

CHEM 101
First Semester (031)
Second Major Exam (Dec 14, 2003)
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Instructions:

1. Print your name, student ID, and section number on the test answer form (upper left corner).
2. Check that the test code on your answer form agrees with the test code on your exam booklet.
3. Code your student ID, section number, and test code on your test answer form.
4. Code your answers on the answer form. You must not give more than one answer per question.

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Instructors	Sections	Lecture Timing
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Dr. Maung	1, 2, 3, 4	7:00 - 7:50 AM

Dr. Fettouhi	5, 6, 7, 8	8:00- 8:50 AM

Dr. Klein	9, 10, 11, 12	9:00- 9:50 AM

Dr. Morsy	13, 14, 15, 16	11:00- 11:50 AM

Dr. Siddiqui	17, 18, 19 , 20	1:10 PM- 2:00PM

Dr. Khaled	25, 26, 27, 28	3:20 PM- 4:00PM

 QUESTION NO: 1

A 10.0 g sheet of gold at 18.0 °C is placed flat on a 20.0 g sheet of iron at 55.6 °C. What is the final temperature of the combined metals if no heat is lost to the surroundings?

Specific heat capacity of gold = 0.242 J/°C.g

Specific heat capacity of iron = 0.487 J/°C.g

- A. 48.1 °C
- B. 102 °C
- C. 50.7 °C
- D. 55.6 °C
- E. 8.0 °C

Gold (Au)

$$m_{Au} = 10.0 \text{ g}$$

$$t_{Au} = 18.0^\circ \text{C}$$

$$S_{Au} = 0.242 \text{ J/}^\circ\text{C.g}$$

Iron (Fe)

$$m_{Fe} = 20.0 \text{ g}$$

$$t_{Fe} = 55.6^\circ \text{C}$$

$$S_{Fe} = 0.487 \text{ J/}^\circ\text{C.g}$$

$$Q_{Au} = -Q_{Fe} \Rightarrow 10.0 \times 0.242 \times (t_f - 18.0) = -[20.0 \times 0.487 \times (t_f - 55.6)]$$

$$(m S \Delta t)_{Au} = -(m S \Delta t)_{Fe}$$

 QUESTION NO: 2

The combustion of what volume of ethane (C_2H_6) measured at 23.0 °C and 752 mmHg, would be required to heat 855 g of water from 25.0 °C to 98.0 °C. The enthalpy of combustion of ethane is -343 kJ/mol.

Specific heat capacity of water = 4.18 J/°C.g

- A. 18.7 L
- B. 22.4 L
- C. 0.758 L
- D. 93.0 L
- E. 19.4 L

$$\Delta H_{\text{C}_2\text{H}_6} = -343 \text{ kJ/mol}$$

$$1 \text{ mol} \rightarrow -343 \text{ kJ}$$

$$n \rightarrow 261 \text{ kJ}$$

$$n_{\text{C}_2\text{H}_6} = \frac{261}{343} = 0.761 \text{ mol}$$

$$P V = n R T$$

$$\frac{752}{760} \times V_{\text{C}_2\text{H}_6} = 0.761 \times 0.08206 \times (23 + 273)$$

$$Q_{\text{water}} = m S \Delta t$$

$$= 855 \times 4.18 \times 73$$

$$= 261 \text{ kJ}$$

QUESTION NO: 3

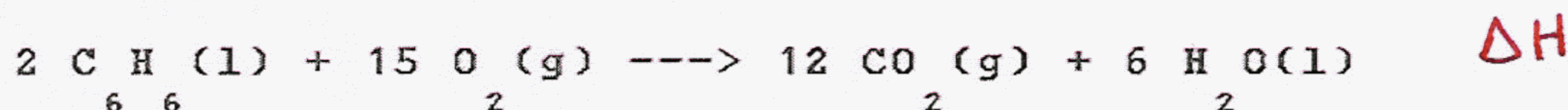
Which of the following statements is NOT true for a bomb calorimetry experiment?

- A. The energy change, associated with a combustion reaction in a bomb calorimeter, is equal to the P-V work.
- B. Under constant volume conditions, the heat transferred corresponds to the change in internal energy.
- C. There is no P-V work done in a bomb calorimetry.
- D. The energy change is determined by measuring the increase in the temperature of water and other calorimeter parts.
- E. The energy change occurs at constant volume.

