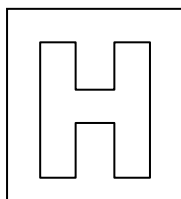


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## 2025 Preliminary Examination Pre-University 2

### H1 CHEMISTRY

Paper 1 Multiple Choice

**8873/01**

**17 September 2025**

**1 hour**

Additional materials: Multiple Choice Answer Sheet  
Data Booklet

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### READ THESE INSTRUCTIONS FIRST

**Do not turn over this question paper until you are told to do so**

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, class and admission number in the spaces provided at the top of this page and on the Multiple Choice Answer Sheet provided.

There are **thirty** questions on this paper. Answer **ALL** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the Multiple Choice Answer Sheet provided.

**Read the instructions on the Multiple Choice Answer Sheet very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this question paper.

The use of an approved scientific calculator is expected, where appropriate.

| FOR EXAMINER'S USE |  |
|--------------------|--|
| TOTAL (30 marks)   |  |

- 1 Which of the following statements about 1 mol of a gas is always correct?
- A** It has the same mass as any gas with  $6.02 \times 10^{23}$  molecules.  
**B** It has the same number of atoms as 1 mol of hydrogen gas.  
**C** It occupies the same volume as 1 mol of  $\text{H}_2\text{S}$  gas under the same conditions.  
**D** It contains the same number of particles as  $\frac{1}{12}$  g of  $^{12}\text{C}$ .
- 2 In an experiment,  $50 \text{ cm}^3$  of a  $0.1 \text{ mol dm}^{-3}$  solution of a metallic salt reacts exactly with  $25 \text{ cm}^3$  of  $0.1 \text{ mol dm}^{-3}$  aqueous sodium sulfite,  $\text{Na}_2\text{SO}_3$ . The half-equation for the oxidation of the sulfite ion is shown below:



If the original oxidation number of the metal ion for the metallic salt is +3, what is the new oxidation number of the metal ion?

- A** +1                      **B** +2                      **C** +4                      **D** +5
- 3 A carbon-containing macromolecule contains a large amount of carbon, mainly of isotopes  $^{12}\text{C}$  and  $^{13}\text{C}$ . It was found that the relative atomic mass of carbon in the molecule is 12.2.

What is the ratio of  $^{12}\text{C}$  to  $^{13}\text{C}$  in the molecule?

- A** 3:1                      **B** 4:1                      **C** 3:4                      **D** 1:4
- 4 *Use of the Data Booklet is relevant to this question.*

What does the ion  $^{31}\text{P}^{3-}$  have in common with an  $^{40}\text{Ar}$  atom?

- A** They have isoelectronic structures.  
**B** Both have more neutrons than electrons.  
**C** The electronic configuration of their valence electron shell is  $2\text{s}^2 2\text{p}^6$ .  
**D** Both particles are deflected to the same extent when passed through an electric field with the same strength.

- 5 Elements **X** and **Y** have successive ionisation energies as shown:

|          | ionisation energies / kJ mol <sup>-1</sup> |                 |                 |                 |                 |                 |                 |
|----------|--------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|          | 1 <sup>st</sup>                            | 2 <sup>nd</sup> | 3 <sup>rd</sup> | 4 <sup>th</sup> | 5 <sup>th</sup> | 6 <sup>th</sup> | 7 <sup>th</sup> |
| <b>X</b> | 787                                        | 1577            | 3232            | 4356            | 16091           | 19805           | 23780           |
| <b>Y</b> | 1310                                       | 3400            | 5300            | 7500            | 11000           | 13300           | 20300           |

What could be the formula of the compound of these two elements?

- A**  $X_2Y_3$                       **B**  $X_3Y_2$                       **C**  $XY$                       **D**  $XY_2$
- 6 What is the electronic configuration of an element with its first ionisation energy higher than each of the elements before and after it in the Periodic Table?
- A**  $1s^22s^22p^2$   
**B**  $1s^22s^22p^3$   
**C**  $1s^22s^22p^4$   
**D**  $1s^22s^22p^5$
- 7 An element **R** has a giant molecular structure.

Which statements are true of **R**?

