UNIVERSITAS INDONESIA

Veritas, Probitas, Iustitia

NATURAL SCIENCES TEST

- Mathematics for Natural Sciences
- Biology
- Physics
- Chemistry
- Integrated Natural Sciences

SIMAK UI

ENTRANCE TEST
UNIVERSITAS INDONESIA
2014

GENERAL INSTRUCTIONS

1. Before you begin work on the test, check the number of questions and the page numbers in the test booklet.
   The booklet consists of a front page, a general instructions page, an answer sheet, and 13 question pages.
2. The answer sheet attached to this booklet can only be used for this test booklet. If you need a new answer sheet, you should use the test booklet which the answer sheet was attached.
3. You have to take the answer sheet from the test booklet. If the top left of the answer sheet is damaged or torn, the answer sheet still can be processed.
4. Write your student test number on the space provided in the answer sheet.
5. Read carefully each and every instruction on how to answer the questions.
6. Think carefully before answering every question, because an incorrect answer will deduct 1 point from your total score (scoring system: correct +4, blank 0, incorrect -1).
7. Work on questions you find easy first, then continue with harder questions.
8. Write your answers on the answer sheet provided.
9. Since scrap paper is not provided, you can make use of the empty space in your test booklet to do calculations. **Do not use the empty space on your answer sheet**.
10. During the test, you are not allowed to ask or seek explanation about the questions being tested to anyone including the test supervisor.
11. When you have finished doing the test, you are required to stay in your seat until the test supervisor approaches you to collect the answer sheet.
12. Make sure the answer sheet is not dirty, wet, folded, and torn.

SPECIFIC INSTRUCTIONS

INSTRUCTION A:
Choose the best answer.

INSTRUCTION B:
Each question consists of 3 parts, i.e. STATEMENT, CAUSE, and REASON that are arranged in sequence.
Choose:

(A) If the statement is correct, the reason is correct, and both show a cause and effect relationship.

(B) If the statement is correct, the reason is correct, but both do not show a cause and effect relationship.

(C) If the statement is correct and the reason is incorrect.

(D) If the statement is incorrect and the reason is correct.

(E) If the statement and the reason are both incorrect.

INSTRUCTION C:
Choose:

(A) If (1), (2), and (3) are correct.

(B) If (1) and (3) are correct.

(C) If (2) and (4) are correct.

(D) If only (4) is correct.

(E) If all of them are correct.

Answer Sheet
University of Indonesia's Entrance Test (SIMAK UI)

D3 S1

Testee's Name

Testee's Number

Answer Sheet's Number

	1	8							
0	○	○	○	○	○	○	○	○	○
1	●	○	○	○	○	○	○	○	○
2	○	○	○	○	○	○	○	○	○
3	○	○	○	○	○	○	○	○	○
4	○	○	○	○	○	○	○	○	○
5	○	○	○	○	○	○	○	○	○
6	○	○	○	○	○	○	○	○	○
7	○	○	○	○	○	○	○	○	○
8	○	●	○	○	○	○	○	○	○
9	○	○	○	○	○	○	○	○	○

Date of Birth

0	○	○	○	○	○	○	○	○
1	○	○	○	○	○	○	○	○
2	○	○	○	○	○	○	○	○
3	○	○	○	○	○	○	○	○
4	○	○	○	○	○	○	○	○
5	○	○	○	○	○	○	○	○
6	○	○	○	○	○	○	○	○
7	○	○	○	○	○	○	○	○
8	○	○	○	○	○	○	○	○
9	○	○	○	○	○	○	○	○

Hereby I declare that the data provided in this form are correct. I agree that if I violate the above statement, this answer sheet will not be processed.

Signature

First

Second

This answer sheet can only be used with its paired test book. Use 2B pencil to answer the questions and use a pen when you write your signature.

