4th INTERNATIONAL JUNIOR SCIENCE OLYMPIAD TEST COMPETITION

December 4, 2007

Read carefully the following instructions:

1. The time available is 3 hours.
2. The total number of the questions is 30. Check that you have a complete set of the test questions and the answer sheet.
3. Use only the pen provided.
4. Write down your name, code, country and signature in your answer sheet.
5. Read carefully each problem and choose your correct answer by crossing one of the capital letters in your answer sheet. There is only one right answer for each problem.

   Example:

1	~~A~~	B	C	D

6. If you want to change your answer, you have to circle the first answer and then cross a new letter as your correct answer. You may only allow making one correction.

   Example:

1	~~A~~	B	C	~~D~~

   A is the first answer and D is the corrected answer

7. All competitors are not allowed to bring any stationary and tools provided from outside. After completing your answers, all of the question and answer sheets should be put neatly on your desk.
8. Point rules :
   - Correct answer : + 1.0 point
   - Wrong answer : – 0.25 point
   - No answer : 0.0 point

EXAMINATION RULES

1. All competitors must be present at the front of examination room ten minutes before the examination starts.

2. No competitors are allowed to bring any tools except his/her personal medicine or any personal medical equipment.

3. Each competitor has to sit according to his or her designated desk.

4. Before the examination starts, each competitor has to check the stationary and any tools (pen, ruler, calculator) provided by the organizer.

5. Each competitor has to check the question and answer sheets. Raise your hand, if you find any missing sheets. Start after the bell.

6. During the examination, competitors are not allowed to leave the examination room except for emergency case and for that the examination supervisor will accompany them.

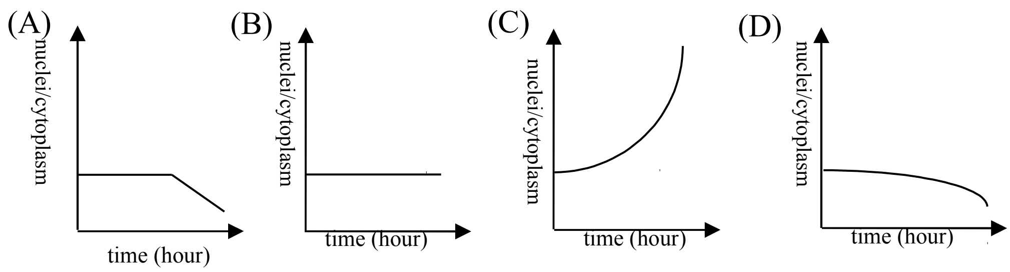
7. The competitors are not allowed to bother other competitor and disturb the examination. In case any assistance is needed, a competitor may raise his/her hand and the nearest supervisor will come to help.

8. There will be no question or discussion about the examination problems. The competitor must stay at their desk until the time allocated for the examination is over, although he/she has finished the examination earlier or does not want to continue working.

9. At the end of the examination time there will be a signal (the ringing of a bell). You are not allowed to write anything on the answer sheet, after the allocated time is over. All competitors must leave the room quietly. The question and answer sheets must be put neatly on your desk.

TEST COMPETITION

1. In general, during the early stage of embryogenesis, the zygote divides continuously. In this stage, the volume of the developing embryo does not obviously increase; however, the ratio of the total mass of nuclei to the total mass of cytoplasm for the developing embryo changes. Which one of the following curves shows the change of the ratio correctly?



2. The cell wall in plants is formed by the protoplast. The wall layer that is formed first makes up the primary wall (PW). The union region between the primary walls of the adjacent cells is called the middle lamella (ML). Many plant cells, such as fiber cells, also possess additional walls, known as the secondary wall (SW). Which one of the followings lists the correct sequence of the location of the wall layers between two mature fiber cells?

