

注意：考試開始鈴響前，不得翻閱試題，
並不得書寫、畫記、作答。


國立清華大學 113 學年度碩士班考試入學試題

系所班組別：動力機械工程學系
丙組(固體與奈微米力學組)

科目代碼：1302

考試科目：科技英文

—作答注意事項—

1. 請核對答案卷(卡)上之准考證號、科目名稱是否正確。
2. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清(含未依範例畫記)致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「國立清華大學試場規則及違規處理辦法」，無法因本試題封面作答注意事項中未列明而稱未知悉。

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*請在【答案卷、卡】作答

Questions I (2.5 points each)

Choose the best answer to replace the section in the question that has an underline.

1. Carbon dioxide is a _____ of carbon and oxygen.
(A) compound, (B) compounds, (C) compounding, (D) compound in, (E) compounded
2. The new machine _____ the engineers attracted many possible sponsors.
(A) production, (B) produced, (C) produced by, (D) producing, (E) producing by
3. The development of new technologies _____ challenging.
(A) remain, (B) remains, (C) is remained, (D) are remained, (E) remaining
4. Each of the members _____ been selected by election.
(A) have, (B) has, (C) is, (D) are, (E) were
5. The submitted paper was published _____ November 2023.
(A) at, (B) of, (C) in, (D) on, (E) for
6. _____ solve the issues, we have previously developed a special machine.
(A) In, (B) Of, (C) For, (D) From, (E) To
7. A microscope _____ a small thing appear much larger than it is.
(A) make, (B) makes, (C) made in, (D) made from, (E) making
8. The narrower channel fabrication is _____ fabrication than the wider channel fabrication.
(A) difficult, (B) more difficult, (C) most difficult, (D) difficulty, (E) difficulties
9. The glass material has good _____ for chemical samples.
(A) stay, (B) stable, (C) stability, (D) static, (E) steady
10. The _____ of the coated material was nanometer level.
(A) thick, (B) thicker, (C) thickest, (D) thickness, (E) thicks.
11. The characteristic _____ of the sample were performed by the experiments.
(A) analyze, (B) analyzed, (C) analyst, (D) analysis, (E) analyses
12. The droplet size _____ as the pressure increases.
(A) depends, (B) demands, (C) decreases, (D) defends, (E) defines
13. The errors in the data were estimated using calculations of standard _____.
(A) delivery, (B) demonstration, (C) deviation, (D) declaration, (E) decomposition

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14. The target molecule was damaged by _____ measurement methods.
(A) incentive, (B) inventive, (C) instinctive, (D) instructive, (E) invasive
15. Phase _____ occurs during the boiling of the water.
(A) transition, (B) transmission, (C) translation, (D) transaction, (E) transportation
16. The Carnot cycle is closely related to the second law of _____.
(A) thermal, (B) thermally, (C) thermodynamic, (D) thermodynamics, (E) thermodynamically
17. The meeting had great difficulty in developing a consensus due to the _____ opinions of members.
(A) trivial, (B) common, (C) divergent, (D) explicit, (E) fundamental
18. Too much information in the presentation disturbed a better _____ of the audience.
(A) beauty, (B) understanding, (C) element, (D) transparency, (E) concern
19. The energy conversion _____ was improved by the doping of different ions.
(A) efficiency, (B) intelligence, (C) mineral, (D) prestige, (E) stomach
20. Discovered air bubbles trapped thousands of years ago in Antarctic ice are _____ time capsules filled with information for scientists.
(A) amiable, (B) impenetrable, (C) treatable, (D) valuable, (E) unreasonable
21. The _____ of the particles under a pressure-driven flow was recorded using a microscope and camera.
(A) director, (B) perception, (C) security, (D) trajectory, (E) wisdom
22. The unit of energy is _____.
(A) W, (B) N, (C) N/m, (D) N/m², (E) J
23. _____ is calculated by multiplying current by voltage.
(A) Resistance, (B) Power, (C) Force, (D) Intensity, (E) Capacitance
24. Silicon carbide (chemical formula: _____) is widely used as a semiconductor material.
(A) SC, (B) SCa, (C) SiC, (D) SiCO, (E) SiCa
25. The _____ energy from the turbine is converted into electric power in a power plant.
(A) electric, (B) thermal, (C) chemical, (D) optical, (E) kinetic

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Questions II (2.5 points each)

Try to help complete the description of nanofluidics by filling in the answers. In addition, try to answer the related questions.