01	A○B○C○D○E○	21	A○B○C○D○E○	41	A○B○C○D○E○	61	A○B○C○D○E○	81	A○B○C○D○E○
02	○ ○ ○ ○ ○	22	○ ○ ○ ○ ○	42	○ ○ ○ ○ ○	62	○ ○ ○ ○ ○	82	○ ○ ○ ○ ○
03	○ ○ ○ ○ ○	23	○ ○ ○ ○ ○	43	○ ○ ○ ○ ○	63	○ ○ ○ ○ ○	83	○ ○ ○ ○ ○
04	○ ○ ○ ○ ○	24	○ ○ ○ ○ ○	44	○ ○ ○ ○ ○	64	○ ○ ○ ○ ○	84	○ ○ ○ ○ ○
05	○ ○ ○ ○ ○	25	○ ○ ○ ○ ○	45	○ ○ ○ ○ ○	65	○ ○ ○ ○ ○	85	○ ○ ○ ○ ○
06	○ ○ ○ ○ ○	26	○ ○ ○ ○ ○	46	○ ○ ○ ○ ○	66	○ ○ ○ ○ ○	86	○ ○ ○ ○ ○
07	○ ○ ○ ○ ○	27	○ ○ ○ ○ ○	47	○ ○ ○ ○ ○	67	○ ○ ○ ○ ○	87	○ ○ ○ ○ ○
08	○ ○ ○ ○ ○	28	○ ○ ○ ○ ○	48	○ ○ ○ ○ ○	68	○ ○ ○ ○ ○	88	○ ○ ○ ○ ○
09	○ ○ ○ ○ ○	29	○ ○ ○ ○ ○	49	○ ○ ○ ○ ○	69	○ ○ ○ ○ ○	89	○ ○ ○ ○ ○
10	○ ○ ○ ○ ○	30	○ ○ ○ ○ ○	50	○ ○ ○ ○ ○	70	○ ○ ○ ○ ○	90	○ ○ ○ ○ ○
11	○ ○ ○ ○ ○	31	○ ○ ○ ○ ○	51	○ ○ ○ ○ ○	71	○ ○ ○ ○ ○	91	○ ○ ○ ○ ○
12	○ ○ ○ ○ ○	32	○ ○ ○ ○ ○	52	○ ○ ○ ○ ○	72	○ ○ ○ ○ ○	92	○ ○ ○ ○ ○
13	○ ○ ○ ○ ○	33	○ ○ ○ ○ ○	53	○ ○ ○ ○ ○	73	○ ○ ○ ○ ○	93	○ ○ ○ ○ ○
14	○ ○ ○ ○ ○	34	○ ○ ○ ○ ○	54	○ ○ ○ ○ ○	74	○ ○ ○ ○ ○	94	○ ○ ○ ○ ○
15	○ ○ ○ ○ ○	35	○ ○ ○ ○ ○	55	○ ○ ○ ○ ○	75	○ ○ ○ ○ ○	95	○ ○ ○ ○ ○
16	○ ○ ○ ○ ○	36	○ ○ ○ ○ ○	56	○ ○ ○ ○ ○	76	○ ○ ○ ○ ○	96	○ ○ ○ ○ ○
17	○ ○ ○ ○ ○	37	○ ○ ○ ○ ○	57	○ ○ ○ ○ ○	77	○ ○ ○ ○ ○	97	○ ○ ○ ○ ○
18	○ ○ ○ ○ ○	38	○ ○ ○ ○ ○	58	○ ○ ○ ○ ○	78	○ ○ ○ ○ ○	98	○ ○ ○ ○ ○
19	○ ○ ○ ○ ○	39	○ ○ ○ ○ ○	59	○ ○ ○ ○ ○	79	○ ○ ○ ○ ○	99	○ ○ ○ ○ ○
20	A○B○C○D○E○	40	A○B○C○D○E○	60	A○B○C○D○E○	80	A○B○C○D○E○	100	A○B○C○D○E○

SIMAK UI

V(D3) S1R S1P Pro Sp. S2 S3

S2 S3

SUBJECTS	:	Mathematics for Natural Sciences, Biology, Physics, Chemistry, and Integrated Natural Sciences
EXAM DATE	:	15 JUNE 2014
TIME	:	120 MINUTES
NO. OF QUESTIONS	:	60

Notes	:	Questions on MATHEMATICS FOR NATURAL SCIENCES numbers 1 to 12
		Questions on BIOLOGY numbers 13 to 24
		Questions on PHYSICS numbers 25 to 36
		Questions on CHEMISTRY numbers 37 to 48
		Questions on INTEGRATED NATURAL SCIENCES numbers 49 to 60

MATHEMATICS FOR NATURAL SCIENCES

*Use **Instruction A** to answer questions number 1 to 12.*

1. Let $A = \int_0^1 \sqrt{1-x^4}dx$,
   $B = \int_0^1 \sqrt{1+x^4}dx$,
   $C = \int_0^1 \sqrt{1-x^8}dx$, then ... .
   (A) $A < C < 1 < B$
   (B) $A < C < B < 1$
   (C) $C < A < 1 < B$
   (D) $C < A < B < 1$
   (E) $A < B < 1 < C$