(A) PW, SW, ML, SW, PW

(B) SW, PW, ML, PW, SW

(C) ML, PW, SW, SW, PW, ML

(D) PW, ML, SW, SW, ML, PW

3. As plants undergo respiration, the ratio of the number of ATP produced to the consumed number of O_2 molecules is called the P/O ratio. Under normal condition, the ratio of P/O is 3. During respiration, the ratio of the number of CO_2 molecules released to the molecules of absorbed O_2 (CO_2 /O_2) is called Respiration Quotient (R.Q.). In general, certain organic substance, such as glucose ($C_6H_{12}O_6$ =α) , citric acid ($C_6H_8O_7$ =β), or fatty acid ($C_6H_{12}O_2$ =γ), is needed for the respiration of plants. When any one of these substances with the same amount of moles is supplied to plants, which one of the followings is the correct order for the values of R.Q. and the produced numbers of ATP generated by respiration of plants?

(A) R.Q.: $\beta \geq \cancel{>} \alpha \geq \cancel{>} \gamma$; the produced number of ATP: $\gamma \geq \cancel{>} \alpha \geq \cancel{>} \beta$

(B) R.Q.: $\gamma \geq \cancel{>} \alpha \geq \cancel{>} \beta$; the produced number of ATP: $\beta \geq \cancel{>} \alpha \geq \cancel{>} \gamma$

(C) R.Q.: $\gamma \geq \cancel{>} \alpha \geq \cancel{>} \beta$; the produced number of ATP: $\gamma \cancel{>} \geq \alpha \cancel{>} \geq \beta$

(D) R.Q.: $\beta \geq \cancel{>} \alpha \cancel{>} \geq \gamma$; the produced number of ATP: $\beta \geq \cancel{>} \alpha \geq \cancel{>} \gamma$

4. It is known that some specific species of fungi can facilitate the processes of seed germination and seedling growth for the orchids. Concerning the plant organs where the fungi are distributed and the relevant function of the fungi on the orchids, which one of the followings is correct?

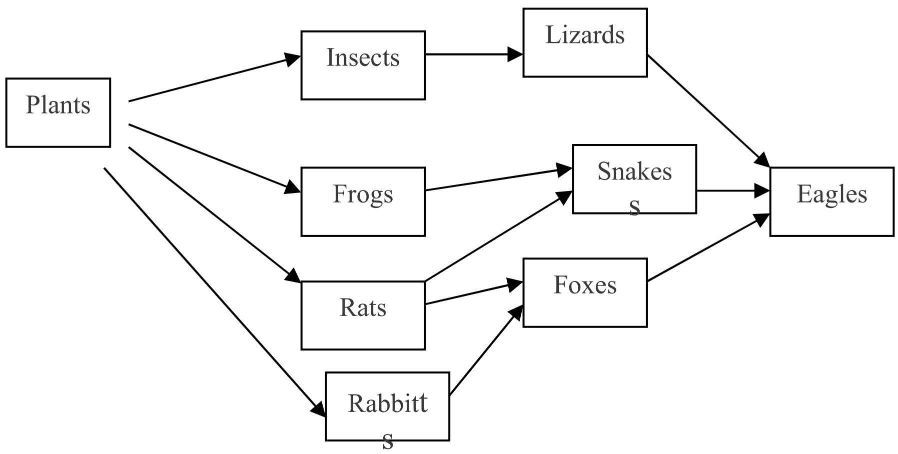
(A) fruit, for facilitating the digestion of nutrients

(B) leaf, for facilitating the formation of nutrients

(C) stem, for facilitating the transportation of water and nutrients

(D) root, for facilitating the water absorption

5. The figure shown below is the food-network of a community. Which one of the following consumers, if it becomes extinct, will make the most significant impact on this ecosystem?