- 1 It has strong covalent bonds between the molecules.
- 2 It has high melting point.
- 3 It is insoluble in water.
- 4 It can conduct electricity in the solid state.

- A** 1 and 2 only  
**B** 1 and 4 only  
**C** 2 and 3 only  
**D** 3 and 4 only

- 8 In which pair of chemical species, is the bond angle of I smaller than that in II?

|          | I                            | II                           |
|----------|------------------------------|------------------------------|
| <b>A</b> | CO <sub>2</sub>              | SF <sub>6</sub>              |
| <b>B</b> | NO <sub>3</sub> <sup>-</sup> | SO <sub>2</sub>              |
| <b>C</b> | CO <sub>2</sub>              | NO <sub>3</sub> <sup>-</sup> |
| <b>D</b> | SF <sub>6</sub>              | NO <sub>3</sub> <sup>-</sup> |

- 9 The following are two observations made of cyclohexane, C<sub>6</sub>H<sub>12</sub>:

|    |                                                                    |
|----|--------------------------------------------------------------------|
| I  | Cyclohexane is often used as a solvent for many organic compounds. |
| II | Cyclohexane is immiscible in H <sub>2</sub> O.                     |

Which of the following statements explain either of the above observations?

- 1 The C–H bonds in cyclohexane are stronger than the O–H bonds in H<sub>2</sub>O.
- 2 There are strong instantaneous dipole – induced dipole interactions between C<sub>6</sub>H<sub>12</sub> and the organic compounds.
- 3 The forces of interactions between C<sub>6</sub>H<sub>12</sub> and H<sub>2</sub>O molecules are weaker than the hydrogen bonds in H<sub>2</sub>O.

- A** 1 and 2 only  
**B** 1 and 3 only  
**C** 2 and 3 only  
**D** 1, 2 and 3 only

- 10 Which reaction is correctly represented with the stated type of standard enthalpy change of reaction?

|          | reaction equation                                                                                             | type of enthalpy change                    |
|----------|---------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| <b>A</b> | CH <sub>4</sub> (g) + 2O <sub>2</sub> (g) → CO <sub>2</sub> (g) + 2H <sub>2</sub> O(g)                        | standard enthalpy change of combustion     |
| <b>B</b> | H <sub>2</sub> SO <sub>4</sub> (aq) + Ca(OH) <sub>2</sub> (aq) → CaSO <sub>4</sub> (s) + 2H <sub>2</sub> O(l) | standard enthalpy change of neutralisation |
| <b>C</b> | C(s) + O <sub>2</sub> (g) → CO <sub>2</sub> (g)                                                               | standard enthalpy change of reaction       |
| <b>D</b> | $\frac{1}{2}$ N <sub>2</sub> (g) → N(g)                                                                       | bond energy                                |

- 11 The lattice energies, cationic and anionic radii in KF and CaO are given as follows:

|     | lattice energy / $\text{kJ mol}^{-1}$ | ionic radius of cation / nm | ionic radius of anion / nm |
|-----|---------------------------------------|-----------------------------|----------------------------|
| KF  | -830                                  | 0.138                       | 0.136                      |
| CaO | -3530                                 | 0.099                       | 0.140                      |

Which statement best explains the difference in their lattice energies?

- A The forces of attraction between the ions in KF is stronger than that in CaO.
- B The inter-ionic distance in KF is larger than in CaO.
- C Both KF and CaO have the same total number of electrons in one mole of the compound.
- D KF has a higher degree of covalent character than CaO.

