

2023 IUT 3rd Admission Test(SBL)

Math Examination(TYPE A)

< Multiple choice Types > There is only one correct answer per each question. Mark your answer choice on the OMR answer sheet.

- For each correct answer, you will get the points indicated next to each question number.
- No penalty point is applied to an incorrect answer.

1. [3 points]

Compute $\sqrt{7-\sqrt{48}} + \sqrt{5-\sqrt{24}}$.

- ① $\sqrt{2}$ ② $\frac{\sqrt{2}}{2}$ ③ $1 - \frac{\sqrt{2}}{2}$
 ④ $2 - \sqrt{2}$ ⑤ $2 - \frac{\sqrt{2}}{2}$

2. [3 points]

When $a = \sqrt{2} + 1$ and $b = \sqrt{2} - 1$, find $a^3 - b^3$.

- ① 14 ② 17 ③ 20 ④ 23 ⑤ 26

3. [3 points]

Compute $\sum_{k=1}^{14} \log_2 \frac{k+2}{k}$.

- ① $3 + \log_2 15$ ② $5 + \log_2 15$ ③ $9 + \log_2 15$
 ④ $12 + \log_2 15$ ⑤ $15 + \log_2 15$

4. [3 points]

When a polynomial $P(x)$ is divided by $x^4 - 1$, the remainder is $x^3 + 2x^2 - 3x + 1$. When $P(x)$ is divided by $x^2 - 1$, the remainder is $ax + b$. Find $a^2 + b^2$.

- ① 11 ② 13 ③ 15 ④ 17 ⑤ 19

5. [3 points]

When α, β, γ are the solutions of

$$x^3 - 5x^2 + 4x - 2 = 0, \text{ find } \frac{\beta + \gamma}{\alpha} + \frac{\gamma + \alpha}{\beta} + \frac{\alpha + \beta}{\gamma}.$$

- ① 1 ② 3 ③ 5 ④ 7 ⑤ 9

6. [3 points]

When $A = \begin{pmatrix} 3 & -1 \\ 4 & 1 \end{pmatrix}$, $B = \begin{pmatrix} 2 & -1 \\ 5 & -3 \end{pmatrix}$ and

$$BAB^{-1} = \begin{pmatrix} a & b \\ c & d \end{pmatrix}, \text{ find } a + b + c + d.$$

- ① -15 ② -17 ③ -19 ④ -21 ⑤ -23

7. [3 points]

When $A = \begin{pmatrix} 2 & 3 \\ 5 & 7 \end{pmatrix}$, $I = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ and

$$(A - 2I)(A^{-1} + I) = \begin{pmatrix} a & b \\ c & d \end{pmatrix}, \text{ find } a + b + c + d.$$

- ① 11 ② 13 ③ 15 ④ 17 ⑤ 19

8. [3 points]

When $x^2 + x^{-2} = 7$ for $x > 1$, find $x^3 - x^{-3}$.

- ① $2\sqrt{5}$ ② $4\sqrt{5}$ ③ $6\sqrt{5}$ ④ $8\sqrt{5}$ ⑤ $10\sqrt{5}$

9. [3 points]

When $\lim_{x \rightarrow 2} \frac{x^2 - 4}{x^2 + ax + b} = \frac{4}{5}$, find $a + b$.

- ① -1 ② -3 ③ -5 ④ -7 ⑤ -9

10. [3 points]

When $x + x^{-1} = 1$, find $5x^{30} - 3x^{20} - 3x^{10}$.

- ① 1 ② 2 ③ 4 ④ 6 ⑤ 8

11. [3 points]

Find $\left(\frac{\sqrt{2}(1-i)}{\sqrt{2}-\sqrt{2}+i\sqrt{2}+\sqrt{2}}\right)^2$.

- ① $-1 + i$ ② $\sqrt{2}(-1 + i)$ ③ $\frac{\sqrt{2}}{2}(-1 + i)$
④ $\frac{\sqrt{2}}{4}(-1 + i)$ ⑤ $\frac{\sqrt{2}}{8}(-1 + i)$

12. [3 points]

When $z = \frac{\sqrt{3}+i}{2}$, find z^{2023} .

- ① 1 ② i ③ $-\frac{\sqrt{3}+i}{2}$
④ $\frac{1-\sqrt{3}i}{2}$ ⑤ $\frac{\sqrt{3}-i}{2}$

13. [3 points]

When $25^a = 27^b = 15$, find $\frac{3}{2a} + \frac{1}{b}$.

