GATE 2025 ES

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General Aptitude (GA)

Q.1 – Q.5 Carry ONE mark Each

1) If '→' denotes increasing order of intensity, then the meaning of the words

$$[\text{sick} \rightarrow \text{infirm} \rightarrow \text{moribund}] \quad (1)$$

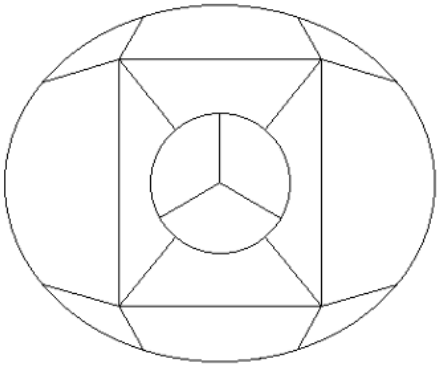
is analogous to

$$[\text{silly} \rightarrow \_\_\_\_\_ \rightarrow \text{daft}] \quad (2)$$

Which one of the given options is appropriate to fill the blank? (*GATE ES* 2025)

a) frown
b) fawn
c) vein
d) vain

2) The 15 parts of the given figure are to be painted such that no two adjacent parts with shared boundaries (excluding corners) have the same color. The minimum number of colors required is (*GATE ES* 2025)



a) 4
b) 3
c) 5
d) 6

3) How many 4-digit positive integers divisible by 3 can be formed using only the digits $\{1, 3, 4, 6, 7\}$, such that no digit appears more than once in a number? (*GATE ES* 2025)

a) 24 b) 48 c) 72 d) 12

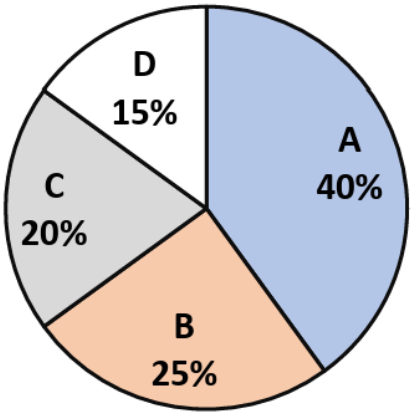
4) The sum of the following infinite series is

$$2 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{8} + \frac{1}{9} + \frac{1}{16} + \frac{1}{27} + \cdots$$

(*GATE ES* 2025)

a) $\frac{11}{3}$ b) $\frac{7}{2}$ c) $\frac{13}{4}$ d) $\frac{9}{2}$

5) In an election, the share of valid votes received by the four candidates A, B, C, and D is represented by the pie chart shown. The total number of votes cast in the election were 1,15,000, out of which 5,000 were invalid. (*GATE ES* 2025)



Share of valid votes

Based on the data provided, the total number of valid votes received by the candidates B and C is (*GATE ES* 2025)

a) 45,000
b) 49,500
c) 51,750
d) 54,000

Q.6 – Q.10 Carry TWO marks Each

6) Thousands of years ago, some people began dairy farming. This coincided with a number of mutations in a particular gene that resulted in these people developing the ability to digest dairy milk.
Based on the given passage, which of the following can be inferred? (*GATE ES* 2025)

a) All human beings can digest dairy milk.

b) No human being can digest dairy milk.
c) Digestion of dairy milk is essential for human beings.
d) In human beings, digestion of dairy milk resulted from a mutated gene.

7) The probability of a boy or a girl being born is $\frac{1}{2}$. For a family having only three children, what is the probability of having two girls and one boy? (*GATE ES* 2025)

a) $\frac{3}{8}$ b) $\frac{1}{8}$ c) $\frac{1}{4}$ d) $\frac{1}{2}$

8) Person 1 and Person 2 invest in three mutual funds A, B, and C. The amounts they invest in each of these mutual funds are given in the table.

	Mutual fund A	Mutual fund B	Mutual fund C
Person 1	₹10,000	₹20,000	₹20,000
Person 2	₹20,000	₹15,000	₹15,000

At the end of one year, the total amount that Person 1 gets is ₹500 more than Person 2. The annual rate of return for the mutual funds B and C is 15% each. What is the annual rate of return for the mutual fund A? (*GATE ES* 2025)

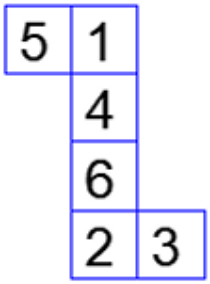
a) 7.5%
b) 10%
c) 15%
d) 20%

9) Three different views of a dice are shown in the figure below.

