CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2012 series

9701 CHEMISTRY

9701/23 Paper 2 (AS Structured Questions), maximum raw mark 60

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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1 In this question, numerical answers should be given to three significant figures.

(a) (i) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ (1)

(ii) M_r $C_6H_{12}O_6 = 180$ (1)

180 g $C_6H_{12}O_6 \rightarrow$ 6 mol CO_2

1200 g $C_6H_{12}O_6 \rightarrow \frac{6 \times 200}{180}$ mol CO_2

= 40.0 mol to 3 sf

allow ecf on wrong equation and/or wrong M_r (1)

(iii) 6.82×10^9 people will produce $6.82 \times 10^9 \times 40.0$ mol CO_2

$= 2.728 \times 10^{11}$ mol CO_2 (1)

2.728×10^{11} mol $CO_2 \equiv 2.728 \times 10^{11} \times 44 = 1.20032 \times 10^{13}$ g

$= 1.20 \times 10^7$ tonnes CO_2 to 3 sf (1) [5]

allow ecf on answer from **(ii)**

(b) (i) $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ **or**

$C_8H_{18} + 12½O_2 \rightarrow 8CO_2 + 9H_2O$ (1)

(ii) M_r $C_8H_{18} = (8 \times 12) + (18 \times 1) = 114$ (1)

mass of 4.00 dm^3 of octane = 4000×0.70 = 2800 g (1)

$n(C_8H_{18}) = \frac{2800}{114} = 24.56140351$ mol in 4.00 dm^3

= 24.6 mol to 3 sf (1)

(iii) 2 mol C_8H_{18} produce 16×44 g CO_2

24.6 mol C_8H_{18} produce $\frac{16 \times 44 \times 24.6}{2}$ g CO2

= 8659.2 g CO_2

= 8660 g CO_2 to 3 sf (1) [5]

(c) 6.82×10^9 people produce 1.20×10^7 tonnes CO_2 per day

8660 g CO_2 produced when car travels 100 km

when travelling 1 km, car produces $\frac{8660}{100} = 8.66 \times 10^{-1}$ g

$= 8.66 \times 10^{-5}$ tonnes (1)

to produce 1.20×10^7 tonnes CO_2 car must travel

$$\frac{1.20 \times 10^7}{8.66 \times 10^{-5}}$$

$= 1.385681293 \times 10^{11} = 1.39 \times 10^{11}$ km to 3 sf (1) [2]

(d) possible pollutants and the damage they cause

CO	NO_X		SO_2	H_2O	C	unburned C_8H_{18}
	NO	NO2				
toxic	toxic	toxic	toxic			
	global warming	respiratory problems	respiratory problems	global warming	respiratory problems	respiratory problems
	photochemical smog	acid rain	acid rain			

compound (1)
damage (1) [2]

[Total: 14]

2 (a) (i) white fumes/steamy fumes (1)

(ii) $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$ **or**
$2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$ (1)

(iii) an acid that is completely ionised in solution **or**
an acid that is completely dissociated into H^+ ions in solution (1) [3]

(b) (i) purple/violet vapour (I_2) or black/brown solid (I_2) **or**
irritating/acrid gas (SO_2) or stinking gas (H_2S) **or**
yellow solid (S) (1)

(ii) conc. H_2SO_4 is an oxidising agent **or** HI is a reducing agent (1)
which oxidises HI **or** which reduces H_2SO_4 (1) [3]

(c) (i) white ppt formed – **not** creamy white or off white (1)
which dissolves in $NH_3(aq)$ (1)

(ii) $NaCl(aq) + AgNO_3(aq) \rightarrow AgCl(s) + NaNO_3(aq)$ **or**
$Cl^-(aq) + Ag^+(aq) \rightarrow AgCl(s)$

equation (1)
all state symbols correct (1)

$AgCl(s) + 2NH_3(aq) \rightarrow [Ag(NH_3)_2]^+ Cl^-(aq)$ **or**
$AgCl(s) + 2NH_3(aq) \rightarrow [Ag(NH_3)_2] Cl(aq)$

equation (1)
all state symbols correct (1)

