulfur trioxide is acidic [1]

(iii) in basic oxides, the difference in electronegativity between the element and oxygen is large
OR
explanation that the electronegativity of oxygen is high, sodium is low, sulfur is higher than sodium i.e. explains electronegativity differences. [1]

(iv) the ability of a substance to react with / to act as an acid and a base [1]

(b) **(i)** hydrogen bonding [1]

(ii) Van der Waals' / dipole-dipole [1]

(iii) hydrogen bonding is much stronger than Van der Waals' / dipole-dipole
OR
much more energy is needed to separate molecules [1]

[Total: 8]

3 (a) (i) 18.0 squares from graph (at 1.0 ms per square giving T = 18.0 ms) [1]
(frequency =) 55.6 (Hz) [1]

(ii) intensity $\propto$ amplitude^2 [1]

(iii) use of (amplitude 1)^2 leading to 1 : 9 [1]

(b) (i) destructive interference is quiet and constructive interference loud [1]

Either
constructive is (exactly) in phase (with direct wave) [1]
OR
destructive is (180°) out of phase (with direct wave)

reference to extra distance reflected wave travels causing phase difference [1]

(ii) use of $v = f\lambda$ leading to λ = 320/55.6 [1]
= 5.76 (m) [1]
(5.76/4 =) 1.44 m [1]

(iii) the intensities/amplitude of the two waves are different or are not the same/OWTTE [1]

[Total: 11]

4 (a) (n$NaCl$ = 800/58.5 =) 13.68 [1]
(nNa_2CO_3 = ½ × 13.68 =) 6.84 **or** via n$NaHCO_3$ = 13.68 [1]
(mass = 6.84 × 106 =) 725 (g) [1]

(b) (i) (nHCl =) $25.7 \times 10^{-3} \times 0.175 = 4.50 \times 10^{-3}$ (mol) [1]

(ii) (nNa_2CO_3 =) ½ × $4.50 \times 10^{-3} = 2.25 \times 10^{-3}$ [1]
M_r (washing soda) = $0.643 / 2.25 \times 10^{-3}$ = 286 [1]

(iii) M_r (xH_2O) = 286 – 106 = 180 [1]
(x = 180/18 =) 10 [1]

[Total: 8]

5 (a) (i) use of $\Delta E_p = m g \Delta h$ (= $0.314 \times 9.81 \times 0.774$) [1]
= 2.38 (J) [1]

(ii) (E_k =) 2.38 (J) or equal to value in **(a)(i)** [1]

(b) (i) use of $E_k = ½ m v^2$ leading to $v^2 = 2 \times 2.80 / 0.774$ [1]
v = 2.69 ($m s^{-1}$) [1]

(ii) use of mass of bullet × velocity of bullet = mass of [target + bullet] × velocity [1]
($0.024 \times v = 0.774 \times 2.69$)
v = 86.7 ($m s^{-1}$) [1]

(iii) E_k for bullet = $½ \times 0.024 \times 86.7^2$ = 90.2 (J) [1]
E_k for bullet > E_k for target [1]
clear consistent conclusion using the term inelastic / not elastic [1]

[Total: 10]

6 (a) (i) the triple bond (between the nitrogen atoms) is (very) strong [1]

(ii) $N_2 + O_2 \rightarrow 2NO$ [1]

(b) (i) the minimum amount of energy required for a reaction to occur [1]

(ii) correct profile showing a peak between reactants and products
and E_a is clearly < ΔH [1]

the peak is correctly labelled as E_a /+132
and with an arrow going upwards from the reactants line. [1]

the enthalpy change enthalpy change is correctly labelled with ΔH or –226 with an arrow going down from the reactants line [1]

(iii) correct catalysed profile line that starts at the reactants line, ends at the products line and tracks below the non-catalysed profile line **and** is labelled 'C' [1]

(c) (i) E_a(cat) lies to the left of E_a and is on the x-axis [1]

(ii) more / higher proportion of molecules will have $E \geqslant E_a$(cat) [1]
more / a higher proportion of collisions will be successful [1]

[Total: 10]

7 **(a)** minimum four straight vertical lines and starting and finishing on both plates and roughly equally spaced and at right angles to plates [1]
arrows from positive to negative plates [1]

(b) **(i)** no change [1]

(ii) decreases [1]

(c) **(i)** use of $E = V/d$ (= $1560/8 \times 10^{-3}$) [1]
$= 1.95 \times 10^{5}$ **and** $V\,m^{-1}$ or $N\,C^{-1}$ [1]

(ii) 9.03×10^{-13} (N) [1]

(iii) use of $E = F/Q$ leading to $Q = 9.03 \times 10^{-13}/-1.95 \times 10^{5}$ [1]
$= -4.63 \times 10^{-18}$ (C) [1]

(iv) use of $n = Q/q$ = $(-4.63 \times 10^{-18}/1.6 \times 10^{-19} = 28.9)$ [1]
round to whole number / 28 or 29 [1]

[Total: 11]

8 **(a)** Brønsted-Lowry acid: proton donor [1]
strong acid: highly dissociated [1]

(b) **(i)** a temperature of 350–500 °C / Kelvin equivalents [1]
use the catalyst V_2O_5 / vanadium(V) oxide [1]

(ii) there are fewer moles of product than reactant in the equation [1]
(at high pressure) equilibrium moves right / increased yield [1]
to decrease the pressure/number of molecules [1]

(c) **(i)** $(CH_3)_2CHCO_2H + H_2O \rightleftharpoons H_3O^+ + (CH_3)_2CHCO_2^-$ [1]

(ii) potassium cyanide / KCN [1]

(iii) 2-methylpropan(e)nitrile [1]

(iv) 1. not an acid
argues that the –ve response with sodium carbonate means it can't be an acid [1]
2. ketone
argues that +ve 2.4-DNPH and –ve Tollens' means it must be ketone [1]
3. primary alcohol
argues that as **Q** is oxidised to a carboxylic acid, it must be a primary alcohol [1]

(v) clear (structural) formula for 1-hydroxybutan-2-one/4-hydroxybutan-2-one
$CH_3CH_2COCH_2OH$ / $CH_3COCH_2CH_2OH$ [1]

[Total: 14]