2. A quadratic equation $x^2 + 4x\cos\theta + \cot\theta = 0$ has multiple roots, then the value of θ, where $0 < \theta < \frac{\pi}{2}$, is ... .
   (A) $\frac{\pi}{6}$
   (B) $\frac{\pi}{12}$
   (C) $\frac{\pi}{3}$
   (D) $\frac{\pi}{6}$ or $\frac{5\pi}{6}$
   (E) $\frac{\pi}{12}$ or $\frac{5\pi}{12}$

3. If a,b,c are real numbers satisfying the following system
   $$\begin{cases} a+2b+3c = 12 \\ 2ab+3ac+6bc = 48, \end{cases}$$
   then the value of $a+b+3c$ is ... .
   (A) 8
   (B) 9
   (C) 10
   (D) 11
   (E) 14

4. Let $S = 2x + 2x^3 + 2x^5 + ... + 2x^{2k-1} + ...$, where $|x| < 1$, be written as $\frac{1}{P} - \frac{1}{Q}$. If P and Q are polynomial in x with integer coefficients, then $P+Q =$ ... .
   (A) 1
   (B) 2
   (C) $1+x$
   (D) $1-x$
   (E) $1-x^2$

5. The values of a and b so that $ax+2<3x+b$ for all $x<0$ are ... .

(A) $a>3, b=2$

(B) $a\geq 3, b=2$

(C) $a=2, b>3$

(D) $a<3, b=4$

(E) $a=3, b>2$

6. If the sum of the first 10 terms and the sum of the first 100 terms of a given arithmetic progression are 100 and 10, respectively, then the sum of the first 110 terms is ... .

(A) -140

(B) -130

(C) -120

(D) -110

(E) -100

7. Let A, B, C and D are four points in the 3-dimensional space. If $|\overrightarrow{AB}|=3, |\overrightarrow{BC}|=7, |\overrightarrow{CD}|=11$ and $|\overrightarrow{DA}|=9$, then $|\overrightarrow{AC}|.|\overrightarrow{BD}|$ = ...

(A) 0

(B) 1

(C) 2

(D) 3

(E) 4

8. Let $x\in\left[-\frac{5\pi}{12}, -\frac{\pi}{3}\right]$. Then the maximum value of

$$y=\tan\left(x+\frac{2\pi}{3}\right)-\tan\left(x+\frac{\pi}{6}\right)+\cos\left(x+\frac{\pi}{6}\right)$$

is ... .

(A) $\frac{12}{5}\sqrt{2}$

(B) $\frac{11}{6}\sqrt{2}$

(C) $2\sqrt{3}$

(D) $\frac{11}{6}\sqrt{3}$

(E) $\frac{12}{5}\sqrt{3}$

9. Suppose A and B are two angles such that

$$\begin{cases} \sin A+\sin B=1 \\ \cos A+\cos B=0. \end{cases}$$

The value of $12\cos 2A + 4\cos 2B$ is ... .

(A) 2

(B) 4

(C) 6

(D) 8

(E) 10

10. Let X and Y be nonempty subsets of $\mathbb{R}$ and let $f: X\to Y$ be a function and $f^{-1}(y)=\{x\in X | f(x)=y\}$. If $A\subseteq X$ and $B\subseteq Y$, the following statement which must be true is ... .

(A) $A\subseteq f^{-1}(f(A))$

(B) $B\subseteq f(f^{-1}(B))$

(C) $f^{-1}(f(A))\subseteq A$

(D) $f^{-1}(f(A))\subseteq f(f^{-1}(B))$

(E) $f(f^{-1}(B))=f^{-1}(B)$

11. Given a cubic function of the form $y=ax^3+bx^2+cx+d$. If the slope of the tangent at the point of inflection is $2c$, then ... .

(A) $b^2+3ac=0$

(B) $b^2-3ac=0$

(C) $3b^2+ac=0$

(D) $3b^2-ac=0$

(E) $b^2-4ac=0$

12. Cube $ABCD.EFGH$ has edge length 1 and is cut by a plane passing through vertex D and the midpoints M and N of $\overline{AB}$ and $\overline{CG}$, respectively. The plane divides the cube into two solids. The volume of the larger of the two solids can be written in the form $\frac{p}{q}$ where p and q are relatively prime positive integers. The value of $p+q$ is ... .

