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

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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 = $4000 \times 0.70 = 2800$ 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]

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(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]

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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]

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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)** $K_c = \dfrac{[CO_2][H_2]}{[CO][H_20]}$ (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]

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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]

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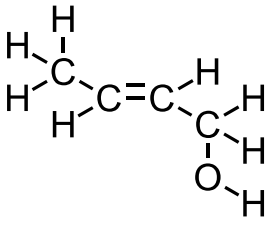
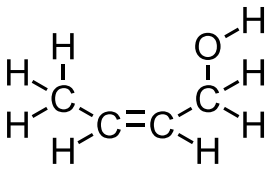
5 (a) (i)

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)

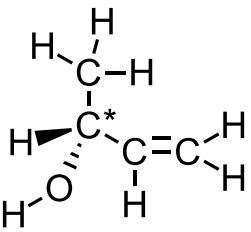
(ii)





(1)

(iii)



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

[8]

[Total: 8]

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