- ① 1 ② 3 ③ 6 ④ 9 ⑤ 12

14. [3 points]

Solve the equation $8^x = 2^{2x+1} + 13 \cdot 2^x + 10$.

- ① $\log_2 5$ ② $\log_2 7$ ③ $\log_2 9$
④ $\log_2 11$ ⑤ $\log_2 13$

15. [3 points]

When $x = \log_2 \sqrt{3 + \sqrt{5}}$, find $4^x + 4^{1-x}$.

- ① 6 ② 8 ③ 10 ④ 12 ⑤ 14

16. [3 points]

Find the minimum value of the function

$$f(x) = |3x + 1| + |2x - 1|.$$

- ① $\frac{4}{3}$ ② $\frac{3}{2}$ ③ $\frac{5}{3}$ ④ $\frac{11}{6}$ ⑤ 2

17. [3 points]

Compute $\cos \frac{5\pi}{12}$

- ① $\frac{\sqrt{6}-\sqrt{2}}{\sqrt{2}}$ ② $\frac{\sqrt{6}-\sqrt{2}}{\sqrt{3}}$ ③ $\frac{\sqrt{6}-\sqrt{2}}{2}$
④ $\frac{\sqrt{6}-\sqrt{2}}{3}$ ⑤ $\frac{\sqrt{6}-\sqrt{2}}{4}$

18. [3 points]

When $\cos 2\theta = \frac{1}{3}$ for $0 < \theta < \frac{\pi}{2}$,

find $\sin \theta + \cos \theta$.

- ① $\frac{1}{3}$ ② $\frac{\sqrt{6}+\sqrt{3}}{3}$ ③ $\frac{\sqrt{6}-\sqrt{3}}{3}$
④ $\frac{\sqrt{6}+\sqrt{3}}{6}$ ⑤ $\frac{\sqrt{6}-\sqrt{3}}{6}$

19. [3 points]

Find the sum of all solutions of $5\sin x + 3 = \cos 2x$, ($0 \leq x \leq 2\pi$).

- ① π ② 2π ③ 3π ④ 4π ⑤ 5π

20. [3 points]

Find the sum of all solutions of

$$\log_3 x + 3 \log_{\sqrt{x}} 3 = 5.$$

- ① 12 ② 24 ③ 36 ④ 48 ⑤ 60

21. [4 points]

Find $\lim_{n \rightarrow \infty} (n+3 - \sqrt{n^2 - n + 5})$.

- ① $\frac{1}{2}$ ② $\frac{3}{2}$ ③ $\frac{5}{2}$ ④ $\frac{7}{2}$ ⑤ $\frac{9}{2}$

22. [4 points]

Find $\lim_{x \rightarrow 0} \frac{2x^3}{(1 - \cos x) \sin 3x}$.

- ① $\frac{2}{3}$ ② $\frac{4}{3}$ ③ 2 ④ $\frac{8}{3}$ ⑤ $\frac{10}{3}$

23. [4 points]

When $f(x) = \frac{1}{1 + \sqrt{x}}$, find $f'(4)$.

- ① $-\frac{1}{12}$ ② $-\frac{1}{18}$ ③ $-\frac{1}{24}$ ④ $-\frac{1}{30}$ ⑤ $-\frac{1}{36}$

24. [4 points]

When $y = ax + b$ is the tangent line to $f(x) = x^3 + x^2 - x + 1$ at $x = 1$, find $a^2 + b^2$.

- ① 4 ② 8 ③ 12 ④ 16 ⑤ 20

25. [4 points]

When M and m are the maximum and minimum values of $f(x) = x^3 + 3x^2 - 9x + 4$, ($0 \leq x \leq 2$), find $M + m$.

- ① 5 ② 7 ③ 9 ④ 11 ⑤ 13

26. [4 points]

When $f(x) = (x^3 - 2x^2 - 2x - 4)^4$, find $f'(3)$.

- ① -20 ② -28 ③ -36 ④ -44 ⑤ -52

27. [4 points]

Find $\int_1^2 (2x-1)^3 dx$.

- ① 6 ② 10 ③ 14 ④ 18 ⑤ 22

28. [4 points]

Find the minimum value of

$f(x) = \sin^3 x - 4\cos^2 x - 3\sin x + 5$, ($0 \leq x \leq 2\pi$).

- ① $\frac{11}{27}$ ② $\frac{13}{27}$ ③ $\frac{5}{9}$ ④ $\frac{17}{27}$ ⑤ $\frac{19}{27}$

29. [4 points]

Find $\int_0^1 \frac{2x+2}{\sqrt{2x^2+4x+1}} dx$.