QUESTION NO: 4

The standard heats of formation of $\text{C}_6\text{H}_6(\text{l})$, $\text{CO}_2(\text{g})$ and $\text{H}_2\text{O}(\text{l})$ are 49.0, -394 and -286 kJ/mol respectively.

Determine the heat of combustion for one mole of $\text{C}_6\text{H}_6(\text{l})$ in kJ/mol.



A. -3271

B. -631

C. -226.7

D. -1979

E. +226.7

$$\Delta H = [12 \Delta H_f(\text{CO}_2(\text{g})) + 6 \Delta H_f(\text{H}_2\text{O}(\text{l}))] - [2 \Delta H_f(\text{C}_6\text{H}_6(\text{l})) + 15 \Delta H_f(\text{O}_2(\text{g}))]$$

$$= [12 \times (-394) + 6 \times (-286)] - [2 \times 49.0 + 15 \times 0]$$

$$= -6444 - 98 = -6542 \text{ kJ}$$

Every 2 mol of C_6H_6 will give 6542 kJ upon combustion

$$\Rightarrow \Delta H = -3271 \text{ kJ/mol C}_6\text{H}_6$$

 QUESTION NO: 5

What is the energy of 1 mole of photons having a wavelength of 285 nm?

- A. 420. kJ
- B. 6.97×10^{-19} J
- C. 572 kJ
- D. 2.38×10^{-6} J
- E. 27.0 kJ

For 1 photon

$$E = \frac{hC}{\lambda}$$

For 1 mol photons: $E = \text{Avog.} \cdot \frac{hC}{\lambda}$

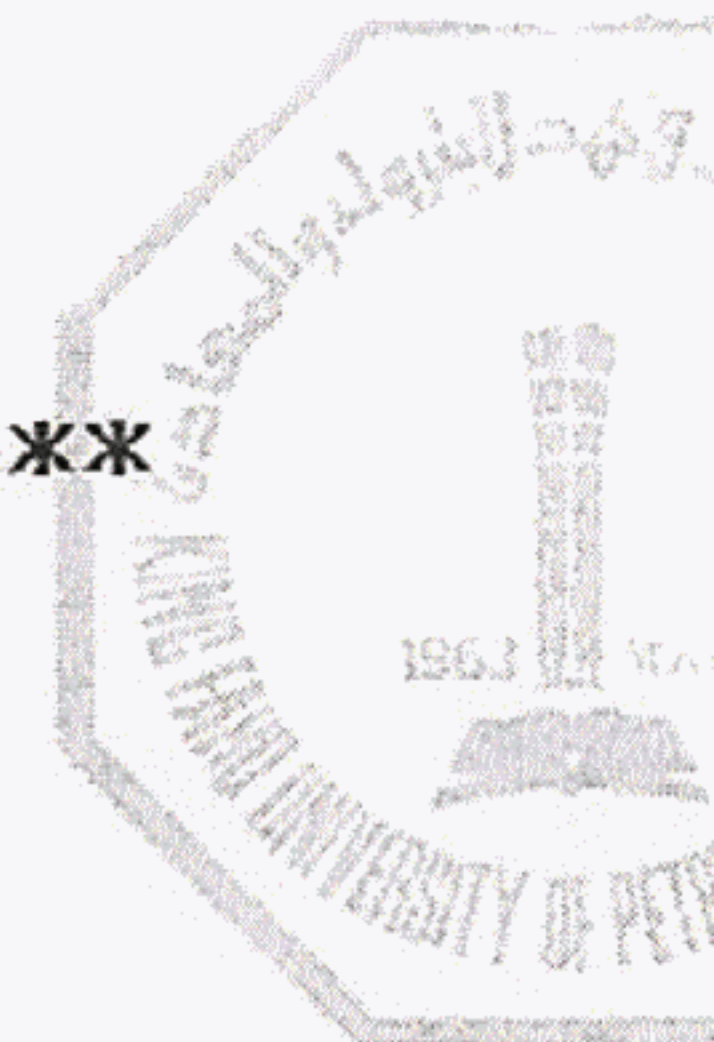
$$E = \frac{6.022 \times 10^{23} \times 6.626 \times 10^{-34} \times 3 \times 10^8}{285 \times 10^{-9}}$$

$$E = 420 \text{ KJ}$$

 QUESTION NO: 6

Which of the following statement(s) are True?