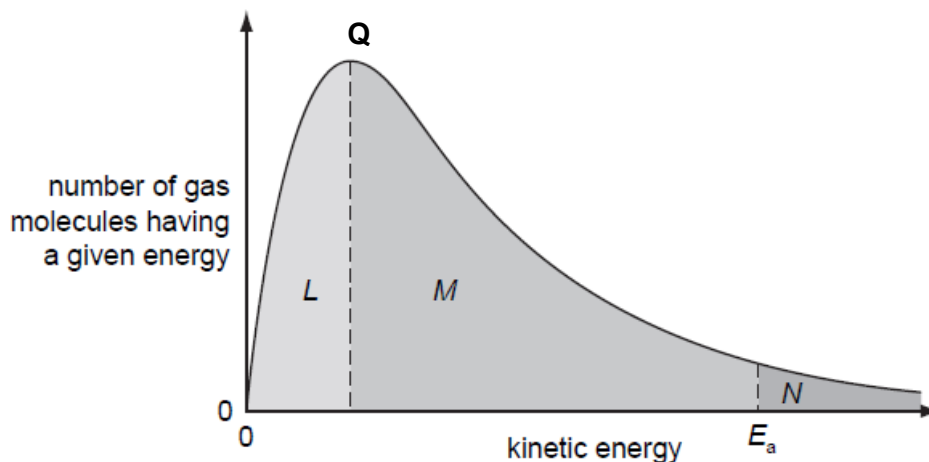
- 12 *Use of the Data Booklet is relevant to this question.*

A student carried out an experiment to determine the enthalpy change of combustion of ethanol ( $M_r = 46.0$ ). It was found that the combustion of 1.00 g of ethanol raises the temperature of 100 g of water by 43 °C.

Given that the enthalpy change of combustion of ethanol is  $-1370 \text{ kJ mol}^{-1}$ , what is the percentage efficiency of the heat transfer process?

- A 97%                      B 81%                      C 60%                      D 46%

- 13 The Maxwell-Boltzmann Energy distribution graph shows the number of molecules having a particular kinetic energy at constant temperature.



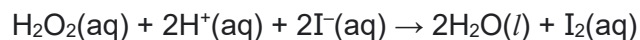
Which statement is correct?

- A As temperature decreases, the total area under the curve remains the same.
  - B At a higher temperature, area *N* decreases.
  - C At lower temperature, the proportion of molecules in *L* and *M* increases and *E<sub>a</sub>* becomes higher.
  - D As temperature increases, the maximum point **Q** shifts to the left.
- 14 Platinum is a material used as a catalyst in a catalytic converter. It is used in the form of nanoparticles. These nanoparticles can exhibit enhanced chemical reactivity, making them useful in catalysis and other chemical processes.

Which statement about the platinum catalyst is correct?

- A Less sites are available for catalysis to occur in spherical nanoparticles with a smaller diameter.
- B Nanoparticles of platinum are used since they have a large surface area to volume ratio.
- C Platinum nanoparticles react with nitrogen oxide to form nitrogen and platinum oxide.
- D The platinum catalyst helps to remove pollutants such as carbon dioxide gas from the exhaust.

- 15 Hydrogen peroxide reacts with acidified iodide ions and produces iodine according to the equation shown.



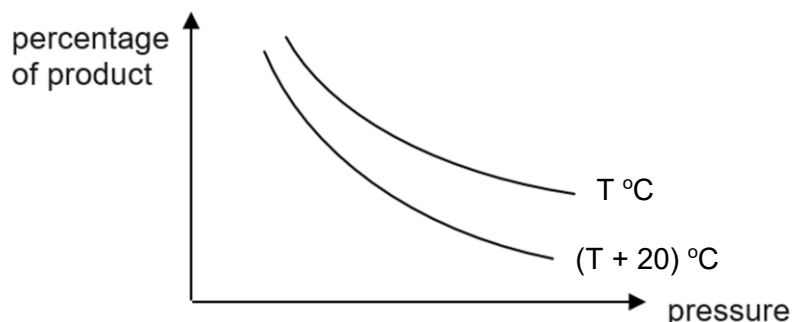
The following results were obtained.

| Experiment | initial concentrations of reactants<br>/ mol dm <sup>-3</sup> |                   |                   | initial rate of<br>formation of I <sub>2</sub><br>/ mol dm <sup>-3</sup> s <sup>-1</sup> |
|------------|---------------------------------------------------------------|-------------------|-------------------|------------------------------------------------------------------------------------------|
|            | [H <sub>2</sub> O <sub>2</sub> ]                              | [I <sup>-</sup> ] | [H <sup>+</sup> ] |                                                                                          |
| 1          | 0.010                                                         | 0.010             | 0.10              | 2.0 × 10 <sup>-6</sup>                                                                   |
| 2          | 0.030                                                         | 0.010             | 0.10              | 6.0 × 10 <sup>-6</sup>                                                                   |
| 3          | 0.030                                                         | 0.020             | 0.10              | 1.2 × 10 <sup>-5</sup>                                                                   |
| 4          | 0.030                                                         | 0.020             | 0.20              | 1.2 × 10 <sup>-5</sup>                                                                   |
| 5          | 0.020                                                         | 0.020             | 0.020             | unknown                                                                                  |