- ① $\sqrt{2} - 1$ ② $\sqrt{3} - 1$ ③ $\sqrt{5} - 1$
④ $\sqrt{6} - 1$ ⑤ $\sqrt{7} - 1$

30. [4 points]

Find the area of the region enclosed by

$y = 2x^3 - x^2 + 3x - 1$ and $y = 2x^3 + 3x^2 + 3x - 2$.

- ① $\frac{1}{2}$ ② $\frac{1}{3}$ ③ $\frac{1}{4}$ ④ $\frac{2}{3}$ ⑤ $\frac{3}{4}$

2023 IUT 3rd SBL Answer Sheets

[TypeA]

No.	1	2	3	4	5	6	7	8	9	10
Ans.	④	①	①	②	④	⑤	④	④	③	⑤
No.	11	12	13	14	15	16	17	18	19	20
Ans.	③	③	②	①	①	③	⑤	②	③	③
No.	21	22	23	24	25	26	27	28	29	30
Ans.	④	②	⑤	⑤	①	⑤	②	②	⑤	④

Math Examination(TYPE A)

< Multiple choice Types > There is only one correct answer for each question. Mark your choice on the OMR answer sheet.

- The points for each question are listed next to the question number.
- You can use the right side of each page for your memo.

1. [2 points]

Simplify $\sqrt{4+2\sqrt{3}} + \sqrt{4-2\sqrt{3}}$.

- ① 1 ② $\sqrt{2}$ ③ $\sqrt{3}$
 ④ $2\sqrt{2}$ ⑤ $2\sqrt{3}$

2. [2 points]

Simplify $\left(\frac{1+i}{1-i}\right)^{50}$.

- ① -1 ② -i ③ 0 ④ 1 ⑤ i

3. [2 points]

When $x + \frac{1}{x} = 3$, find $x^3 + \frac{1}{x^3}$.

- ① 9 ② 12 ③ 15
 ④ 18 ⑤ 21

4. [2 points]

Simplify $\log_2 3 \times \log_3 8 \times \log_3 25$.

- ① 5 ② 6 ③ 7 ④ 8 ⑤ 9

5. [2 points]

Evaluate $\sum_{n=1}^{99} \frac{1}{\sqrt{n} + \sqrt{n+1}}$.

- ① 1 ② 3 ③ 5 ④ 7 ⑤ 9

6. [2 points]

When α, β, γ are solutions of

$$x^3 - 3x^2 + 2x + 1 = 0,$$

find $\frac{1}{\alpha} + \frac{1}{\beta} + \frac{1}{\gamma}$.

- ① -2 ② -1 ③ 0 ④ 1 ⑤ 2

7. [3 points]

Evaluate $\lim_{x \rightarrow 0} \frac{x e^x - x}{1 - \cos x}$.

- ① 1 ② $\frac{3}{2}$ ③ 2 ④ $\frac{5}{2}$ ⑤ 3

8. [3 points]

When $\sin\theta = \frac{2\sqrt{2}}{3}$ and $\cos\theta > 0$, find $\tan\frac{\theta}{2}$.

- ① $\frac{1}{2}$ ② $\frac{\sqrt{2}}{2}$ ③ 1 ④ $\sqrt{2}$ ⑤ 2

9. [3 points]

For a triangle $\triangle ABC$ with $\overline{AB}=5$, $\overline{AC}=4$, $\overline{BC}=7$, find the area of $\triangle ABC$.

- ① $3\sqrt{6}$ ② $\frac{7\sqrt{6}}{2}$ ③ $4\sqrt{6}$
④ $\frac{9\sqrt{6}}{2}$ ⑤ $5\sqrt{6}$

10. [3 points]

When $\sum_{k=1}^n a_k = n^2 + 5n$ for $n = 1, 2, 3, \dots$,

find a_{10} .

- ① 15 ② 18 ③ 21 ④ 24 ⑤ 27

11. [3 points]

When $f(x) = \sqrt{1 + \sin 2x}$, find $f'(\pi)$.

- ① $\frac{1}{2}$ ② $\frac{\sqrt{2}}{2}$ ③ 1 ④ $\sqrt{2}$ ⑤ 2

12. [3 points]

Compute $\int_0^\pi x \sin 2x \, dx$.

- ① $-\pi$ ② $-\frac{\pi}{2}$ ③ 0 ④ $\frac{\pi}{2}$ ⑤ π

13. [4 points]

Find the minimum of

$$f(x) = (x^2 - 5x + 5)e^x$$

for $x \geq 0$.