(A) 7

(B) 41

(C) 49

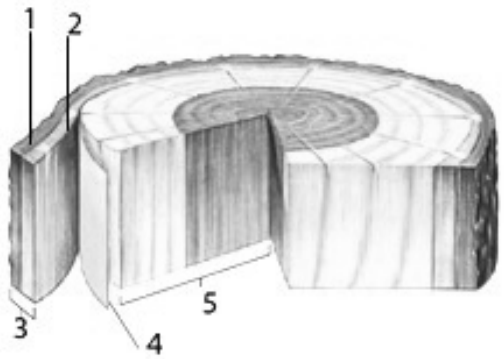
(D) 55

(E) 89

BIOLOGY

*Use **Instruction A** to answer questions number 13 to 17.*

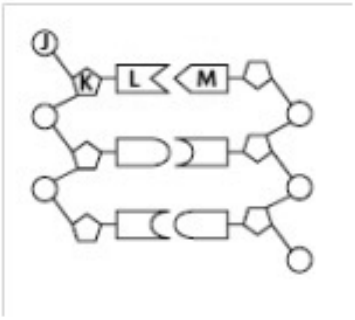
13. Which of the following group of organisms, is the early development of Eukaryotic?
    (A) Archaea
    (B) Fungi
    (C) Plantae
    (D) Protists
    (E) Animalia

14. 

    Use the figure of the stem cross-section to answer the question. The parts resulted from the secondary growth are ... .
    (A) 4 and 5
    (B) 2 and 5
    (C) 1 and 2
    (D) 2 and 4
    (E) 3 and 5

15. The number of chromosomes of a cell during metaphase I of meiosis when the cell has 6 chromosomes during interphase is ... .
    (A) 3
    (B) 6
    (C) 12
    (D) 24
    (E) 36

16. The meaning of the term Blue Carbon Sink is ... .
    (A) the process of carbon uptake by marine organisms autotrophs
    (B) the process of petroleum formation of carbon deposits
    (C) the process of sinking carbon in the form of lime in the sea
    (D) the process of dissolution of lime in the ocean at deep of 5000 meters
    (E) the process of carbon sequestration by forests in the taiga

17. 

    Look at the image above. The JKL symbol in it is called ... .
    (A) DNA
    (B) Nitrogen Bases
    (C) Nucleotide
    (D) Deoxyribose
    (E) Genes

*Use **Instruction B** to answer questions number 18 to 22.*

18. Ecdison hormone plays an important role in the growth of insects.

    BECAUSE

    The hormone serves to stop the molting process.

19. Protein synthesis in eukaryotic cells occurs in the ribosome.

    BECAUSE

    Ribosomes can be found in prokaryotic cells.

20. The strobilus pine plants have a cone-shaped.

    BECAUSE

    Pine plants belong to Conifer.

21. Stomata are open when the air is saturated.

    BECAUSE

    Water enters into the guard cell by osmosis.

22. Urethra in men is only to drain urine.

    BECAUSE

    Urethra begins from the bladder.

*Use **Instruction C** to answer questions number 23 to 24.*

23. Which of the following is/are the characteristic(s) of annelid?

    (1) Its nerve is located on the ventral side of body.
    (2) It has segmentation on the body.
    (3) It has a coelom.
    (4) It is a parasitic on aquatic animal.

24. Nephridia is an organ of excretion system that serves to filter ... .

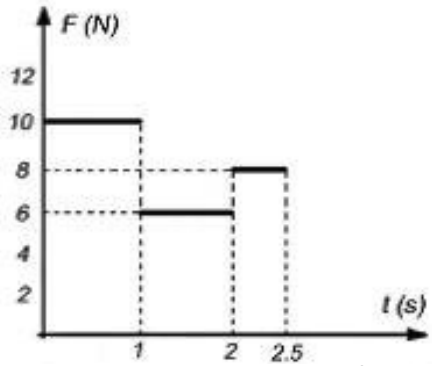
    (1) ammonia
    (2) uric acid
    (3) urea
    (4) urine

PHYSICS

*Use **Instruction A** to answer questions number 25 to 36.*

25. A particle moves along a straight line in such a way that its displacement during any given interval of 1 second is 3 meters larger than its displacement during the previous interval of 1 second. Which one of the following options is correct?
    (A) The particle moves with constant acceleration of $3\,m/s^2$.
    (B) The particle moves with constant velocity of 3 m/s.
    (C) The particle moves with constant acceleration of $6\,m/s^2$.
    (D) The acceleration of the particle is increasing with time.
    (E) The particle moves with constant velocity of $6\,m/s^2$.

26. A truck weighing 6000 kg runs into a car weighing 800 kg. The truck was moving at $15\,ms^{-1}$ and the car was at rest. Assuming that the truck and car continue moving together, the final speed of the combined car/truck system is ... .
    (A) $1.8\,ms^{-1}$
    (B) $7.5\,ms^{-1}$
    (C) $13.0\,ms^{-1}$
    (D) $17.0\,ms^{-1}$
    (E) $113.0\,ms^{-1}$

27. 