- I. The de Broglie wavelength can be determined if the mass and the velocity of a particle are known.
 - II. The energy of a photon is proportional to its wavelength.
 - III. A line spectrum is emitted when atoms have discrete energy levels.
 - IV. Hydrogen emits a continuous spectrum of light.
- A. I and III
 - B. II and IV
 - C. I and II
 - D. III and IV
 - E. II and III



 QUESTION NO: 7

What is the change in energy of 1 mole of hydrogen atoms if all atoms are initially in the excited state with $n = 6$ and fall back to the ground state with $n = 1$?

- A. -1276 kJ
- B. -2.117×10^{-18} J
- C. +1276 kJ
- D. -1.633×10^{-18} J
- E. +983.4 kJ

$$\begin{aligned}\Delta E &= R_H \left(\frac{1}{n_i^2} - \frac{1}{n_f^2} \right) \\ &= 2.178 \times 10^{-18} \left(\frac{1}{6^2} - \frac{1}{1^2} \right) \\ &= -2.1175 \times 10^{-18} \text{ kJ for 1 atom} \\ \Rightarrow \text{For 1 mol: } \Delta E &= -6.022 \times 10^{23} \times 2.1175 \times 10^{-18}\end{aligned}$$

 QUESTION NO: 8

Which of the followings is an allowed set of quantum numbers for an electron?

- A. $(n = 5, l = 2, m_l = -2, m_s = -1/2)$
- B. $(n = 1, l = \underline{1}, m_l = -1, m_s = +1/2)$
- C. $(n = 5, l = 2, m_l = \underline{3}, m_s = -1/2)$
- D. $(n = 2, l = -2, m_l = 0, m_s = 1)$
- E. $(n = 4, l = \underline{0}, m_l = 1, m_s = +1/2)$

$$l = 0$$

$$m_l = -2, -1, 0, +1, +2$$

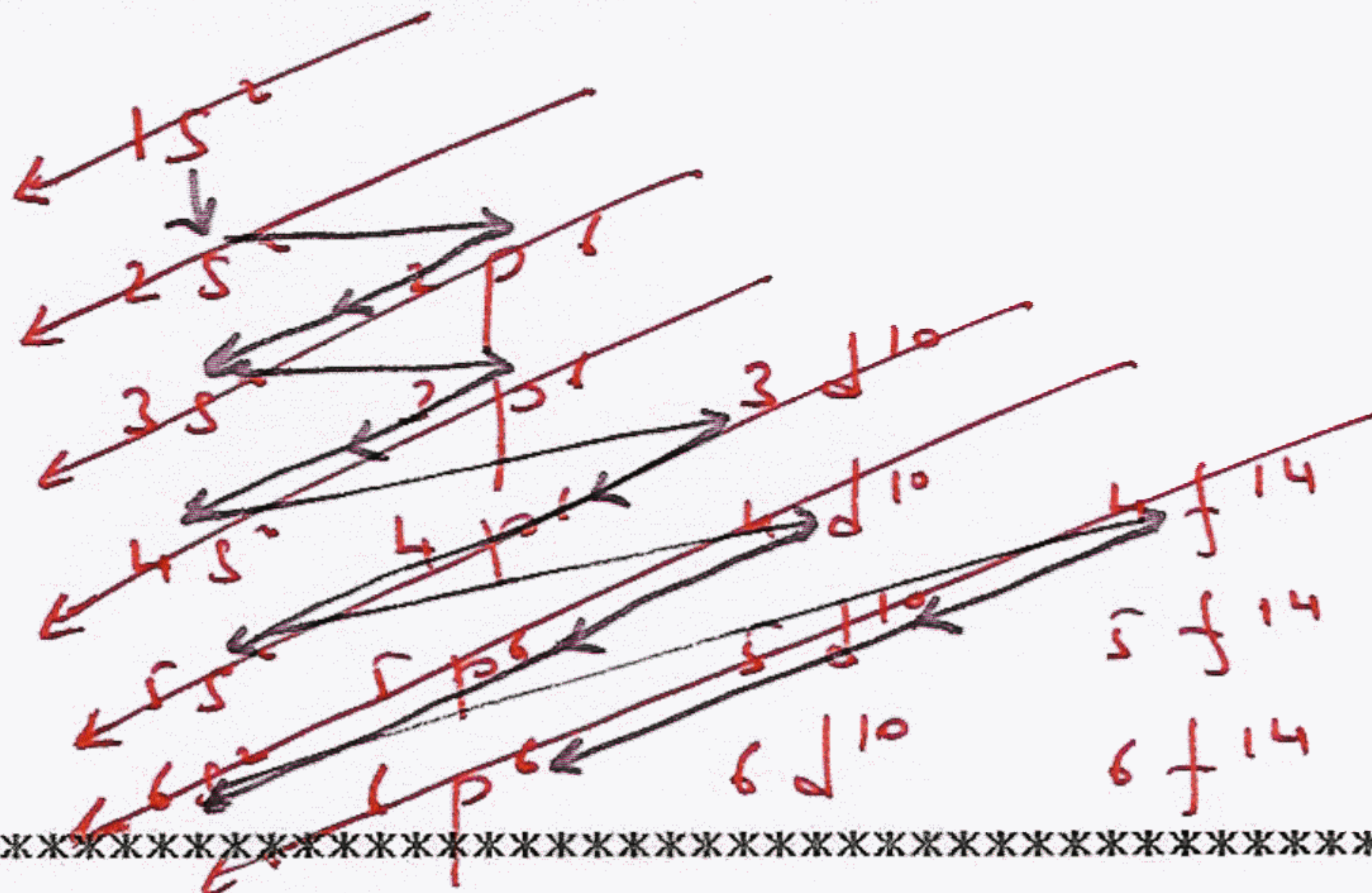
$$m_s = +\frac{1}{2} \text{ or } -\frac{1}{2}$$