- ① $-e^3$ ② $-e^2$ ③ $-e$ ④ 1 ⑤ e

14. [4 points]

Find the distance between the point $(1, 1)$ and the line passing through two points $(-2, 4)$, $(-3, 3)$.

- ① 2 ② $2\sqrt{2}$ ③ 4 ④ $3\sqrt{2}$ ⑤ 5

15. [4 points]

When $A = \begin{pmatrix} 3 & -1 \\ 5 & -2 \end{pmatrix}$ and $2A + A^{-1} = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$,

find $a + b + c + d$.

- ① 9 ② 11 ③ 13 ④ 15 ⑤ 17

16. [4 points]

Find $\lim_{h \rightarrow 0} \frac{1}{h} \int_1^{1+h} \cos(\pi x^2) dx$.

- ① -1 ② $-\frac{1}{2}$ ③ 0 ④ $\frac{1}{2}$ ⑤ 1

17. [4 points]

When a line $y = ax + b$ is tangent to the curve $y = e^x + e^{-2x}$ at $(0, 2)$, find $a + b$.

- ① -1 ② $-\frac{1}{2}$ ③ 0 ④ $\frac{1}{2}$ ⑤ 1

18. [5 points]

When $\int_0^x (x-t)f(t) dt = (e^x - 1)\sin x$, find $f(0)$.

- ① -2 ② -1 ③ 0 ④ 1 ⑤ 2

19. [5 points]

Let f be given by

$$f(x) = \begin{cases} \frac{\sqrt{1+x^2}-a}{\ln(1+x^2)} & (x \neq 0), \\ b & (x = 0) \end{cases}$$

for constants a, b . When f is continuous over real numbers, find $a + b$.

- ① $\frac{1}{2}$ ② 1 ③ $\frac{3}{2}$ ④ 2 ⑤ $\frac{5}{2}$

20. [5 points]

Evaluate $\lim_{n \rightarrow \infty} \frac{1}{n} \sum_{k=1}^n \ln\left(1 + \frac{k}{n}\right)$.

- ① $\ln 2 - 1$ ② $\ln 2$ ③ $\ln 2 + 1$
④ $2\ln 2 - 1$ ⑤ $2\ln 2$

21. [5 points]

Find the volume of the solid obtained by rotating the region bounded by the x -axis and

$$y = \sin x \cos x \quad \left(0 \leq x \leq \frac{\pi}{2}\right)$$

about the x -axis.

- ① $\frac{\pi^2}{32}$ ② $\frac{\pi^2}{16}$ ③ $\frac{\pi^2}{8}$
④ $\frac{\pi^2}{4}$ ⑤ $\frac{\pi^2}{2}$

|

**Answers to 2023 IUT SOCIE Admission Test
(nonscholarship)**

- Type A

1	2	3	4	5	6	7
⑤	①	④	②	⑤	①	③
8	9	10	11	12	13	14
②	③	④	③	②	①	④
15	16	17	18	19	20	21
③	①	⑤	⑤	③	④	②

2023 IUT Admission Test(SOCIE)

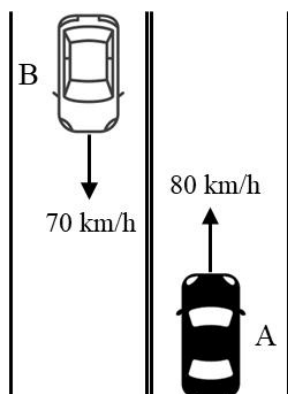
Physics Examination(A TYPE)

<Multiple choice Types> There is only one correct answer per each question. Mark your answer choice on the OMR answer sheet.

- For each correct answer, you will get the points indicated next to each question number.
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1. [3 points]

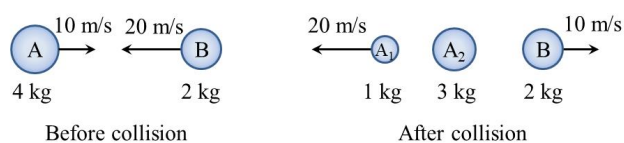
As shown in the figure below, when a person riding car A traveling north at 80 km/h on a highway sees car B traveling south at 70 km/h, what is the velocity of car B seen by the person riding in car A?



- ① 10 km/h north
- ② 10 km/h south
- ③ 150 km/h north
- ④ 150 km/h south
- ⑤ 75 km/h north

2. [5 points]

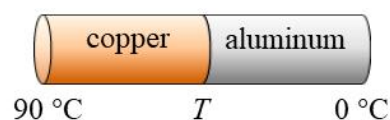
The figure below shows a head-on collision between an object A with a mass of 4 kg and an object B with a mass of 2 kg on a straight line in outer space. After the collision, object A splits into object A₁ with a mass of 1 kg and object A₂ with a mass of 3 kg. What is the velocity of object A₂ after the collision?