(A) Lizards

(B) Snakes

(C) Eagles

(D) Rats

6. Regarding the functions of the stomach, which ones of the following statements are true?~~?~~

(1) digestion and decomposition of proteins

(2) digestion and absorption of fat

(3) killing of most bacteria in food

(4) storage of partial digested food

(A) 1, 2

(B) 1, 3

(C) 2, 4

(D) 2, 3

7. RU486 is a legal abortive drug and its pharmacological effect is to inhibit the progesterone binding with its receptor in endometrium, causing in endometrium erosion, and finally resulting in the abortion of early pregnancy. The effect of prostaglandin is to promote uterus contraction. If a woman were administrated with the combination usage of RU486 and prostaglandin within 49 days after the end of menses, the successful ratio of abortion could be high and ranges from 96% to 99%. However, this woman has to be strictly checked and traced by doctors for 2~3 weeks to guarantee her safety.

Administrated RU486 with prostaglandin can make women to abort. The following chart lists possible effects of these drugs. Which combination is correct ?

RU486 action	Prostaglandin action
1. inhibit progesterone receptor formation	a. promote the binding of RU486 to the progesterone receptor
2. promote progesterone action	b. relieve pain
3. inhibit embryo implantation	c. anesthetic effect
4. cause endometrium inflammation	d. strengthen uterus contraction

(A) 1, d
(B) 2, a
(C) 3, d
(D) 4, c

8. Which one of the following experience is the most critical evidence for proving the relevance of *Helicobacter pylori* infection with gastric ulcer?

(A) *H. pylori* is found in all gastric ulcer patients' stomach.

(B) Widely effective antibiotic treatment can successfully cure gastric ulcer.

(C) Gastric ulcer can be induced in healthy people who are infected by *H. pylori.*

(D) Patients, treated with drugs that inhibit gastric acid secretion to reduce *H. pylori* growth, can successfully cure gastric ulcer.

9. Mr. Wang and his wife had twin babies of a boy and a girl. The probability that the twin babies possess the same X chromosome is

(A) 1/2

(B) 1/4

(C) 1/6

(D) 1/8

10. The Logol solution is a kind of fixatives for storage of phytoplanktons in the field studies. It is known that a 200 mL Logol-solution contains 20 g of KI, 10 g of I_2, 10 mL of glacial acetic acid, and 2.5 % of formaldehyde. Commercial formalin, containing formaldehyde near 40 %, is used for making the Logol solution. Therefore, if one wants to use formalin to prepare a 200 mL Logol-solution, one needs__X__ml of formalin. Robert prepared an incorrect 200 mL Logol-solution by mistaking the percentage of formaldehyde in formalin for 100 %. He tried to remedy this incorrect Logol-solution by adding more solutions to make it to be a 400 mL Logol solution. He first added some water to the incorrect Logol-solution, and then he added 20 g KI, 10 g I_2, 10 mL glacial acetic acid, and Y__mL formalin. Finally, he added more water so that the total volume of the solution is 400 mL exactly. What are X and Y ?

(A) 5, 10

(B) 12.5, 12.5

(C) 12.5, 20

(D) 12.5, 25

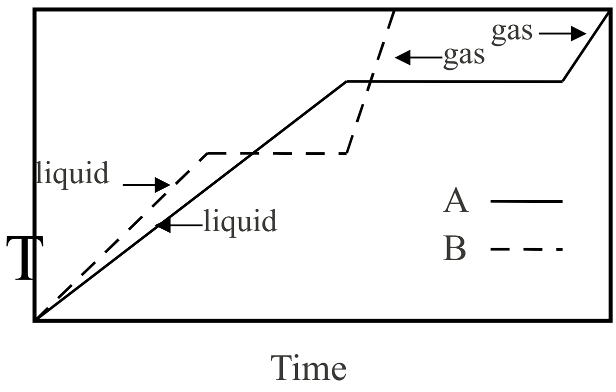
11. The following figure shows the heating curves of two liquids A and B obtained by measuring temperatures (T) as a function of time using a burner with a constant heating rate. Suppose that two liquids have the same mass. Which one of the following statements is correct?

(A) The boiling point of B is larger than that of A.

(B) The specific heat capacity of gas is greater for B than for A.

(C) The heat of vaporization per gram of liquid for A is greater than that for B.

(D) The specific heat capacity of gas is greater than that of liquid for substance B.