$$m_l = 0$$

QUESTION NO: 9

As atomic orbitals are filled, the 6p orbitals are filled immediately after which of the following orbitals?

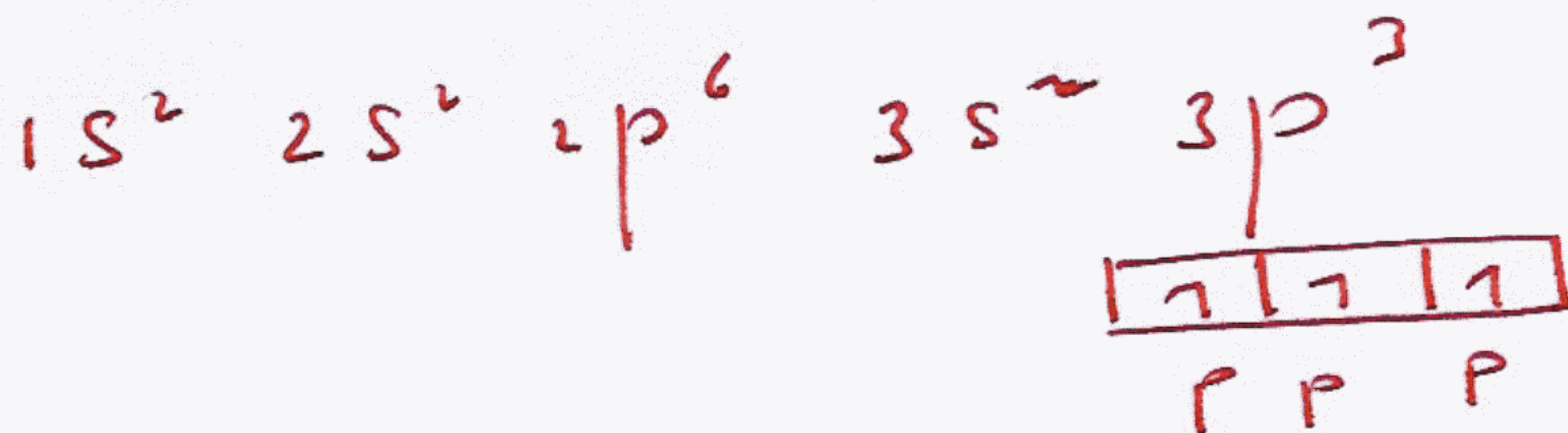
- A. 5d
- B. 4f
- C. 6s
- D. 7s
- E. 6d



QUESTION NO: 10

Which of the following neutral atoms has the larger number of unpaired electron?

- A. P
- B. C
- C. Al
- D. Si
- E. S



QUESTION NO: 11

Which of the following ionization energies (IE) is the largest?

