جامعة الملك سعود
**King Saud University**  1957

**COLLEGE OF SCIENCE**
**Chemistry Department**

| الاسم : ................................................................. | Write your answer in the table below | | |
|---|---|---|---|
| | Q1: | Q6: | Q11: |
| الرقم الجامعي : ................................................................. | Q2: | Q7: | Q12: |
| رقم الشعبة : ................................................................. | Q3: | Q8: | Q13: |
| Sunday21/11/1438H07:00-08:30 PM | Q4: | Q9: | Q14: |
| Time allowed : **90 minutes** | Q5: | Q10: | Q15: |

*Information you may need*

*Periodic table:*

| 1 IA | | | | | | | | | | | | | | | | | 18 VIIIA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 **H** 1.008 | 2 IIA | | | | | | | | | | | 13 IIIA | 14 IVA | 15 VA | 16 VIA | 17 VIIA | 2 **He** 4.003 |
| 3 **Li** 6.94 | 4 **Be** 9.01 | | | | | key | atomic number **symbol** atomic weight | | | | | 5 **B** 10.811 | 6 **C** 12.01 | 7 **N** 14.01 | 8 **O** 16.00 | 9 **F** 19.00 | 10 **Ne** 20.18 |
| 11 **Na** 23.00 | 12 **Mg** 24.31 | 3 IIIB | 4 IVB | 5 VB | 6 VIB | 7 VIIB | 8 | 9 VIIIB | 10 | 11 IB | 12 IIB | 13 **Al** 26.98 | 14 **Si** 28.09 | 15 **P** 30.97 | 16 **S** 32.07 | 17 **Cl** 35.45 | 18 **Ar** 39.98 |
| 19 **K** 39.09 | 20 **Ca** 40.08 | 21 **Sc** 44.96 | 22 **Ti** 47.87 | 23 **V** 50.94 | 24 **Cr** 52.00 | 25 **Mn** 54.94 | 26 **Fe** 55.85 | 27 **Co** 58.93 | 28 **Ni** 58.69 | 29 **Cu** 63.546 | 30 **Zn** 65.41 | 31 **Ga** 69.72 | 32 **Ge** 72.64 | 33 **As** 74.9216 | 34 **Se** 78.96 | 35 **Br** 79.90 | 36 **Kr** 83.80 |
| 37 **Rb** 85.47 | 38 **Sr** 87.62 | 39 **Y** 88.91 | 40 **Zr** 91.23 | 41 **Nb** 92.91 | 42 **Mo** 95.94 | 43 **Tc** [98] | 44 **Ru** 101.07 | 45 **Rh** 102.91 | 46 **Pd** 106.42 | 47 **Ag** 107.87 | 48 **Cd** 112.41 | 49 **In** 114.82 | 50 **Sn** 118.71 | 51 **Sb** 121.760 | 52 **Te** 127.60 | 53 **I** 126.90 | 54 **Xe** 131.29 |
| 55 **Cs** 132.91 | 56 **Ba** 137.33 | 71 **Lu** 174.97 | 72 **Hf** 178.49 | 73 **Ta** 180.95 | 74 **W** 183.84 | 75 **Re** 186.21 | 76 **Os** 190.23 | 77 **Ir** 192.22 | 78 **Pt** 195.08 | 79 **Au** 196.97 | 80 **Hg** 200.59 | 81 **Tl** 204.38 | 82 **Pb** 207.2 | 83 **Bi** 208.980 | 84 **Po** [209] | 85 **At** [210] | 86 **Rn** [222] |
| 87 **Fr** [223] | 88 **Ra** [226] | 103 **Lr** [262] | 104 **Rf** [261] | 105 **Db** [262] | 106 **Sg** [266] | 107 **Bh** [264] | 108 **Hs** [269] | 109 **Mt** [268] | 110 **Ds** [271] | 111 **Rg** [272] | 112 **Uub** [285] | 113 **Uut** [286] | B | | | | |

*Constants:*

1 atm = 760 torr = 101.325 kPa

R = 8.314 Pa m$^3$ mol$^{-1}$ K$^{-1}$ = 0.0821 atm L mol$^{-1}$ K$^{-1}$ = 8.314 J mol$^{-1}$ K$^{-1}$ = 62.36 torr L mol$^{-1}$ K$^{-1}$