Nanofluidics is the study of fluids ____26____ in nanochannels (channel size: 1-1000 nm) and has recently attracted much attention ____27____ the development of new functionalities and applications. For nanofluidics, precise channel fabrication and fluidic control are ____28____ at the nanometer scale. The primary feature of the nano-spaces involved in this field is their small size since spaces on the nanometer scale are similar to the size of macromolecules. The volumes of these nano-spaces are on the attoliter to femtoliter scale, which is many times smaller than the volumes of liquids handled in conventional bulk techniques. In addition, ____29____ the surface-to-volume ratio of a nano-space is extremely high, the surface is its ____30____ feature. In such nano-spaces, chemical properties such as ion concentrations can become heterogeneous even when uniform in the bulk liquid. Therefore, the unique aspects of nano-spaces (small dimensions, extremely low volumes, very high surface-to-volume ratios, and unique liquid properties) can be used to realize novel functional devices ____31____ difficult to obtain using conventional bulk spaces.

26. (A) confine, (B) confines, (C) confined, (D) is confined, (E) are confined
27. (A) regard, (B) regards, (C) regarded, (D) is regarded, (E) regarding
28. (A) require, (B) requires, (C) required, (D) need, (E) needs
29. (A) since, (B) from, (C) that, (D) however, (E) for
30. (A) assertive, (B) conscientious, (C) dominant, (D) graceful, (E) talented
31. (A) are, (B) that, (C) are that, (D) that are, (E) are going to be
32. What is equal to 1000 nm?
(A) 10^{-3} m, (B) 10^{-6} m, (C) 10^{-9} m, (D) 10^{-12} m, (E) 10^{-15} m
33. What is the volume of the cubic with 100 nm width, 100 nm height, and 100 nm length?
(A) 10^{-6} liter, (B) 10^{-9} liter, (C) 10^{-12} liter, (D) 10^{-15} liter, (E) 10^{-18} liter
34. When 1 nN is applied to the area with 1000 nm width and 1000 nm height, what is the pressure value?
(A) 1 mPa, (B) 1 Pa, (C) 1 hPa, (D) 1 kPa, (E) 1 MPa

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Questions III (3 points each)

Try to answer the following questions based on the figures and the description.

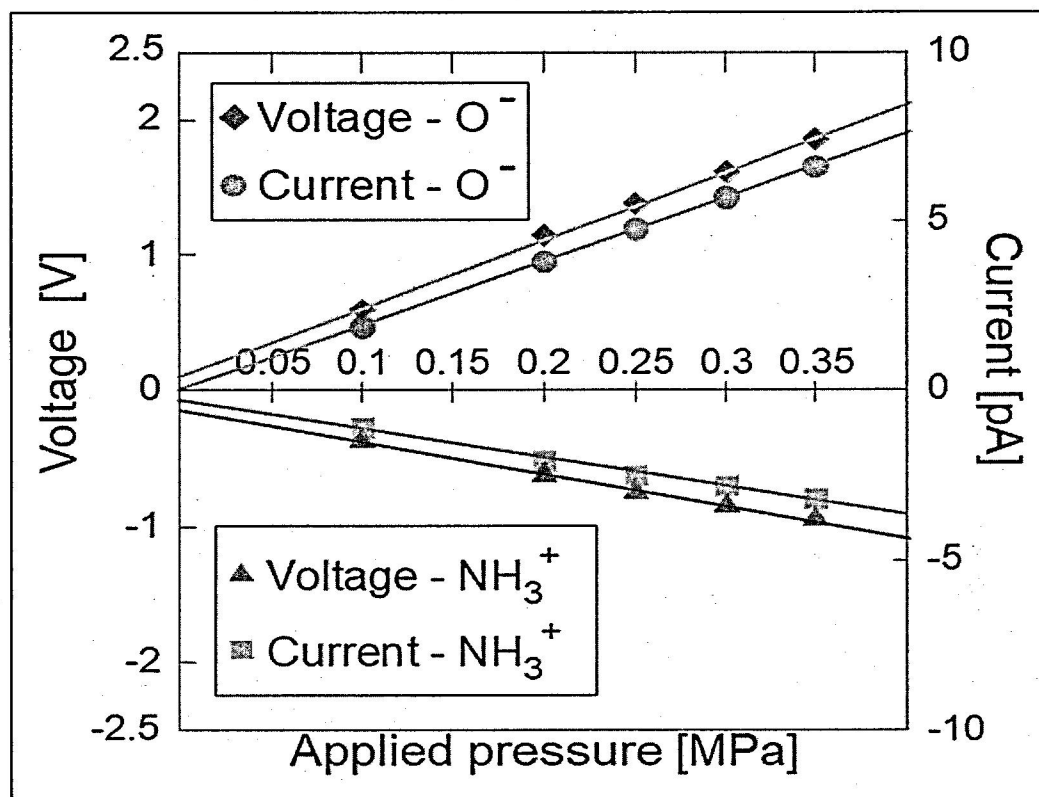


Figure 1. Measured voltage and current value as functions of applied pressure with controlling the pressure pump. “-O⁻” shows an unmodified glass surface, and “-NH₃⁺” shows a modified surface by amino group. The current and voltage were proportional to the applied pressure, which indicates that the flow rate inside the channels was increased according to the increase of applied pressures. Then, the increase of flow rate contributed to the increase of current and voltage. Positive current and voltage values were obtained on a negatively charged surface. A positively charged surface was obtained by modification with amino group, which resulted in surface amino groups yielding negative current and voltage values. Therefore, information corresponding to the surface charge state was reflected by the electric signals obtained.

