Theoretical test

Model Answer

DECEMBER 6th, 2019

Name		Code	
Country		Signature	

QUESTION 1			
Part 1		Points	Answers
I	i	0.25	$CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$ $\Delta H = -802.3$ kJ/mol
	ii	0.5	$Q = m \times c \times \Delta t$ $= 60g \times 4.18$ J/g°C x (40-25)°C = 3.76 kJ
			Energy released = 3.76 kJ
	iii	0.5	(Show your work) $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$ $\Delta H = -802.3$ kJ/mol (4C-H + 2X 498 kJ/mol) – (2X841 kJ/mol + 2X 46 4kJ/mol X 2) = - 802.3 kJ/mol (4C-H + 996 kJ/mol) – (3 538kJ/mol) = - 802.3 kJ/mol (4C-H) = +2 542kJ/mol – 802.3 kJ/mol (4C-H) = + 1652kJ/mol C-H = +435 kJ/mol **Final answer is correct 0.5** **If final is incorrect but workout correct = 0.25**
			Bond enthalpy = + 413kJ/mol

QUESTION 1			
Part 2		**Points**	**Answers**
II	**i**	0.25	(Show your work) $PV = nRT$ $V = \frac{nRT}{P} = \frac{1.25 \times 8.314 \times 3.10 \times 10^2}{101 \times 10^3}$ $= 3.19 \times 10^{-2} m^3$ *volume* = $3.19 \times 10^{-2} m^3$
	ii	0.5	(Show your work) $V(\text{of one molecule}) = \frac{4}{3}\pi R^3 = \frac{4}{3}\pi \left(\frac{2.50 \times 10^{-10}}{2}\right)^3 = 8.18 \times 10^{-30} m^3$ $N(\text{number of molecules})$ $= n\,(\text{number of moles}) \times N_A(\text{Avogadro's number})$ $V\,(\text{total volume of molecules})$ $= N\,(\text{number of molecules})$ $\times V(\text{volume of one molecule})$ $V(\text{total volume of molecules})$ $= 1.25 \times 6.02 \times 10^{23} \times 8.18 \times 10^{-30} = 6.16 \times 10^{-6} m^3$ $\text{fracrion of the volume occupied by gas molecules}$ $= \frac{\text{total volume of molecules}}{\text{total volume of the container}} = \frac{6.16 \times 10^{-6}}{3.19 \times 10^{-2}}$ $= 1.93 \times 10^{-4}$ (0.25 for workings out) *Fraction of volume* = $= 1.93 \times 10^{-4}$ (0.25 for correct answer)
	iii	0.5	(Show your work) $T = -125\ C^o(\pm 6.25) = 148K(\pm 6.25)$ $P = 10 \times 10^5\ Pa\ (\pm 2.5)$ $V = \frac{nRT}{P} = \frac{1.25 \times 8.314 \times 148}{10 \times 10^5} = 1.54 \times 10^{-3}\ m^3$ $\frac{\Delta V}{V_1} = \frac{1.54 \times 10^{-3} - 3.19 \times 10^{-2}}{3.19 \times 10^{-2}} \times 100 = -95.2\%$ (0.25) Percentage volume change $= -95.2\%$ (-0.25 for omitting the sign). (0.25)