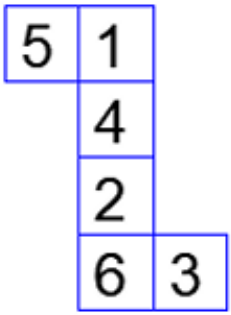
Fig. 1: Different Views of a dice

The piece of paper that can be folded to make this dice is

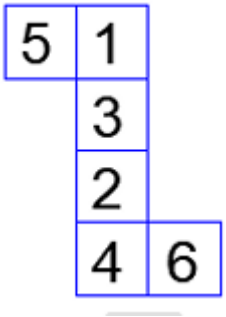
(*GATE ES* 2025)



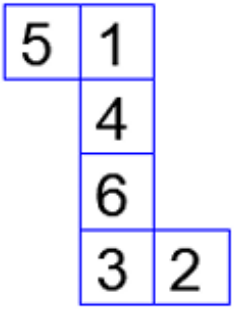
a)



b)



c)



d)

10) Visualize two identical right circular cones such that one is inverted over the other and they share a common circular base. If a cutting plane passes through the vertices of the assembled cones, what shape does the outer boundary of the resulting cross-section make? (*GATE ES* 2025)

a) A rhombus
b) A triangle
c) An ellipse
d) A hexagon

Environmental Science and Engineering (ES)

Q.11 – Q.35 Carry ONE mark Each

11) Ten cards in a pack are numbered as 1, 2, 3, ..., 10. The probability of drawing a card with an even number or a number which is a multiple of 5 from the pack is _____. (*GATE ES* 2025)

a) $\frac{4}{10}$
b) $\frac{6}{10}$
c) $\frac{2}{10}$
d) $\frac{3}{10}$

12) Hardness in water is NOT caused by _____. (*GATE ES* 2025)

a) Ca^{2+}
b) Si^{2+}
c) Mg^{2+}
d) CO_3^{2-}

13) The maximum coordination number of Sn^{4+} is _____. (*GATE ES* 2025)

a) 4
b) 8
c) 6
d) 2

14) Rod shaped bacterial cells are called _____. (*GATE ES* 2025)

a) Bacilli
b) Cocci
c) Spirilla
d) Diplococci

15) Tuberculosis is predominantly caused by _____. (*GATE ES* 2025)

a) Entamoeba histolytica
b) Salmonella typhi
c) Mycobacterium bovis
d) Bacillus cereus

16) Which one of the following conversions belongs to nonsymbiotic nitrogen fixation? (*GATE ES* 2025)

a) Atmospheric nitrogen to ammonia by *Rhizobium* bacteria in nodules attached to roots of legumes
b) Atmospheric nitrogen to ammonia by *Azotobacter* species
c) Nitrate to gaseous nitrogen under anaerobic conditions
d) Nitrate to ammonia under aerobic conditions

17) Crown corrosion of reinforced cement concrete sewer is caused by _____. (*GATE ES* 2025)

a) sulfur oxidizing bacteria
b) iron oxidizing bacteria
c) denitrifying bacteria
d) fermentative bacteria

18) The processes of removal of particles in a rapid sand filter with their description is given in the table.

Process	Description
(i) Straining	P: Removes only particles in the water large enough to get caught in the pores of the filter
(ii) Sedimentation	Q: Larger and heavier particles do not follow the fluid streamline around the sand grain and settle on the grain
(iii) Interception	R: Particles that do follow the streamline, but are too large and are caught because they brush up against the sand grains
(iv) Diffusion	S: Very small particles are experiencing Brownian motion and may collide with the sand grains by chance

Select the correct match. (*GATE ES* 2025)

a) i-S; ii-P; iii-Q; iv-R
b) i-Q; ii-R; iii-S; iv-P
c) i-R; ii-S; iii-P; iv-Q
d) i-P; ii-Q; iii-R; iv-S

19) The environmental temperature increases by 6°C/km with height at a particular location. The stability condition of the atmosphere at the location is _____. (*GATE ES* 2025)

a) stable
b) unstable
c) inversion
d) neutral

20) As per the United Nations agenda for sustainable development adopted in September 2015, the number of Sustainable Development Goals (SDGs) are _____ and the proposed target year to achieve them is _____. (*GATE ES* 2025)

a) 15; 2035
b) 17; 2030
c) 20; 2050
d) 18; 2047

21) Which one of the following is **NOT** a greenhouse gas? (*GATE ES* 2025)

a) CO_2
b) CH_4
c) H_2S
d) H_2O

22) As per the United Nations Environmental Program (UNEP) guidelines 2004, the maximum size of microplastics is _____. (*GATE ES* 2025)

a) $10mm$
b) $5mm$
c) $10\mu m$
d) $5\mu m$

23) The costliest functional element in an urban centralized Municipal Solid Waste management infrastructure for a typical Indian Tier I city is _____. (*GATE ES* 2025)

a) biological treatment
b) collection and transport
c) disposal in a sanitary landfill
d) thermal treatment