(iii) precipitate is yellow (1)
precipitate does not dissolve (1) [8]

[Total: 14]

3 (a) manufacture of ammonia/Haber process **or** hydrogenation of fats/oils **or** making margarine **or** hydrocracking (1) [1]

(b) (i) increasing the pressure
equilibrium will move to LHS (1)
fewer moles/molecules on LHS or more moles/molecules on RHS (1)

(ii) decreasing the temperature
equilibrium will move to LHS (1)
forward reaction is endothermic (1) [4]

(c) rate will increase (1)
collisions will occur more frequently (1) [2]

(d) (i) $K_c = \dfrac{[CO_2][H_2]}{[CO][H_2O]}$ (1)

(ii)

	$CO(g)$	+ $H_2O(g)$	⇌ $CO_2(g)$	+ $H_2(g)$
initial moles	0.40	0.40	0.20	0.20
equil moles	(0.40 – y)	(0.40 – y)	(0.20 + y)	(0.20 + y)
equil concn./mol dm^{-3}	$\frac{(0.40 - y)}{1}$	$\frac{(0.40 - y)}{1}$	$\frac{(0.20 + y)}{1}$	$\frac{(0.20 + y)}{1}$

$K_c = \dfrac{(0.20 + y)^2}{(0.40 - y)^2} = 6.40 \times 10^{-1}$ (1)

$\dfrac{(0.20 + y)}{(0.40 - y)} = \sqrt{6.40 \times 10^{-1}} = 0.8$

$(0.20 + y) = 0.8 \times (0.40 - y)$

$0.20 + y = 0.32 - 0.8\,y$

$1.8\,y = 0.12$

gives $y = 0.067$ (1)

at equilibrium

$n(CO) = n(H_2O) = (0.40 - 0.067) = 0.33$ mol **and**
$n(CO_2) = n(H_2) = (0.20 + 0.067) = 0.27$ mol (1)

allow ecf as appropriate [5]

[Total: 12]

4 (a) (i)

reaction	organic compound	reagent	structural formulae of organic product
A	$CH_3CH(OH)CH_3$	$NaBH_4$	no reaction
B	CH_3COCH_3	Tollens' reagent warm	no reaction
C	$CH_3CO_2CH(CH_3)_2$	KOH(aq) warm	CH_3CO_2K **or** $CH_3CO_2^-$ + $(CH_3)_2CHOH$
D	$(CH_3)_3COH$	$Cr_2O_7^{2-}/H^+$ heat under reflux	no reaction
E	CH_3COCH_3	$NaBH_4$	$CH_3CH(OH)CH_3$
F	$(CH_3)_3COH$	PCl_5	$(CH_3)_3CCl$
G	$CH_3CH=CHCH_2OH$	MnO_4^-/H^+ heat under reflux	CH_3CO_2H + HO_2CCO_2H

each correct answer gets 1 (9 × 1)

(ii)

reaction	colour at the beginning of the reaction	colour at the end of the reaction
G	purple	colourless **not** clear

(1 + 1 + 1) [12]

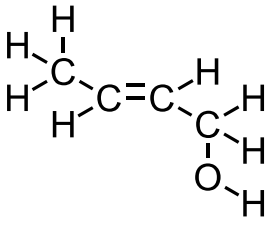
[Total: 12]

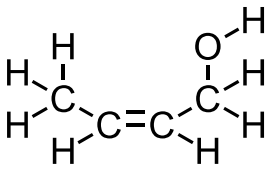
5 (a) (i)

H	J	K
$CH_2=CHCH_2CH_2OH$	$CH_3CH_2COCH_3$	$CH_3CH_2CH_2CHO$
$CH_3CH=CHCH_2OH$		
$CH_2=CHCH(OH)CH_3$		

each correct answer gets 1 (5 x 1)

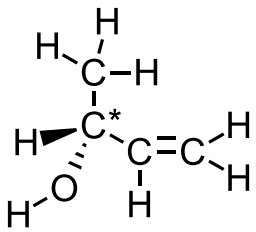
(ii)





(1)

(iii)



correct structure drawn fully displayed (1)
chiral centre clearly shown by* (1)

[8]

[Total: 8]