The diagram above shows changing force which is applied to a body with the mass of 5 kg in the same direction. The body is initially at rest. What is the final speed in m/s after 2.5 s?
    (A) 4
    (B) 6
    (C) 8
    (D) 10
    (E) 12

28. A block of 0°C ice with the mass of 50 kg mass slides on a horizontal surface. The initial velocity of the ice is 6.0 m/s and it stops after a distance of 28.3 m. How much ice melts due to the friction? (specific latent heat of fusion of ice, $L_f = 80$ cal/g and 1 cal = 4.18 J and ignore the heat transfers to the environment) ...
    (A) 2.7 g
    (B) 4.7 g
    (C) 11.2 g
    (D) 47.0 g
    (E) 57.2 g

29. Which of the following is the best evidence that light is a wave?
    (A) Light beams can interfere
    (B) Light energy comes in packets called photons
    (C) Light beams can be reflected
    (D) Light beams travel in straight lines
    (E) Light comes in different colours

30. Television signals are carried by radio waves, which travel at the speed of light 3×10^8 m/s. The frequency of a certain television channel is 600 MHz. The corresponding wavelength is therefore:

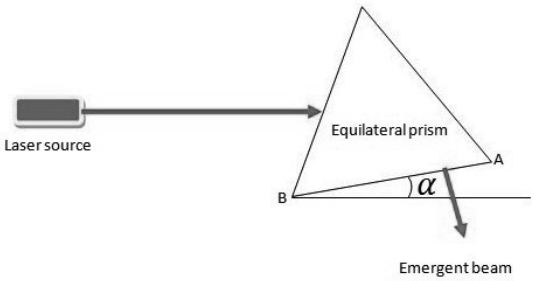
(A) 5 km

(B) 50 m

(C) 5 m

(D) 50 cm

(E) 5 cm

31. 

A light beam from a laser source which is parallel to a horizontal surface hits an equilateral prism as shown in the figure above. What is the angle α (between AB and the horizontal surface) if the emergent beam is perpendicular to the face AB? (Refractive index of the prism is 2) ...

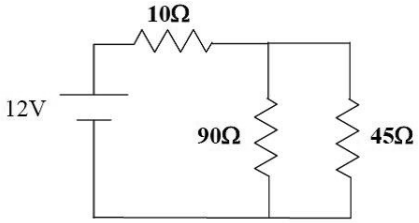
(A) 15.0°

(B) 24.5°

(C) 30.0°

(D) 42.5°

(E) 46.0°

32. 

In the circuit above there is a current of 0.3 amps flowing through the 10 ohm resistor. How much current flows through the 90 ohm resistor?

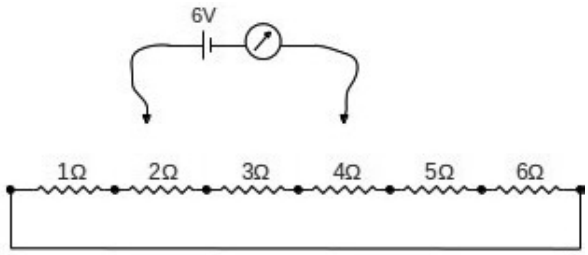
(A) 0.05 A

(B) 0.10 A

(C) 0.15 A

(D) 0.20 A

(E) 0.30 A

33. 

Consider six resistances connected as shown in the figure above. Note that the extreme ends are shorted. A circuit element consisting of a 6V battery and an ideal ammeter can be connected across any two different points marked by dots in the resistance network.
The *minimum* possible value of the current passing through the ammeter would be ... .

(A) 0.29 A

(B) 1.15 A

(C) 1.17 A

(D) 1.41 A

(E) 1.71 A

34. A solid steel ball with a small positive electrical charge on it is brought into contact with an identical uncharged ball and then they are separated. After the contact, the electrical charges on the balls are ... .

(A) swapped : the charge is transferred to the second ball

(B) unchanged : static electricity cannot flow

(C) unchanged : the charge is in the interior of the ball and cannot affect the second ball

(D) cancelled : there is no net charge after the contact

(E) equal : the original charge is shared equally between the two balls.

35. If generator at a hydro power station with 2000 kg/s of water flowing through its turbine at a speed of 10 m/s converts 80% of the water's kinetic energy to electricity, the electrical power output from the turbine is ... .

(A) 80 kJ

(B) 80 kW

(C) 800 kW

(D) 800 KJ

(E) 8000 MW

36. The Earth is 81 times more massive than the moon and for the purpose of this question they can be assumed to be a stationary frame of reference where Newton's laws of motion apply. As explained by an observer on Earth, the moon does not fall and crash into the Earth because ... .