24) The eigen values of the matrix $\begin{pmatrix} 4 & 3 \\ 3 & 4 \end{pmatrix}$ are (*GATE ES* 2025)

a) 1 b) 2 c) 7 d) 4

25) If X is a vector, and A and B are linear operators; then the correct mathematical relationship(s) is/are (*GATE ES* 2025)

a) $(A + B)X = AX + BX$
b) $(\lambda A)X = \lambda (AX)$
c) $(AB)X = A(BX)$
d) $(A + B)X = A^T X + B^T X$

26) In the context of fluid flow, which of the following statement(s) is/are correct? (*GATE ES* 2025)

a) *Streamline* is a line, tangent to which at any point gives the direction of the velocity vector
b) *Streakline* is the actual path traversed by a given fluid particle in an unsteady flow
c) *Streakline* and *streamline* are same for a steady flow
d) *Pathline* and *streamline* are same for a steady flow

27) In a rectangular open channel, the flow is critical, and the flow depth is $2m$. Select the correct statement(s) (*GATE ES* 2025)

a) Specific energy for the flow is $3.0m$
b) Specific energy for the flow is $2.0m$
c) Froude number is 1.0
d) Froude number is 1.5

28) With respect to particle settling in wastewater treatment systems; the correct statement(s) is/are (*GATE ES* 2025)

a) Settling in grit chamber and primary sedimentation tanks are examples of Type-I settling
b) Settling in primary sedimentation tank and secondary sedimentation tank are examples of Type-II settling
c) Settling in grit chamber is an example of Type-I settling, whereas settling in primary sedimentation tank is an example of Type-II settling
d) Settling in secondary sedimentation tank is an example of Type-III settling, whereas settling in primary sedimentation tank is an example of Type-II settling

29) The equipment that can be used to control particulate air pollution in an industrial unit is/are (*GATE ES* 2025)

a) Electrostatic precipitator
b) Cyclone separator
c) Gravity settler
d) Incinerator

30) Which is/are the secondary air pollutant(s)? (*GATE ES* 2025)

a) O_3
b) HNO_3
c) CO_2
d) H_2SO_4

31) As per the Hazardous Waste (Management and Handling) Rules, 2016, of India, which is/are the characteristic(s) that must be exhibited by a waste to be classified as a "characteristic" hazardous waste? (*GATE ES* 2025)

a) Ignitability
b) Reactivity
c) Radioactivity
d) Toxicity

32) $f(x) = x^3 - 4.5x^2 - 12x$ has a local maximum at $x =$ _____ *(an integer value)* in the range $x = -2$ to $+2$. (*GATE ES* 2025)

33) Consider the equation

$$\frac{dy}{dx} - x^2 + e^x = 0$$

with $y = 1$ at $x = 0$. The value of y at $x = 1$ is _____ *(rounded off to 2 decimal places)*. Take the value of e (base of natural logarithm) as 2.7. (*GATE ES* 2025)

34) A municipal solid waste digester generates 1000 kg of methane gas. The volume of the tank needed to store this gas at 30°C and 3 atmospheric pressure is _____ liters *(an integer value)*. Use $R = 0.082$ L-atm/mole-K, Atomic weights of $C = 12$, and $H = 1$. (*GATE ES* 2025)

35) A Class-A pan was setup adjacent to a lake for measuring evaporation losses in the lake. The depth of water in the pan at the beginning of a certain week was 250*mm*. In that week, there was a rainfall event with 10*mm* depth. Water depth in the pan at the end of the week was 240*mm*. The pan coefficient is 0.8. The estimated lake evaporation during the week was _____ mm *(an integer value)*. (*GATE ES* 2025)

Q.36 – Q.65 Carry TWO marks Each

36) A population (with mean μ) follows normal distribution. Ten samples (N) are drawn at random with a mean value of "x" and standard deviation of "S". Following table provides the confidence limits, $C(t)$ of the cumulative probability function for Student's t - distribution two-tailed test with degree of freedom, D. Which one of the following expression is correct for testing the null hypothesis H_o: $\mu = 0$ at 10% significance level? (*GATE ES* 2025)