What is the initial rate of formation of I<sub>2</sub>, in mol dm<sup>-3</sup> s<sup>-1</sup> for Experiment 5?

- A 6.4 × 10<sup>-11</sup>
- B 3.2 × 10<sup>-9</sup>
- C 1.6 × 10<sup>-7</sup>
- D 8.0 × 10<sup>-6</sup>
- 16 Which statement about the reversible reaction,  $\text{S} \rightleftharpoons \text{T}$ , is correct when the system is at equilibrium?
- A The concentrations of **S** and **T** are constant.
- B The rates of the forward and reverse reactions are equal to zero.
- C The rate constants of the forward and reverse reactions are equal.
- D The concentrations of **S** and **T** are equal.

- 17 The graph below shows how the percentage of product present at equilibrium varies with temperature and pressure for a reaction.



Which reaction could be represented in the graph above?

- |          |                                                                                                  |                                       |
|----------|--------------------------------------------------------------------------------------------------|---------------------------------------|
| <b>A</b> | $2\text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$                       | $\Delta H = -57 \text{ kJ mol}^{-1}$  |
| <b>B</b> | $2\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{CO}(\text{g})$             | $\Delta H = -222 \text{ kJ mol}^{-1}$ |
| <b>C</b> | $\text{COCl}_2(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + \text{Cl}_2(\text{g})$         | $\Delta H = +107 \text{ kJ mol}^{-1}$ |
| <b>D</b> | $\text{NH}_4\text{Cl}(\text{s}) \rightleftharpoons \text{NH}_3(\text{g}) + \text{HCl}(\text{g})$ | $\Delta H = +176 \text{ kJ mol}^{-1}$ |

- 18 The rate constant,  $k$ , of a reversible reaction are as shown below.



Which change(s) would cause both rate constants,  $k_1$  and  $k_{-1}$  to be increased?

- 1 Increasing the concentrations of the reactants.
- 2 Increasing temperature of the equilibrium mixture.
- 3 Adding a catalyst.

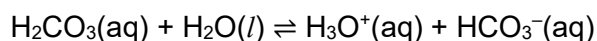
- A** 1 and 2 only  
**B** 1 and 3 only  
**C** 2 and 3 only  
**D** 1, 2 and 3

19 Which of the following underlined species is acting as a Brønsted base?

- A  $\text{HSO}_4^- + \text{H}_2\text{O} \rightleftharpoons \text{SO}_4^{2-} + \text{H}_3\text{O}^+$   
 B  $\text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$   
 C  $\text{H}_3\text{PO}_4 + \text{CH}_3\text{NH}_2 \rightarrow \text{H}_2\text{PO}_4^- + \text{CH}_3\text{NH}_3^+$   
 D  $\text{HNO}_2 + \text{HCO}_2^- \rightarrow \text{NO}_2^- + \text{HCO}_2\text{H}$

20 Human plasma is buffered mainly by dissolved  $\text{CO}_2$  which has reacted to form carbonic acid.

The equation shows the dissociation of carbonic acid in human plasma:



The pH of human plasma is usually 7.4.

Which statement is correct?