(A) the net force on it is zero

(B) it is being pulled by the Sun and planets as well as the Earth.

(C) it is in the Earth's gravitational field.

(D) the Earth is spinning.

(E) it is possible to accelerate towards something indefinitely without reaching it.

CHEMISTRY

*Use **Instruction A** to answer questions number 37 to 44.*

37. The following experiment is performed to determine the reaction rate of $2A + B \rightarrow A_2B$, and the obtained table below shows the variation of concentration of reactants A and B.

	[A]	[B]	rate
1.	0.050 M	0.050 M	5 $M.s^{-1}$
2.	0.050 M	0.100 M	10 $M.s^{-1}$
3.	0.025 M	0.050 M	2.5 $M.s^{-1}$
4.	0.100 M	0.100 M	20 $M.s^{-1}$

The overall rate law of this reaction is ... .

(A) rate = $k[A]^2[B]^2$

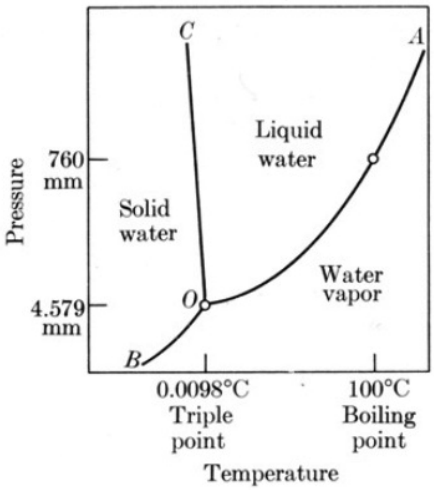
(B) rate = $k[A]^2[B]$

(C) rate = $k[A][B]^2$

(D) rate = $k[A][B]$

(E) rate = k

38.



Consider the water phase diagram above.
The volume of one mole of water in solid phase at the triple point is ... . (At the triple point, the density of $H_2O_{(l)}$ is 0.9998 $g.mL^{-1}$ and the density of $H_2O_{(s)}$ is 0.90 $g.mL^{-1}$. Ar O=16, H=1)

(A) 1 mL

(B) 2 mL

(C) 18 mL

(D) 20 mL

(E) $V = \dfrac{1 \times 0.0821 \times 273.17}{\frac{4.579}{760}}$ L

39. If NaF and $BaCl_2$ of the same volume are mixed, which of the following combinations does not obtain precipitate? Ksp $BaF_2 = 1.7 \times 10^{-7}$

(A) 0.0040 M $BaCl_2$ and 0.020 M NaF

(B) 0.010 M $BaCl_2$ and 0.015 M NaF

(C) 0.010 M $BaCl_2$ and 0.020 M NaF

(D) 0.015 M $BaCl_2$ and 0.010 M NaF

(E) 0.020 M $BaCl_2$ and 0.0020 M NaF

40. Given ozonolysis reaction below
$O_3 + Cl_2 \rightarrow 2OCl + \frac{1}{2}O_2$,
the enthalpy reaction (kJ/mol)of 1 mol Cl_2 is ... .
O-O = 142
O=O = 498
Cl–Cl = 242
Cl–O = 203

(A) −129

(B) −24

(C) −15

(D) 85

(E) 227

41. Which of these elements has the second lowest ionization energy?

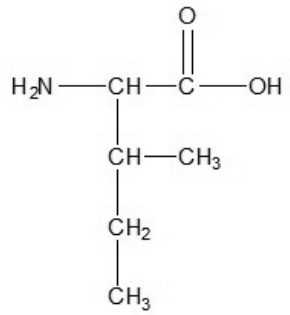
(A) Na

(B) K

(C) Rb

(D) Cs

(E) Li

42. 

Look at the structure of amino acid above, how many chiral centers does an ileusin have?

(A) 1

(B) 2

(C) 3

(D) 4

(E) none

43. Based on the follwing equilibrium reactions:
$N_2H_5^+ + NH_3 \rightarrow NH_4^+ + N_2H_4$
$HF + NH_3 \rightarrow NH_4^+ + F^-$
$N_2H_4 + HF \rightarrow N_2H_5^+ + F^-$
The correct order of acidity rates is ... .

(A) $NH_4^+ > HF > N_2H_5^+$

(B) $NH_4^+ > N_2H_5^+ > HF$

(C) $HF > NH_4^+ > N_2H_5^+$

(D) $HF > N_2H_5^+ > NH_4^+$

(E) $N_2H_5^+ > HF > NH_4^+$

44. HF is a weak acid (Ka = 6.7×10^{-4}). and NH_3 is a weak base (Kb = 1.8×10^{-5}). In A 1.0 M solution of NH_4F, which of the following condition is possible.