- A. Third IE of Mg
- B. First IE of Ba
- C. First IE of Mg
- D. Second IE of Ba
- E. Second IE of Mg

QUESTION NO: 12

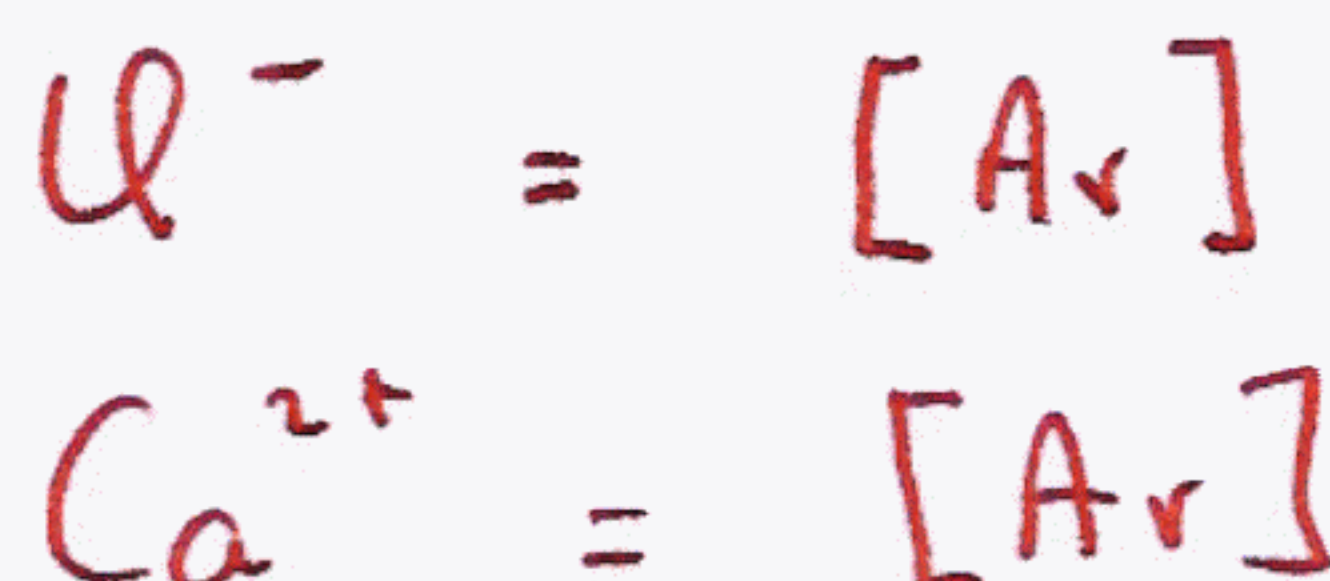
The order of decreasing atomic radius of Rb, Na, K, P and N atoms is,

- A. Rb, K, Na, P, N
- B. N, P, Na, K, Rb
- C. K, Rb, P, Na, N
- D. P, Na, Rb, K, N
- E. N, P, K, Rb, Na

QUESTION NO: 13

Which of the followings is an isoelectronic pair?

- A. Cl^- and Ca^{2+}
- B. Cl^- and Na
- C. F and O^{2-}
- D. Cl^- and Ar^+
- E. Na and Mg^{2+}