12. An electrochemical cell is made by connecting a copper electrode in 0.25 L of 0.100 M $CuSO_4$ solution and a silver electrode in 0.25 L of 0.100 M $AgNO_3$ solution via salt bridge. What is the final concentration of Cu^{2+} (in M) in the anode compartment if it produces an average current of 1.0 A for 12 min? (Faraday = 96485 Coulomb·mol^{-1})

(A) 0.085

(B) 0.115

(C) 0.130

(D) 0.145

13. The density of an unknown substance in the gaseous state is 1.62 g·L^{-1} at 300 K and 1 atm. Which one of the following could be the substance? (relative atomic mass: C=12, O=16, Ne=20, Ar=40, R=0.082 L·atm·mol^{-1}·K^{-1})

(A) Ne

(B) Ar

(C) O_2

(D) CO_2

14. What compound in limestone and marble is corroded by acid rain?

(A) $CaSO_4$

(B) $CaCO_3$

(C) $BaSO_4$

(D) $PbSO_4$

15. Which one of the followings is the correct description of water and D_2O?

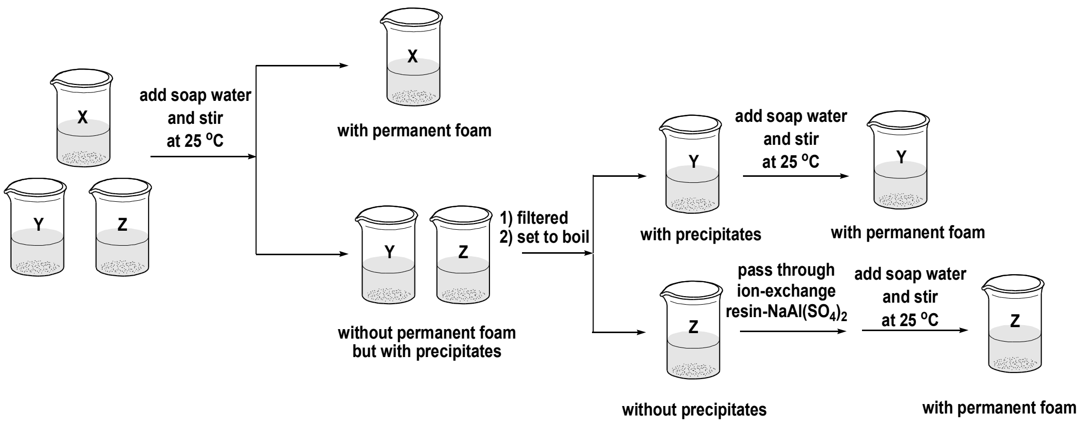
(A) Water and D_2O have the same boiling temperature at the same pressure.

(B) D_2O has one more neutron than the water molecule does.

(C) Both water and D_2O can react with alkali metals vigorously.

(D) ${}^{1}_{1}H$ and ${}^{2}_{1}D$ are allotropes

16. Three randomly labeled beakers, X, Y, and Z, contain either temporary hard water, distilled water, or permanent hard water. They are subjected to a sequence of analytical tests shown in the following figure.



Which one of the followings is the correct identification of their individual content to beakers labeled as X, Y, and Z in that sequence?

(A) distilled water, temporary hard water, permanent hard water

(B) permanent hard water, distilled water, temporary hard water

(C) temporary hard water, distilled water, permanent hard water

(D) distilled water, permanent hard water, temporary hard water

17. The enthalpy of combustion for naphthalene ($C_{10}H_8$) is -1230 kcal·mol^{-1}. The enthalpies of formation for $CO_{2(g)}$ and $H_2O_{(l)}$ are -94 and -68 kcal·mol^{-1}, respectively. What is the enthalpy of formation for naphthalene?

(A) -926 kcal·mol^{-1}

(B) +18 kcal·mol^{-1}

(C) +222 kcal·mol^{-1}

(D) -1680 kcal·mol^{-1}

18. Three solutions of equal volume are labeled as A : 0.05 M $HCl_{(aq)}$, B : 0.05 M $H_2SO_{4(aq)}$, and C : 0.05 M $CH_3CO_2H_{(aq)}$. Which one of the following statements is correct?