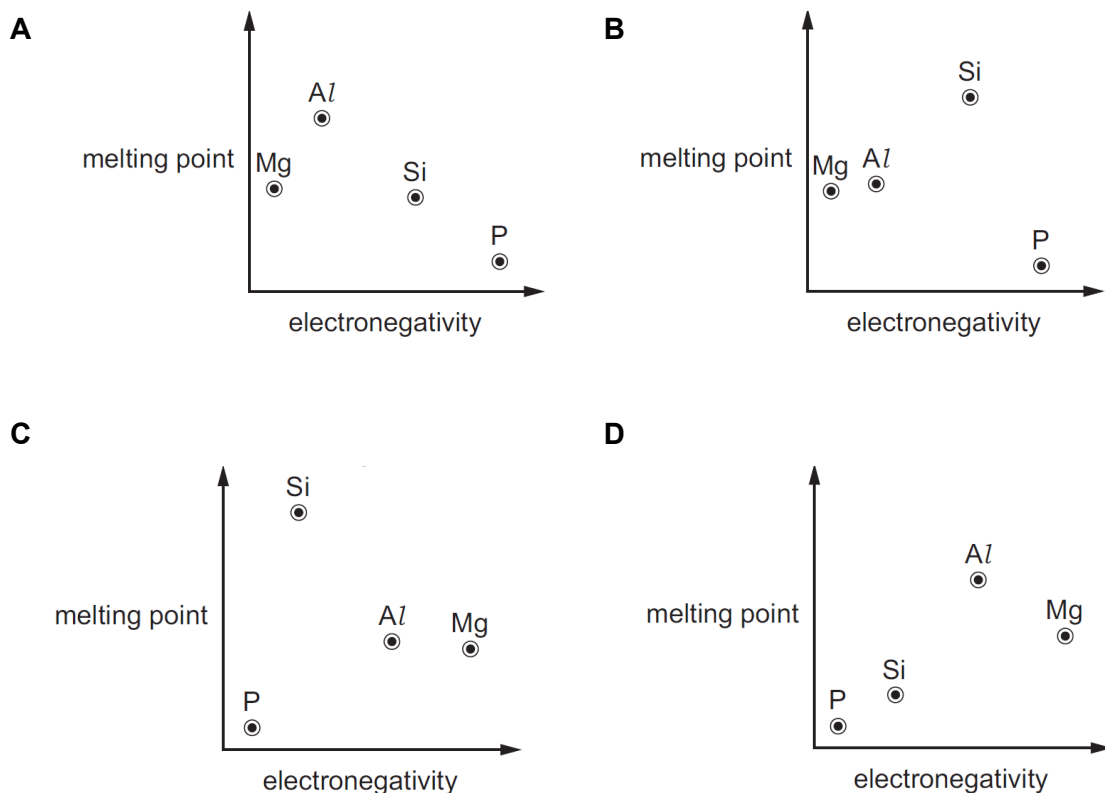
- A The pH of human plasma increases when the equilibrium of the dissociation reaction shifts to the right.  
 B With the slight surge in acidic materials in the human plasma, there will be an immediate decrease in concentration of the conjugate base,  $\text{HCO}_3^-$  in the plasma.  
 C The pH of human plasma tends to increase when it is diluted with large amount of water.  
 D This buffer system can be prepared by mixing varying amounts of sodium carbonate and potassium carbonate.

21 Period 3 elements exhibit trends in their properties.

Which trend in the following properties is **true** across the period?

- A Electronegativity decreases.  
 B Covalent character in their chlorides decreases.  
 C Electrical conductivity increases.  
 D First ionisation energy increases.

22 Which graph correctly shows the relative melting points of the elements Mg, Al, Si and P plotted against their relative electronegativities?



23 Astatine is the element below iodine in Group 17 of the Periodic Table.

Which statements about astatine are correct?

- 1 Astatine is less electronegative than iodine.
- 2 Astatine can oxidise chloride ion to chlorine molecules.
- 3 The bond length of H-I is longer than H-At.
- 4 Thermal decomposition of HAt requires lower energy than HCl.