N$_A$ (Avogadro's Number) = 6.022×10$^{23}$ mol$^{-1}$

1 L.atm = 101.325 J

**Choose the correct answer:**

1) Change in internal energy $\Delta E^o$ ($\Delta U^o$), in kJ, of the following reaction is:

$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$ $\qquad \Delta H^o_{rxn} = 129$ kJ
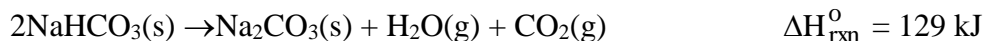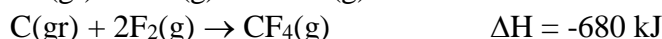
A) 114.04 B) 121.04 C) 134.04 D) 124.04

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2) The combustion of methane ($CH_4$) produces heat energy according to:

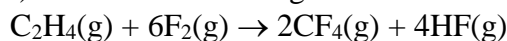$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ $\qquad \Delta H^o_{rxn} = -890$ kJ
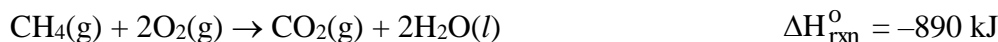
The mass of methane (in g) needed to produce 62692 kJ of heat energy, is:

A) 1100 B) 1120 C) 1130 D) 1150

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3) From the enthalpies of the following reactions:

$2HF(g) \rightarrow H_2(g) + F_2(g)$ $\qquad \Delta H = 537$ kJ
$2C(gr) + 2H_2(g) \rightarrow C_2H_4(g)$ $\qquad \Delta H = 52$ kJ
$C(gr) + 2F_2(g) \rightarrow CF_4(g)$ $\qquad \Delta H = -680$ kJ
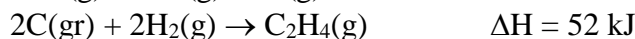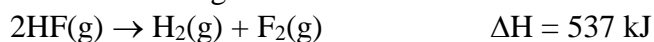
Calculate (in kJ) $\Delta H$ for the following reaction:
$C_2H_4(g) + 6F_2(g) \rightarrow 2CF_4(g) + 4HF(g)$

A) +2174 B) -2486 C) -2298 D) -2174

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4) Knowing that $\Delta H^o_f$ $CO_2(g) = -393.5$ kJ/mol, $\Delta H^o_f$ $H_2O(l) = -285.8$ kJ/mol, $\Delta H^o_f$

$NO_2(g) = +33.3$ kJ/mol, and $\Delta H^o_f$ $CH_3NO_2(l) = -112.4$ kJ/mol.

Calculate (in kJ) $\Delta H^o_{rxn}$ for the following reaction:

$4CH_3NO_2(l) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l) + 4NO_2(g)$ $\qquad \Delta H^o_{rxn} =$
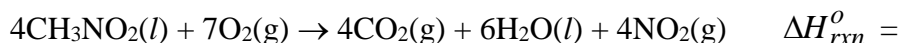
A) 4496 B) –2706 C) –4496 D) 2706

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5) An ideal gas is allowed to expand from 7.0 L to 15.0 L at 0.76 atm, after absorbing 476 J of heat. The change in the internal energy $\Delta E$ ($\Delta U$) for this gas system (in J) is:

A) –180 B) +180 C) –160 D) –140

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6) A piece of a metal at 180 °C is placed in 120 g of water at 20 °C. If the final temperature of the mixture is 24.4 °C, what is the mass (in g) of this metal?
($C_s$ of the metal is 0.474 J/g °C and $C_s$ of water is 4.184 J/g °C)
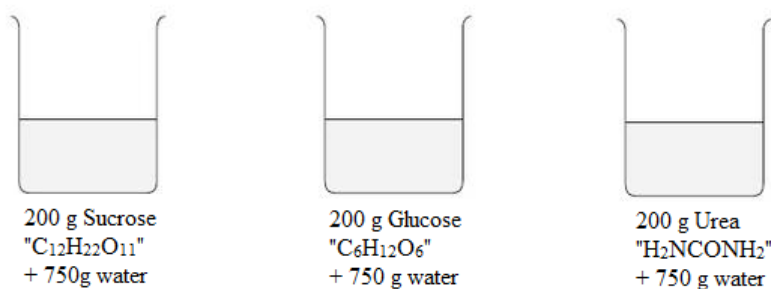
A) 37.5 B) 30.0 C) 26.0 D) 21.5

7) 2.0 L of nitrogen gas expands against a constant pressure of 1.0 atm and does work equals to 650 J. What will be the final volume of the gas (in L)?