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35. What parameters were measured and controlled?

- (A) Voltage was measured with controlling pressure.
- (B) Current was measured with controlling pressure.
- (C) Voltage and current were measured with controlling pressure.
- (D) Pressure was measured with controlling voltage and current.
- (E) All of the voltage, current, and pressure were controlled and measured.

36. Why current and voltage values on unmodified surface were increased with increasing the applied pressure?

- (A) Because the voltage increased the current.
- (B) Because the current increased the voltage.
- (C) Because the current and voltage induced the pressure.
- (D) Because the pressure induced the flow rate and flow rate induced the current and voltage.
- (E) Not mentioned.

37. What is the relationship between the electric signal and surface charge?

- (A) The electric signal with a sign opposite to the surface charge was obtained.
- (B) The electric signal with a sign similar to the surface charge was obtained.
- (C) The electric signal was obtained by neutral surface charge.
- (D) The electric signal was obtained by surface charge only on the unmodified surface.
- (E) No relationship between the electric signal and surface charge.

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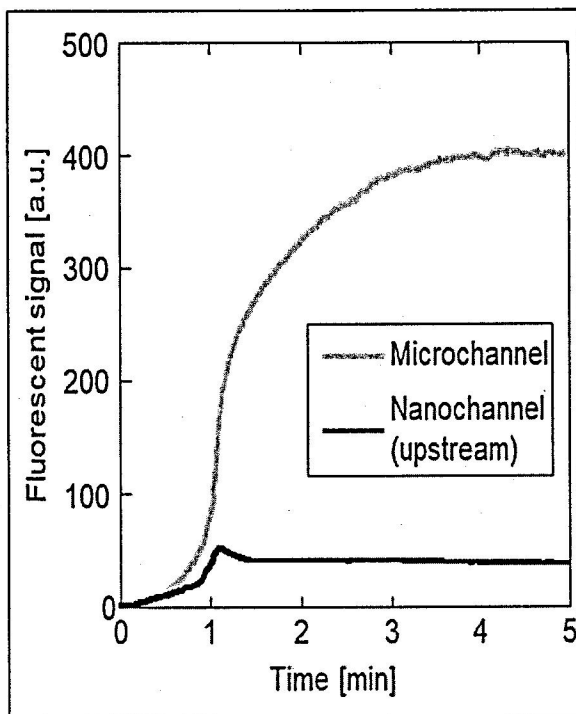


Figure 2: Results of liquid replacement from water to a fluorescent solution using the structure of nanochannel(upstream)-microchannel. The replacement of the liquid in the nanochannel was finished in approximately 1 minute because the fluorescent signal was saturated after 1 minute. Then, the fluorescent solution was continuously supplied to the microchannel, and the replacement of liquids in the microchannel was finished in approximately 4 minutes. The signal intensity of the microchannel was much higher than that of the nanochannel due to the difference in the channel sizes. The replacement time was reasonable because the flow rate of the system was 5 pL/min and the volume of the microchannel was 20 pL. From these results, liquid replacement in the microchannel using the nanochannel was successfully achieved.

38. Why did the fluorescent signal of the microchannel become stable after 4 minutes?
- (A) Because water was introduced to the microchannel after 4 minutes.
 - (B) Because the introduced fluorescent solution was diluted by water in the microchannel.
 - (C) Because water in the microchannel was replaced by the introduced fluorescent solution.
 - (D) Because the fluorescent solution in the microchannel was removed from the nanochannel.
 - (E) Not mentioned.
39. Choose the incorrect answer about the data in Figure 2.
- (A) The fluorescent solution was introduced from the microchannel to the nanochannel.
 - (B) It took approximately 4 minutes to replace the liquid in the microchannel because the fluorescent signal was saturated after 4 minutes.
 - (C) The size of the microchannel was much larger than the nanochannel. Therefore, the fluorescent signals of the microchannel were higher.
 - (D) To replace the 20 pL volume in the microchannel, 20 pL of fluorescent solution was introduced with 5 pL/min for 4 minutes.
 - (E) Finally, water in the microchannel and nanochannels was replaced with a fluorescent solution.