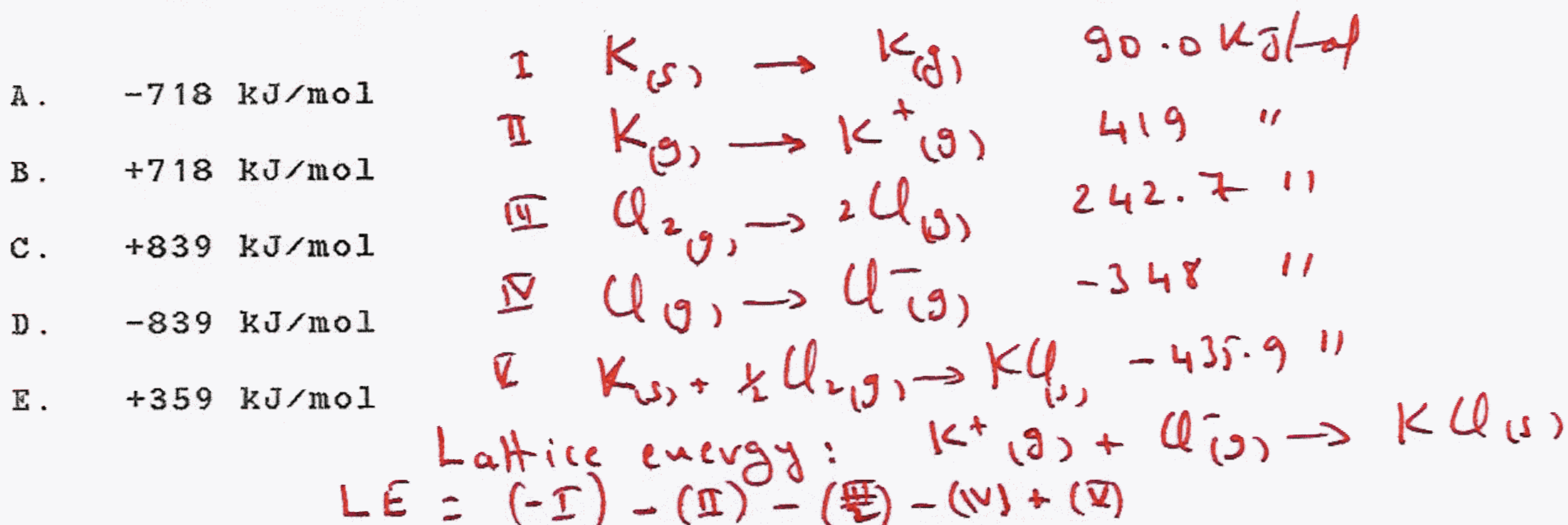




QUESTION NO: 14

Calculate the lattice energy of Potassium Chloride from the following data.

I	Enthalpy of sublimation of Potassium	= 90.0	kJ/mol
II	Ionization energy of Potassium	= 419	kJ/mol
III	Bond dissociation energy of Cl-Cl	= 242.7	kJ/mol
IV	Electron affinity of Chlorine	= -348	kJ/mol
V	Molar heat of formation of KCl	= -435.9	kJ/mol