- ① 2 m/s to the left
- ② 2 m/s to the right
- ③ 0 m/s
- ④ 5 m/s to the left
- ⑤ 5 m/s to the right

3. [4 points]

As shown in the figure below, a copper rod and an aluminum rod with the same length and cross section are connected. If the temperature of the copper end of the connected rod is increased to 90 °C and the aluminum end is made to 0 °C, what is the temperature T at the copper-aluminum joint? (However, it is assumed that the thermal conductivity of copper is twice that of aluminum, and there is no heat loss through contact with air.)



- ① 20 °C
- ② 30 °C
- ③ 45 °C
- ④ 50 °C
- ⑤ 60 °C

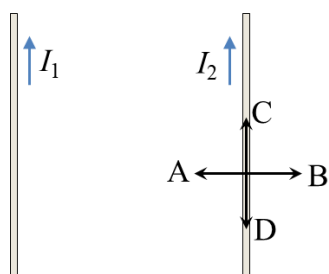
4. [3 points]

If it takes $3.6 \times 10^{-4} \text{ J}$ of work to move a charge of $3.0 \times 10^{-6} \text{ C}$ from one point in the electric field to another, what is the potential difference between the two points?

- ① 100 V ② 120 V ③ 150 V
 ④ 200 V ⑤ 240 V

5. [3 points]

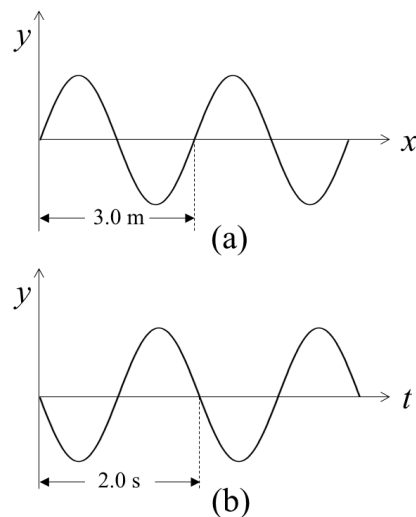
When current flows upward in the same direction through two parallel wires as shown in the figure below, what is the direction of the magnetic force on the right wire?



- ① A ② B ③ C ④ D ⑤ into the page

6. [3 points]

Figure (a) below shows the displacement as a function of position at the time $t = 0$ for a traveling wave, and figure (b) shows the displacement as a function of time at the position $x = 0$ for the wave. What is the speed of this wave?



- ① 1.0 m/s ② 1.2 m/s ③ 1.5 m/s
 ④ 1.8 m/s ⑤ 2.0 m/s

7. [3 points]

Light enters from air into a liquid with an index of refraction of 2.0 at an angle of incidence of 30° . If the angle of refraction is r , what is the value of $\sin r$? (The refractive index of air is assumed to be 1.0)

- ① 0.20 ② 0.25 ③ 0.30
 ④ 0.36 ⑤ 0.50

8. [3 points]

What is the energy of a photon of wavelength 330 nm? (Note that Planck's constant is $h = 6.6 \times 10^{-34} \text{ J} \cdot \text{s}$ and the speed of light is $c = 3.0 \times 10^8 \text{ m/s}$.)

- ① $3.0 \times 10^{-19} \text{ J}$ ② $4.0 \times 10^{-19} \text{ J}$ ③ $5.0 \times 10^{-19} \text{ J}$
 ④ $6.0 \times 10^{-19} \text{ J}$ ⑤ $8.0 \times 10^{-19} \text{ J}$

9. [3 points]

The following is an explanation of the energy levels of electrons in the hydrogen atom.

“The energy levels of the electron in the hydrogen atom are (a). This can be confirmed by (b) spectra emitted by atoms. As electron moves away from the nucleus, its energy increases, and the spacing between adjacent energy levels (c).”

Which of the following is the correct word for (a), (b), and (c)?

- | | <u>(a)</u> | <u>(b)</u> | <u>(c)</u> |
|---|---------------|------------|------------|
| ① | continuous | continuous | decreases |
| ② | continuous | discrete | increases |
| ③ | discontinuous | continuous | decreases |
| ④ | discontinuous | discrete | increases |
| ⑤ | discontinuous | discrete | decreases |

Physics Examination(A TYPE) Answers

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Answers:

1. ④
2. ③
3. ⑤
4. ②
5. ①
6. ③
7. ②
8. ④
9. ⑤