(A) F^- is a less basic than H_2O

(B) NH_4^+ is more basic than H_2O

(C) Hydrolysis degree of NH_4^+ is greater than F^-

(D) pH of solution is basic

(E) pH of solution is acid

*Use **Instruction B** to answer questions number 45 to 46.*

45. The compound $H_2C_2O_4$ participates readily both in acid-base reaction and in oxidation-reduction.

BECAUSE

In a basic solution, $H_2C_2O_4$ is ready to form a salt substance and can be oxidized by $KMnO_4$ forming CO_2.

46. Nitrogen dioxide, NO_2, undergo reactions to form nitrite ion, NO_2^-, and nitronium ion, NO_2^+. According to the Lewis method, structure nitrite ion is linear and the structure of nitronium ion is V-shaped.

BECAUSE

Nitrogen atom in nitrite ion has an electron pair, whereas in nitronium ion has no electron pair in its Lewis structure.

*Use **Instruction C** to answer questions number 47 to 48.*

47. What is the following metallic atom which does not have unpaired electron in *d* orbital?

(1) MnO_4^-

(2) $CuCl_2$

(3) CuCl

(4) $NiCl_4^{2-}$

48. Electrolysis 1.00 L solution of 1.00 M Na_2SO_4 is conducted by passing 1.0 amps electric current for 1 hour and 35 minutes. (1 atm, 25°C, 1 F = 95000 C)

(1) Gas H_2 is produced in cathode

(2) Solution in the cathode area is basic

(3) Gas O_2 is produced in anode

(4) Volume of gas collected in anode is 0.733 L

INTEGRATED NATURAL SCIENCES

COULD BLOOD BE USED TO POWER BATTERIES?

Batteries are practically essential devices but present a lot of problems, e.g. the trouble retaining the charge, overheat or leak or even explode. They are also rigid and sometimes bulky. In 2007, a group of scientists at Rensselaer Polytechnic Institute has claimed that they have created a battery that uses the electrolytes naturally found in bodily fluids. It has generated some excitement as part of a new crop of "bio-batteries" that run off of bodily fluids or other organic compounds. The battery essentially is a paper, consists of 90 % of cellulose and 10 % of aligned carbon nanotubes, give the paper its conductive abilities and also make it black, creating what is called a nanocomposite paper. Using nanotechnology, the battery's small size, flexibility and replenishing electrolyte source, make it ideal for medical applications. The nanocomposite paper can have holes poked in it or be cut into unusual shapes and continue to function. Several sheets could be lumped together to power medical implants, such as pacemakers, artificial hearts or advanced prosthetics. The battery would easily fit under the skin without causing any discomfort. Because the ionic liquid used does not freeze or evaporate like water, the battery could be employed at a wide range of temperatures: from -73°C up to 149°C. The researchers behind the battery claim that their device is unique because it can act "as both a high-energy battery and a high-power supercapacitor".

*Use **Instruction A** to answer questions number 49 to 50.*

49. The total cost to produce 3 bio-batteries of size 3cm × 5cm and 7 bio-batteries 2cm × 4cm is US$54. If a company plans to produce 10 bio-batteries of size 3cm × 5cm and 2cm × 4cm, how many batteries of size 3cm × 5cm can be produced?

    (A) 3

    (B) 4

    (C) 5

    (D) 6

    (E) 7

50. Organisms in which a circulating body fluid is distinct from the fluid that directly surrounds the body's cells are likely to have which of the following ... .

    (A) an open circulatory system

    (B) a closed circulatory system

    (C) a gastrovascular cavity

    (D) branched tracheae

    (E) hemolymph

*Use **Instruction C** to answer questions number 51 to 54.*

51. The correct statement is/are ... .

    (1) the nanocomposite paper consists of 90% silica or 10% carbon nanotubes
    (2) the nanocomposite paper consists of 90% silica and 10% of carbon nanotubes
    (3) nanocomposite paper consists of 90% cellulose or 10% of carbon nanotubes
    (4) the nanocomposite paper consists of 90% cellulose and 10% of carbon nanotubes

52. Supercapacitors may have either symmetric or asymmetric electrodes. Symmetry implies that both electrodes have the same capacitance value. For asymmetric capacitors one of the electrodes typically has a higher capacitance value than the other. The two electrodes form a series circuit of two individual capacitors C_1 and C_2. The correct statement is/are ... .