(A) pH value : B$\geq\cancel{>}$A $\cancel{>}\geq$C

(B) the amount (in moles) of salt produced when each solution is neutralized with the same concentration of aqueous NaOH : B$\geq\cancel{>}$A=C

(C) the amount of NaOH (in mL) needed when each solution is neutralized with the same concentration of aqueous NaOH : B$\cancel{>}\geq$A=C

(D) the final pH value when each solution is neutralized with the same concentration of aqueous NaOH : A< C$\leq\cancel{<}$B

19. There are four metals labeled as M, N, X, and Y. Their corresponding metal ions are M^{2+}, N^{2+}, X^{2+}, and Y^{2+}, respectively. The reaction profiles among them are compiled as shown in the Table below. When M is not reactive toward N^{2+}, it is marked as (−). Conversely, when M is reactive toward X^{2+}, it is marked as (+). Which one of the following statements is correct?

(A) the strongest reducing agent is X

(B) the order of reduction potential is : X$\geq\cancel{>}$N$\geq\cancel{>}$Y$\geq\cancel{>}$M

(C) X^{2+} can oxidize metals M, N, and Y

(D) metals M, N, and X can reduce Y^{2+}

metal / metal ion	**M**	**N**	**X**	**Y**
M^{2+}		+	−	+
N^{2+}	−		−	+
X^{2+}	+	+		+
Y^{2+}	−	−	−	

20. Which of the following combinations of elements of given atomic numbers can lead to a compound with a chemical formula of XY_3?

(A) 2 and 6

(B) 5 and 15

(C) 3 and 18

(D) 13 and 17

21. It is known that when one uses a single battery in connection with a light bulb, the battery can last for time t_0. If one tries to use two identical batteries in connection with two identical light bulbs, which one of the following statements is correct?

(A) If the batteries are in parallel and the light bulbs are in series, the batteries can power for $t_0/2$.

(B) If the batteries are in series and the light bulbs are in series, the batteries can power for 2 t_0.

(C) If the batteries are in parallel and the light bulbs are in parallel, the batteries can power for t_0.

(D) If the batteries are in series and the light bulbs are in parallel, the batteries can power for $4t_0$.

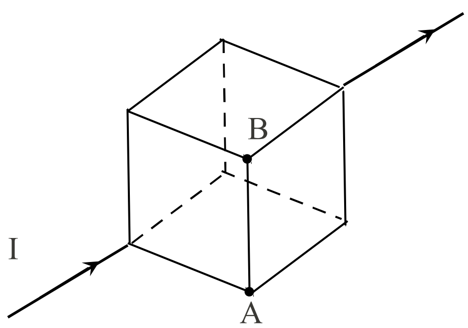
22. Twelve identical resistances are placed at edges of a cube and are connected in the way as the following figure indicates. If a current I is introduced as shown in the figure, what is the current that flows from point A to point B? (negative sign indicates opposite flow direction)

(A) –I/6

(B) –I/3

(C) I/6

(D) I/3



23. A 10 g bullet moving on a horizontal straight line at 500 $m\cdot s^{-1}$ penetrates a 1.0 kg block moving on the same line at -1 $m\cdot s^{-1}$ on a frictionless surface. Right after being penetrated by the bullet, the block moves at 2 $m\cdot s^{-1}$. What is the velocity of the bullet right after it emerges from the block?

(A) 100 $m\cdot s^{-1}$

(B) 200 $m\cdot s^{-1}$

(C) 300 $m\cdot s^{-1}$

(D) 400 $m\cdot s^{-1}$

24. It is known that when 0.1 kg of metal A at 52 ℃ is placed in 0.3 kg of some liquid B at 10 ℃, the final temperature is 16 ℃. Assuming that all of the relevant heat capacities do not depend on temperatures and there is no heat loss, what is the final temperature when 0.2 kg of metal A at 60 ℃ is placed in 0.5 kg of liquid B at 12 ℃ ?