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<tr><th colspan="2">Part 3</th><th>Points</th><th>Answers</th></tr>
<tr><td rowspan="6">III</td><td>i</td><td>0.25</td><td>Choice is ……d…….</td></tr>
<tr><td>ii</td><td>0.25</td><td>Choice is ……a …….</td></tr>
<tr><td>iii</td><td>0.25 for the whole table being correct</td><td>
<table>
<tr><td>Factor</td><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td>f</td><td>g</td></tr>
<tr><td>+/0</td><td>+</td><td>0</td><td>+</td><td>0</td><td>+</td><td>0</td><td>0</td></tr>
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<tr><td>iv</td><td>0.25</td><td>Choice is ……a…….</td></tr>
<tr><td>v</td><td>0.25</td><td>Choice is ……a…….</td></tr>
<tr><td>vi</td><td>0.25</td><td>Choice is …. d …….</td></tr>
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QUESTION 2			
Part 1		**Points**	**Answers**
	i	2.0	(Show your work) Assume a 1 L sample of QI gas, moles of gas is n = PV/ RT = (1.00 atm)(1.00 L)/ ((0.082057 atm L mol^{-1} K^{-1}) (25.0 + 273.15 K)) n = 0.04087 mol, **(0.25)** given the density of the gas (4.668 g/L), the mass of QI gas in 1 L is 4.668 g. Therefore, the molar mass of QI gas is = (4.668 g / 0.04087 mol) = 114.22 g/mol **(0.25)** Moles of C and H: Mole of carbon = 0.003436 mol C **(0.25)** Mole of hydrogen = 0.007727 mol H **(0.25)** Ratio of C: H …..empirical formula is C_4H_9 **(0.25)** and empirical formula mass is 57.11 g/mol **(0.25)** **Ratio of EF: MM = 2 (0.25)**
			The molecular formula = **C_8H_{18}** **(0.25)**
	ii	0.5	
			a = 2 **(0.25)** b = 110 **(0.25)**
	iii	1.0	Show your work) $2C_{57}H_{110}O_6$ → $110H_2O$ 2 X 890 g → 110 X 18 g 1780 g Tristearin → 1.98L H_2O Amount of Tristearin that can produce 3.8L of H_2O = 3416.16 g = X 1 mole Tristearin = 458 moles of ATP **(0.25)** X = 3416.16 g = 3.8 mol of tristearin = 458 X 6.02 X 10^{23} x 3.8 = 1.058 X 10^{27} molecules **(0.25)**
			ATP molecules = 1.058 X 10^{27} molecules **(0.5)**

QUESTION 2			
Part 2		**Points**	**Answers**
	i	0.5	(Show your work) A- Heat lost by camel body = heat gained by water (sweat) $Q = m_c c\Delta T = m_w L_v$ $5.50 \times 10^2 \times 3480 \times (41.0 - 33.0) = m_w \times 2.42 \times 10^6 \quad (\pm 2.50℃)$ $m_w = 6.33kg$ $V = \frac{m}{\rho} = \frac{6.33}{1} = 6.33L$ *Max. amount of water* = $6.33L$
	ii	0.5 (0.25 pt for calculating the total area) + (0.25 pt for calculating the pressure)	(Show your work) A- Area of the circle = $\pi r^2 = 0.0314\ m^2$ Area of the circular sector = $\frac{\theta}{360}\pi r^2 = 0.00262m^2$ Area of a foot = $0.0314 - 0.00262 = 0.0288m^2$ Area of all feet = $0.115\ m^2$ $P = \frac{F}{A} = \frac{5.50 \times 10^2 \times 9.81}{0.115} = 4.69 \times 10^4 Pa$ *Pressure* = $4.68 \times 10^4 Pa$

QUESTION 2			
Part 3		Points	Answers
III	i	0.25	Choice is ……b……..
	ii	0.5	Choice is ……a……..
	iii	0.25	Choice is ……d……..
	iv	0.25	Choice is ……b……..
	v	0.25	Choice is ……c……..
	vi	0.5	Choice is ……c……..

QUESTION 3			
Part 2		**Points**	**Answers**
I	**i**	0.25	Choice is. d. Both dry ice and solid water have polar bonds, London dispersion forces, and hydrogen-bonding in solid water. .
	ii	1.0 (no deduction of points for S.F.). If a ratio is given, also acceptable.	(Show your work) $Q_{total} = Q_{ICE} + L_{FUSION} + Q_{water} + L_{evaporation} + Q_{vapour}$ **(0.25)** $1559 = [0.0005 \times 2090 \times 0-(-5)] + [333000 \times 0.0005] + [0.0005 \times 4180 \times (100-0)] + [2256 \times 0.0005] + [0.0005 \times C_{(VAPOUR)} \times (150-100)]$ $1559 = 381.853 + (0.025 \times C_{(VAPOUR)})$ **(0.25)** $C_{(VAPOUR)} = 49.947 / 0.025 = 1997.88$ J/kg.℃ RATIO $= \frac{C\ ice}{C\ vapour} = 2090/1997.88 = 1.04$
			The ratio is 1.04 **(0. 5)** **If final answer correct = 1.0**