    (1) for symmetric capacitors $C_{total} = 0.5\ C_1 = 0.5C_2$
    (2) for symmetric capacitors the total capacitance value equals half the value of a single electrode
    (3) for asymmetric capacitors $C_{total} \equiv C_1 \equiv C_2$
    (4) for asymmetric electrodes the total capacitance may be approximately equal to that of one of the electrode

53. The electrolytes naturally found in bodily fluids ... .

(1) Keep the pH of the fluid balance at 7.8
(2) Can be used in galvanic cell such as batteries
(3) Can be used in electrolytic cell to switch on the light bulb
(4) Should be replenish to avoid cramp in the muscles

54. Carbon has four crystalline (ordered) allotropes ... .

(1) Diamond (sp3 bonding)
(2) Graphite (sp2)
(3) Carbyne (sp1)
(4) Fullerenes ('distorted'sp2)

THE BAD-BREATH DEFENSE

Bad breath can save a life, particularly for caterpillars, as reported by Ian Baldwin, a chemical ecologist. That is a scientist who studies how living things use chemicals to survive in their environment.

Many types of tobacco plants contain the chemical nicotine (density is 1.01 g/cm^3). This is the highly addictive ingredient in cigarettes that gives smokers a buzz of pleasure. A 30–60 mg (0.5-1.0 mg/kg) can be a lethal dosage for adult humans. It is also a natural poison that helps plants fight pests. At one time many farmers even used it as a pesticide. But the nicotine levels in tobacco plants do not kill the hornworms. In fact, the insects harness it as a chemical bodyguard.

Every living organism contains genes that carry the information to instruct each cell on what it should do. Some genes in tobacco tell it how and when to make nicotine. Baldwin and his coworkers changed these genes in some plants so that they no longer make nicotine.

When a hornworm caterpillar ate normal tobacco leaves, the insect's breath — which comes out of tiny structures called spiracles — turned nasty, the scientists found. The scientists identified a gene that helped caterpillars move nicotine out of their gut so it could be puffed out in their breath. The halitosis (another word for bad breath) was strong enough to drive away wolf spiders. These predators normally would feast on hornworms.

*Use **Instruction A** to answer questions number 55 to 58.*

55. A group of students was designing an experiment to test the effect of smoking on grass frogs. They hypothesized that to keep the frogs in a smoke-filled environment for defined periods would result in lung cancer in the animals. However, when they searched for previously published information to shore up their hypothesis, they discovered they were quite wrong in their original assessment. Even though they were never conducted their experiment (so as not to harm frogs needlessly), they knew that a more likely outcome would be ... .
    (A) the amphibian equivalent of hypertension
    (B) skin cancer
    (C) gill abnormalities in the next generation of tadpoles
    (D) tracheal tube abnormalities
    (E) diminished absorption of oxygen

56. With the density mentioned in the article, the volume of the 0.015 g chemical nicotine is ... . (round to the nearest thousandth)
    (A) 0.015 cm^3
    (B) 1.515 cm^3
    (C) 14.852 cm^3
    (D) 1.490 cm^3
    (E) 0.149 cm^3

57. In 5 kg of tobacco, the minimum and maximum lethal dosage of nicotine for adult humans are ... .
    (A) 148 cm^3 and 297 cm^3
    (B) 148 m^3 and 297 m^3
    (C) 0.148 dm^3 and 0.297 dm^3
    (D) 0.148 m^3 and 0.297 m^3
    (E) 0.148 litres and 0.297 litres.

58. A 100 kg man was hospitalized because overdose in nicotine. The blood test indicated a nicotine content of 0.617 mmol. If the empirical formula of nicotine is C_5H_7N, then the molecular formula of nicotine is ... .
    (A) C_5H_7N
    (B) $C_{10}H_{14}N_2$
    (C) $C_{20}H_{28}N_4$
    (D) $C_{2,5}H_{3,5}N_{0,5}$
    (E) $C_{50}H_{70}N_{10}$

*Use **Instruction C** to answer questions number 59 to 60.*

59. The correct statement is/are ... .
    (1) halitosis can drive away wolf spiders
    (2) the hornworm caterpillars eating normal tobacco leaves does not lead to halitosis
    (3) every gene in tobacco tells how and when to make-nicotine
    (4) every type of tobacco plants contains chemical nicotine

60. Why does nicotine in tobacco plant do not kill the hornworms?

(1) Nicotine is tobaco's secondary metabolit for plant growth and development.
(2) Tobacco is on of plant natural poison for spesific insects.
(3) Nicotine can be used as pesticide.
(4) The hornworms use the nicotin as bodyguard against their predators.