(A) 42 ℃

(B) 36 ℃

(C) 28 ℃

(D) 20 ℃

25. An expanding supernova remnant (SNR) with angular size 120 arcmin (1 degree equal to 60 arcmin.) was discovered in our Galaxy. If the remnant is at 12000 ly (light year) from us with a constant expansion velocity of 6,000 $km\cdot s^{-1}$, when approximately did the progenitor star of the SNR explode? (speed of light : 3.0×10^{5} $km\cdot s^{-1}$)

(A) 12,000 years ago

(B) 22,000 years ago

(C) 32,000 years ago

(D) 42,000 years ago

26. Prof. Z discovers five objects in close to a Sun-like star. The physical properties of these objects derived from the data (see Table below) indicate that only 3 of them are planets orbiting the star, which of the observations are impossible? (Using circular orbits to analyze all the motions involved.)

Object	Velocity ($km \cdot s^{-1}$)	Mass (Earth mass)	Orbital radius (AU)
I	25.0	3	5
II	9.5	2	10
III	6.0	90	23
IV	4.0	17	35
V	3.4	15	80

(1 AU = average Sun-Earth distance)

(A) I and II

(B) IV and V

(C) I and V

(D) I and IV

27. A rubber string of length 0.750 m is fixed at one end to the ceiling. It is found that the string further extends by 10.0 cm after a small ball of mass 0.100 kg is attached to the other end of the string and reaches equilibrium. Now if the ball is raised to the ceiling and released from rest, what is the maximum length of the string? Assume that when the rubber string extends, it behaves like a spring. (The potential energy of the spring with spring constant k and displacement x is $\frac{1}{2}kx^2$.)

(A) 0.750 m

(B) 0.850 m

(C) 1.00 m

(D) 1.25 m

28. It is known that for a given temperature, the amount of water vapor that can be kept in the air has a maximum. When the air contains maximum amount of water vapor, the saturated vapor density is fixed and is shown in the following table:

Temperature (℃)	0	4	8	12	16	20	24	28
saturated vapor density ($g{\cdot}m^{-3}$)	3.66	6.33	8.21	10.57	13.50	17.12	21.54	26.93

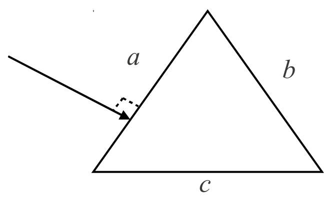
The relative humidity in percent is then defined to be

$$\frac{actual\ vapor\ density}{saturated\ vapor\ density} \times 100\%$$

Suppose that the initial temperature inside a car is 20 ℃ and the relative humidity is 80%. When the temperature inside the car decreases, at what temperature does the moisture start to form?

(A) 12 ℃
(B) 16 ℃
(C) 18 ℃
(D) 22 ℃

29. As shown in the following figure, a light ray travelling in the air is incident perpendicular to the side *a* of an equilateral prism with index of refraction 1.5. Which side will the light beam emerge and what is the angle θ between the



incident ray and the emerging ray?

	Emergent side	θ
(	*b*	$\theta = 60^\circ$
(	*b*	$\theta = 30^\circ$
(	*c*	$\theta = 60^\circ$
(	*c*	$\theta = 30^\circ$

30. A submarine is fixed underwater and emits two sound wave pulses into the water in the forward direction and then detects the echoes reflected from a moving object ahead. If the time interval between two emitted pulses is 10 s and the round-trip travel time intervals are 2.0 s and 2.1 s respectively, what is the average speed of the object moving away from the submarine? (Given that the speed of sound wave in water is 1520 $m \cdot s^{-1}$.)

(A) 3.8 $m \cdot s^{-1}$

(B) 7.6 $m \cdot s^{-1}$

(C) 15 $m \cdot s^{-1}$

(D) 23 $m \cdot s^{-1}$