QUESTION 3			
Part 1		**Points**	**Answers**
II			(Show your work) $W_f = mc\Delta T + ml_f$ $= 5.00 \times 10^{-4} \times 2090 \times (0.00 - (-5.00))$ $+ 5.00 \times 10^{-4} \times 3.33 \times 10^5$ $W_f = 5.225 + 166.5 = 171.7\ J$ (0.5) $\frac{1}{2}mv^2 = mg\Delta h - W_f$ (neglect the mass of the ice) $\frac{1}{2}mv^2 = mg\Delta h - 171.7$ $v_B = \sqrt{2g\Delta h - 68.7}$ $v_B = \sqrt{2 \times 9.81 \times 10 - 68.7} = 11.3\ m/s$ (0.5) **Phase 2:** $v_B sin\theta = gt$ (0.25) $t = 0.575\ s$ Flying time = $2t = 1.15\ s$ $x = v_B cos\theta . t = 11.3\ m$ (0.25) $y = v_B sin\theta . t - \frac{1}{2}gt^2 + 0.2 = 1.82\ m$ (0.25)
	i		*Time = 1.15 s (0.25).*
	ii		*Distance = 11.3 m (0.25)*
	iii		*Maximum height from the ground =1.82 m (0.25*

QUESTION 3			
Part 3		Points	Answers
III	i	0.25	*Choice is .....c.....*
	ii	0.25	*Choice is .....a.....*
	iii	1.0	*Choice is .....d.....*
	iv	0.5	*Choice is .....c.....*
	v	1.0	*Choice is .....d.....*
	vi	0.5	*Choice is .....b.....*
	vii	0.25	*Choice is .....c.....*

QUESTION 4				
Part 1			Points	Answers
	i	a	1.0	(Show your work) $T.d_1 = n.d_2$ - $T = \frac{72.0\times9.81\times13.5\times10^{-2}}{5.20\times10^{-2}} = 1.83\times10^3 N$
				a) *force* $= 1.83\times10^3 N$ (0.5 to write the proper relationship and 0.5 pt to find tension)
		b	0.5	(Show your work) - $S.T = \frac{1.83\times10^3}{23\times10^{-4}} = 7.96\times10^5\ N/m^2$ (0.25)
				b) *specific tension* = $7.96\times10^5\ N/m^2$ *(0.25)*
		c	0.5	(Show your work) - The two gastrocnemius muscles exert force of : $T = 1.83\times10^3\times0.6 = 1.10\times10^3\ N$ So each muscle exerts: $2\grave{T}\cos(20) = 1.10\times10^3\ N$ $\grave{T} = 584N$ (0.25)
				c) force by each muscle = $584N$ (0.25)
	ii		0.25	Your selection is …NO…
			1.0	(Show your work) $F.\Delta t = \Delta P$ $F\times55.0\times10^{-3} = 4.25\times3.20 - 0$ $F = 247\ N$ per $6.20\times10^2\ mm^2$ > $36.0\ N\ per\ 4.90\times10^2\ mm^2$ 0.5 pt for relationships, 0.5 pt for final answer
	iii		0.5	Sorting from highest to lowest performance : Brand 6 > Brand 1> Brand 2 > Brand 3> Brand 5> Brand 4>Brand 7 full answer is required.

QUESTION 4			
Part 2		Points	Answers
	i	0.5	(Show your work) E = constant + 0.059 log[MA^+] -0.430 = Constant + 0.059 log 0.100×10^{-3} Constant = - 0.194 (0.25) To find [MA^+]: -0.300 = - 0.194 + 0.059 log [MA^+] -0.106 = 0.059 log [MA^+] [MA^+] = 0.01597M = 15.97 mM
			[MA^+] is ...15.97 mM **(0.25)**

QUESTION 4			
Part 3		Points	Answers
III	i	0.5	Choice is ……d…….
	ii	0.25	Choice is ……b…….
	iii	0.5	Choice is ……a…….