- A** 1 and 4 only  
**B** 2 and 3 only  
**C** 1, 2 and 3 only  
**D** 3 and 4 only

24 Which of the following is the IUPAC name for the compound,  $\text{C}(\text{CH}_3)_3\text{OH}$ ?

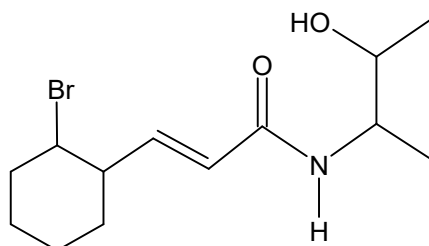
- A 1,1-dimethylethanol
- B 1,2-dimethylethanol
- C 2,2-dimethylethan-2-ol
- D 2-methylpropan-2-ol

25 A reaction occurs when a sample of 1-chloropropane is heated under reflux with sodium hydroxide dissolved in ethanol.

Which row is correct?

|   | type of reaction | name of product |
|---|------------------|-----------------|
| A | elimination      | propan-1-ol     |
| B | elimination      | propene         |
| C | substitution     | propan-1-ol     |
| D | substitution     | propene         |

26 Compound **L** has the following structure.



**L**

Which statements about compound **L** are correct?

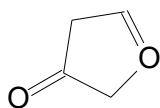
- 1 It can undergo addition with  $\text{H}_2$ , with platinum as the catalyst.
- 2 It undergoes hydrolysis when heated with aqueous  $\text{NaOH}$ .
- 3 It undergoes reduction with  $\text{NaBH}_4$ .

- A 1 and 2 only
- B 1 and 3 only
- C 2 and 3 only
- D 1, 2 and 3

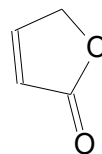
- 27** When  $\text{CH}_2(\text{OH})\text{CH}=\text{CHCO}_2\text{H}$  is warmed with a little concentrated sulfuric acid, a cyclic compound is formed.

What is the skeletal formula of the cyclic compound?

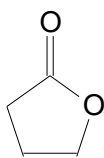
**A**



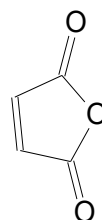
**B**



**C**

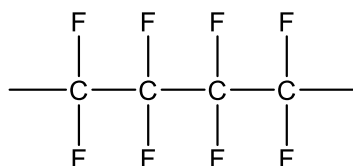


**D**



- 28** Use of the Data Booklet is relevant to this question.

A short section of the chain in the addition polymer Teflon<sup>TM</sup> is shown.

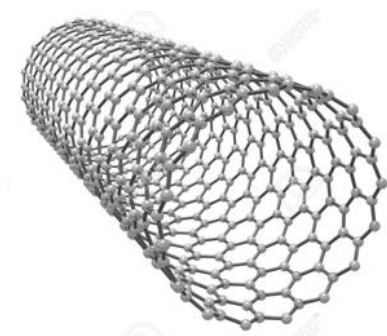


The  $M_r$  of a typical molecule of Teflon<sup>TM</sup> is approximately 200 000.

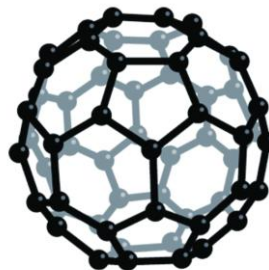
How many carbon atoms are joined together to make this typical polymer molecule?

- A** 2000                      **B** 2800                      **C** 4000                      **D** 8400

- 29 Carbon nanotubes are produced by rolling graphene sheets that are used to generate electricity in solar panels. Another allotrope of carbon, buckminsterfullerenes, are spherical football-like structures that are used in lubricants.



carbon nanotube



buckminsterfullerene

Which of the following properties explains the uses of each allotrope?

|          | <b>carbon nanotube</b> | <b>buckminsterfullerene</b>                 |
|----------|------------------------|---------------------------------------------|
| <b>A</b> | delocalised electrons  | strong covalent bonds within each molecule  |
| <b>B</b> | delocalised ions       | strong covalent bonds within each molecule  |
| <b>C</b> | delocalised electrons  | weak forces of attraction between molecules |
| <b>D</b> | delocalised ions       | weak forces of attraction between molecules |

- 30 Which statement is **not** true?

- A** Graphene is a nanomaterial.
- B** Nanoparticles exhibit chemical properties different from its bulk material.
- C** Nanomaterials have all three dimensions from 1 to 100 nm.
- D** Due to the small particle size, nanoparticles are used as materials to deliver medication in humans.

**END OF PAPER 1**

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