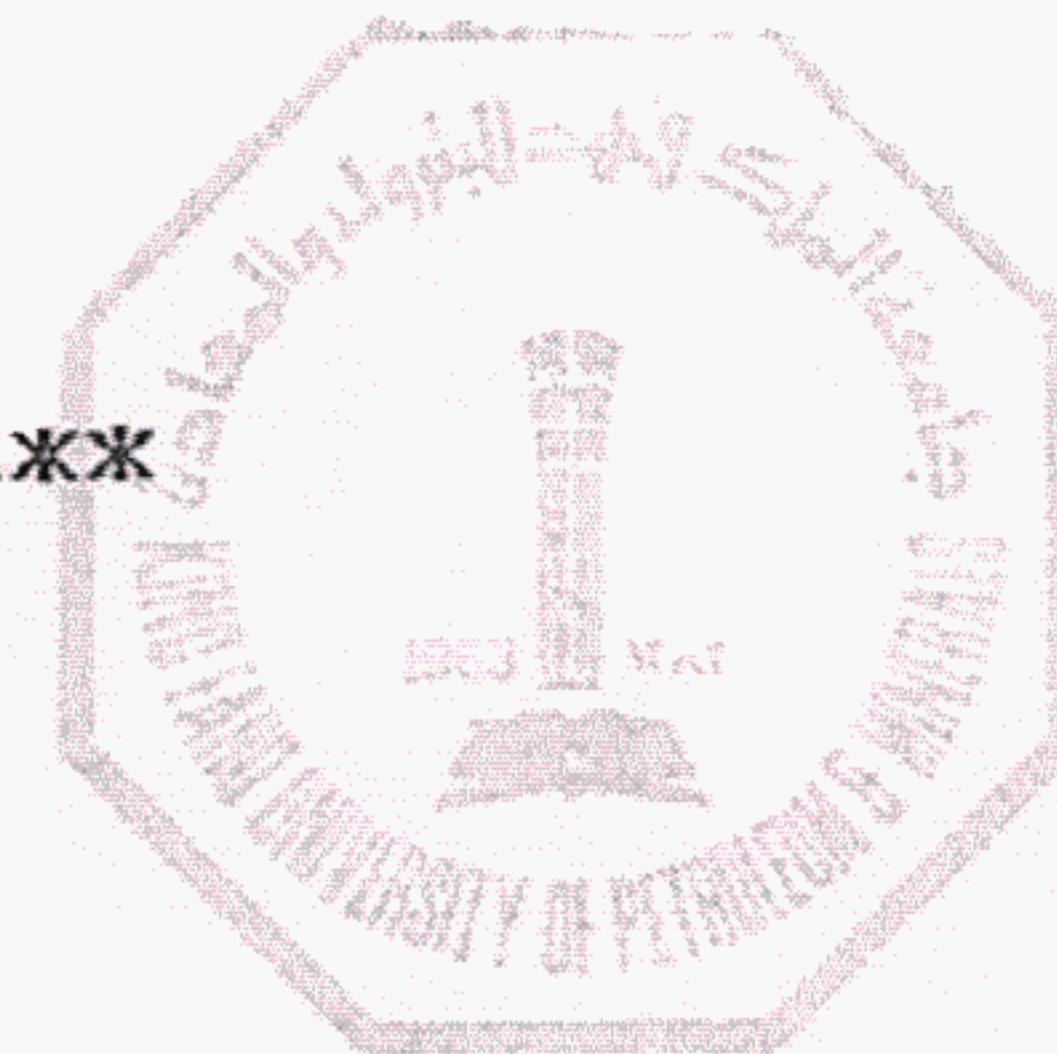


QUESTION NO: 15

Select the correct statement about Silicon tetrafluoride SiF_4 .

4

- A. A non-polar molecule with polar Si-F bonds.
- B. A polar molecule with non-polar Si-F bonds.
- C. A polar molecule with polar Si-F bonds.
- D. A non-polar molecule with non-polar Si-F bonds.
- E. An ionic molecule.



 QUESTION NO: 16

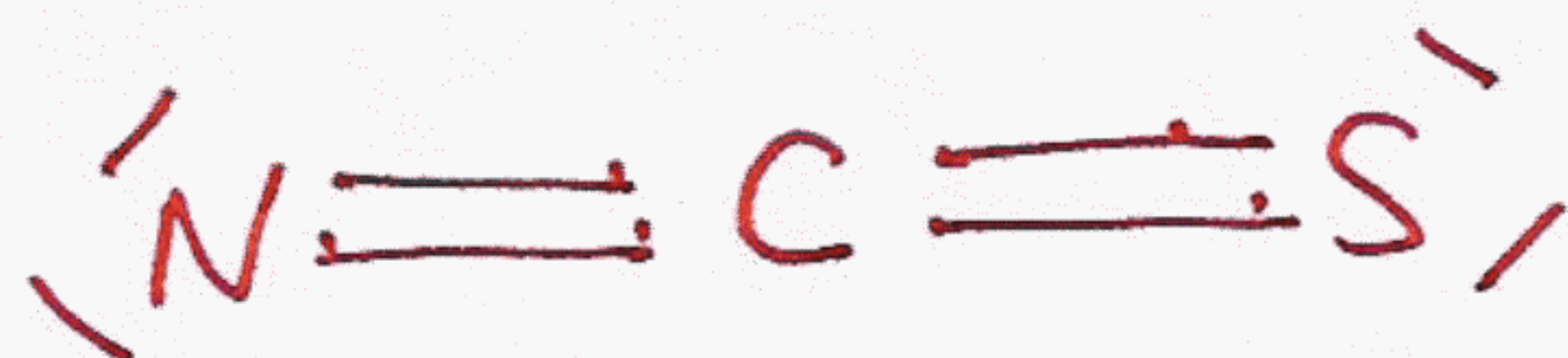
Choose the largest ion from the followings.

- A. Te^{2-}
- B. I^-
- C. Cs^+
- D. La^{3+}
- E. Ba^{2+}

 QUESTION NO: 17

In the preferred Lewis structure of NCS^- , the carbon atom makes a double bond both with the nitrogen and the sulfur atoms. What is the formal charge of sulfur in this Lewis structure?