QUESTION 5

Part 1			Points	Answers
	i		2.0	(Show your work) The reactions are as follows: $ZnCO_{3(s)} + CaCO_{3(s)} \rightarrow ZnO_{(s)} + CaO_{(s)} + 2\ CO_{2(g)}$ Or: $ZnCO_{3(s)} \rightarrow ZnO_{(s)} + CO_{2(g)}$ $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$ **(0.25)** Let m = mass, in grams, of $ZnCO_3$ in the mixture and let 30.00 − m = mass in grams of $CaCO_3$ in the mixture. Students need to write an expression for calculating the mass of CO_2 produced by $ZnCO_3$ and an expression for the mass of CO_2 produced from $CaCO_3$. The sum of the expressions of mass of CO_2 from $ZnCO_3$ and $CaCO_3$ = 12.00g $[(30.00 - m) \times \frac{44.01}{100.09}] + [m \times \frac{44.01}{125.39}] = 12.00$ g **(1)** Solve for m: m = 13.41 g % by mass of $ZnCO_3$ = $\frac{13.41\ g}{30.00\ g} \times 100\ \%$ **(0.5)** = **44.70 %** (4 significant figures) **(0.25)**
				Percentage = **44.70 %**
	ii	a	0.25	*Relative atomic mass* = (50X0.04345) + (52X0.83789) + (53X0.09501) + (54X0.02365) = 52.05541amu = 52.05 amu
		b	0.25 (points will not be deducted whether they used answer of a	$w.^{53}Cr = \frac{250x1000x104.11}{223.833} X\ 0.09501 = 11,047.84717$ g $= 1.1 \times 10^4$ g

QUESTION 5			
Part 1		Points	Answers
	iii	0.25	a) $6Fe^{+2} \rightarrow 6Fe^{+3} + 6e^-$
		0.25	b) $2Cr^{+6} + 6e^- \rightarrow 2Cr^{+3}$ - some may use the $Cr_2O_7^{2-}$
	iv	0.25	*Zinc*
		0.25	*Ecell (Zn)= -0.74 – (-0.76) = +0.02V* *Ecell (Cu) = -0.74 – (+0.34) = -1.08V*

QUESTION 5			
Part 2		Points	Answers
II	i	0.25	Choice is ……b…….
	ii	0.25	Choice is ……b…….
	iii	0.25	Choice is ……a…….
	iv	0.25	Choice is ……c…….
	v	0.25	Choice is ……b…….
	vi	0.25	Choice is ……b…….

QUESTION 5			
Part 3		**Points**	**Answers**
III	**i**	0.5	(Show your work) $F = \frac{YA\Delta L}{L} = \frac{220 \times 10^9 \times 2.0 \times 10^{-6} \times 0.5 \times 10^{-3}}{2.0}$ $= 1.1 \times 10^2 N$ (0.25)
			Weight = $1.1 \times 10^2 N$ (0.25)
	ii	0.5	(Show your work) $\Delta L = \frac{FL}{YA}, \Delta L \propto \frac{L}{r^2}$ $\frac{\Delta L_1}{\Delta L_2} = \frac{L_1 {r_2}^2}{L_2 {r_1}^2} = \frac{1 \times 1^2}{3 \times 3^2} = \frac{1}{27}$ (0.25)
			The ratio = $\frac{1}{27}$ (0.25)
	iii	0.5	*(Show your work)* $\Delta L = \alpha\ L\ \Delta T$ $F = \frac{YA\ \Delta L}{L} = \frac{Y\ A\ \alpha\ L\ \Delta T}{L} = Y\ A\ \alpha\ \Delta T$ (0.25)
			Force exerted = $Y\ A\ \alpha\ \Delta T$ *(0.25)*