A) 5.7          B) 6.4          C) 7.2          D) 8.4

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8) The internal energy $\Delta E$ ($\Delta U$) of the system is always of a positive value if the system:

     A) Absorbs heat and does work.
     B) Absorbs heat and has work done on it.
     C) Release heat and does work.
     D) Release heat and has work done on it.

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9)



200 g Sucrose
"$C_{12}H_{22}O_{11}$"
+ 750g water

200 g Glucose
"$C_6H_{12}O_6$"
+ 750 g water

200 g Urea
"$H_2NCONH_2$"
+ 750 g water

Which of the following statements is true?
     A) The three solutions will have the same vapor pressure.

     B) The sucrose solution will have the highest vapor pressure.

     C) The glucose solution will have the highest vapor pressure.

     D) The urea solution will have the highest vapor pressure.

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10) At a given temperature, the mass (in g) of nitrogen gas "$N_2$" that dissolves in 80.0 L of water and under nitrogen gas partial pressure of 0.79 atm is: (*The Henery's law constant of "$N_2$" in water the same temperature* $= 6.8 \times 10^{-4}$ *mol/L.atm*)

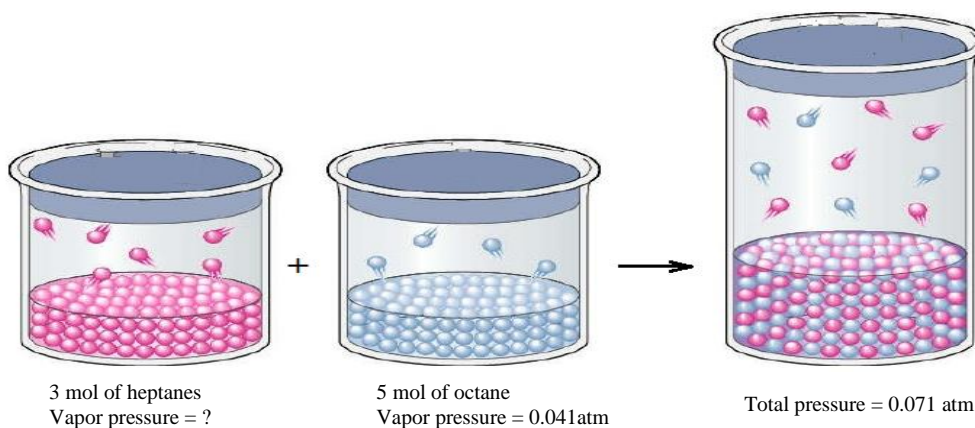A) 1.2          B) 1.4          C) 1.6          D) 1.8

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11) The change in the freezing point ($\Delta T_f$) of a solution prepared by dissolving 50.0 g of glycerin "$C_3H_8O_3$" (a nonelectrolyte) in 200 g of ethanol is: ($K_f$ *of ethanol = 2.0 °C/m*)

A) 2.4          B) 3.4          C) 5.4          D) 7.4

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12) The value of the constant ($k_b$) "*the molal boiling point elevation constant* " depends on:

A) nature of solvent     B) nature of solute    C) solute molar mass    D) pressure

13)



3 mol of heptanes
Vapor pressure = ?

5 mol of octane
Vapor pressure = 0.041atm

Total pressure = 0.071 atm

What will be the vapor pressure (in atm) of pure heptane at the constant temperature?

A) 0.102          B) 0.030          C) 0.142          D) 0.121

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14) At given temperature, the solubility of nitrogen gas at 0.687atm is $4.7\times10^{-4}$mol/L. What is the Henry's law constant (in mol/L.atm) at the same temperature?

A) $3.8\times10^{-4}$          B) $6.8\times10^{-4}$          C) $7.5\times10^{-4}$          D) $8.2\times10^{-4}$

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15) The observed osmotic pressure (in atm) of a 0.01 M magnesium sulfate "MgSO$_4$" solution at 25°C (*knowing that the van Hoff factor for MgSO$_4$ in this solution = 1.3*) is:

A) 0.318          B) 0.488          C) 0.244          D) 0.425

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