- A. 0
- B. -1
- C. +1
- D. +2
- E. -2



$$\text{Total valence} = (5 + 4 + 6) + 1 = 16$$

$$\text{Formal charge on Sulfur} =$$

$$(\# \text{ of valence } e^- \text{ on free atom}) - (\# \text{ lone pair } e^- + \frac{1}{2} \# \text{ shared } e^-)$$

$$= 6 - \left(4 + \frac{1}{2} \times 4 \right) = 0$$

 QUESTION NO: 18

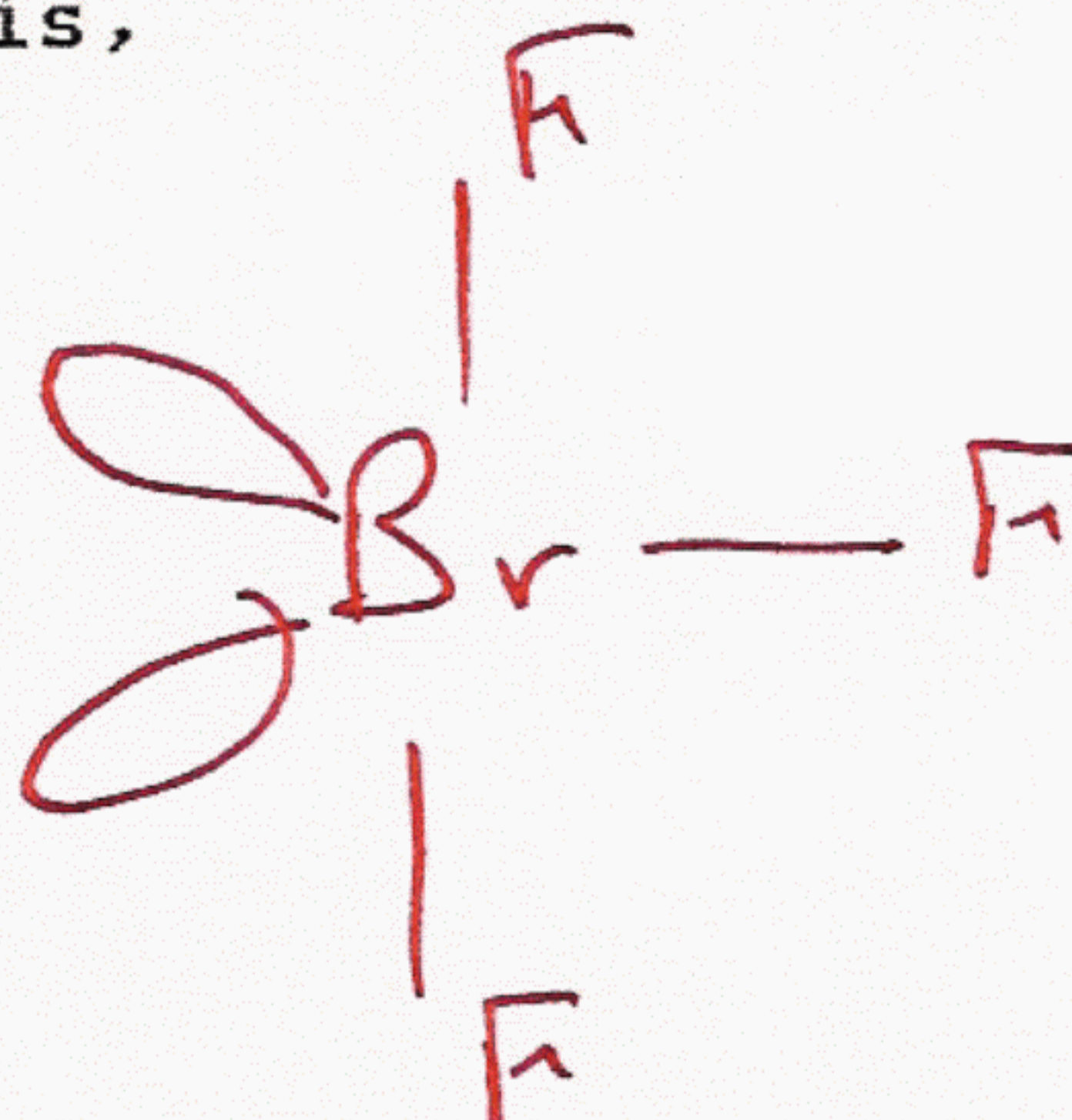
Which of the following atoms is never found with more than an octet of electrons?

- A. N ← no d orbitals available for bonding
 B. P
 C. S } may accommodate e^- in their d orbitals
 D. I } true for large atoms
 E. Xe }

 QUESTION NO: 19

The molecular structure of BrF_3 is,

- A. T-shaped
 B. Trigonal pyramidal
 C. Square planar
 D. Square pyramidal
 E. Octahedral



 QUESTION NO: 20

Which of the following species shows resonance?

- A. NCO^-
 B. NH_4^+
 C. HF
 D. CO
 E. BF_3