D	**C(t)**		
	0.9	**0.95**	**0.975**
9	1.38	1.83	2.26
10	1.37	1.81	2.23
11	1.36	1.80	2.20

a) $-1.81 < \frac{x}{\frac{s}{\sqrt{N-1}}} < 1.81$
b) $-1.83 < \frac{x}{\frac{s}{\sqrt{N-1}}} < 1.83$
c) $-1.37 < \frac{x}{\frac{s}{\sqrt{N-1}}} < 1.37$
d) $-2.23 < \frac{x}{\frac{s}{\sqrt{N-1}}} < 2.23$

37) Which one is the solution $y(x)$ for the following ordinary differential equation and the specified boundary conditions?

$$\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = 2e^{-x}; y(0) = 2; \left(\frac{dy}{dx}\right)_{x=0} = 1$$

(*GATE ES* 2025)

a) $y(x) = \frac{1}{3}e^{-x} - 2e^{x} - \frac{1}{3}e^{2x}$
b) $y(x) = \frac{1}{3}e^{x} + 2e^{x} - \frac{1}{3}e^{2x}$
c) $y(x) = \frac{1}{3}e^{-x} + 2e^{-x} - \frac{1}{3}e^{2x}$
d) $y(x) = \frac{1}{3}e^{-x} + 2e^{x} - \frac{1}{3}e^{2x}$

38) A saturated $CaCO_3$ stock solution is existing at 25°C. In one experiment (i) 25 g Na_2CO_3 is added to the stock solution. In another experiment (ii) 25 g Na_2SO_4 is added to the stock solution. Select the correct statement from the following. (*GATE ES* 2025)

a) Addition of (i) increases the concentration of Ca^{2+} and addition of (ii) decreases the concentration of Ca^{2+}
b) Addition of (i) decreases the concentration of Ca^{2+} and addition of (ii) increases the concentration of Ca^{2+}
c) Addition of (i) and (ii) increase the concentration of Ca^{2+}
d) Addition of (i) and (ii) decrease the concentration of Ca^{2+}

39) Consider second order kinetics ($r_c = -kC^2$) under steady state condition. The ratio of volume of a complete mixed reactor (CMR) to that of a plug flow reactor (PFR) to achieve 90% reduction in the concentration is _____. Inlet concentrations in both the reactors are same. (*GATE ES* 2025)

a) 10.0
b) 1.0
c) 0.1
d) 2.3

40) Consider two horizontal layers of an aquifer as shown in Fig. **??**. Each layer is isotropic and homogeneous. Flow is parallel to the stratification. Thickness and horizontal hydraulic conductivity of layer-1 are h_1 and K_1, respectively. Thickness and horizontal hydraulic conductivity of layer-2 are h_2 and K_2, respectively, where h_1 is not equal to h_2. The equivalent horizontal conductivity K_x for the aquifer system is given by _____. (*GATE ES* 2025)

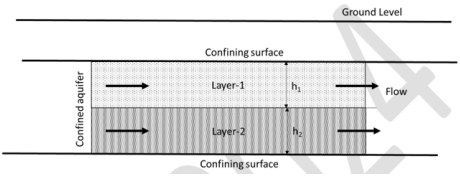


Fig. 2

a) $K_x = \frac{K_1h_1+K_2h_2}{h_1+h_2}$
b) $K_x = \frac{K_1+K_2}{2}$
c) $K_x = \frac{K_1h_2+K_2h_1}{h_1+h_2}$
d) $K_x = \sqrt{K_1K_2}$

41) A gravity settling chamber of height 'H' and length 'L' is designed to control particulate air pollution. In the chamber, the horizontal velocity of air flow is 'V_h' and terminal settling velocity of the target particle is 'V_t'. Which one of the following expressions is the correct concept used to calculate the minimum size of the target particle that will be removed with 100% efficiency? (*GATE ES* 2025)

a) $\frac{V_t}{L} = \frac{V_h}{H}$
b) $V_h \times V_t = L \times H$
c) $V_h = V_t \times L \times H$
d) $\frac{V_t}{H} = \frac{V_h}{L}$

42) Consider the function $f(x) = \ln(\sin(x))$. Expand $f(x + h)$ using Taylor's series. In this context, the correct statement(s) is/are (*GATE ES* 2025)

a) Second term in the Taylor's series i.e., the term which includes h is: $h \cdot \ln(\sin(x))$
b) First term is $\ln(\sin(x))$
c) Third term in the Taylor's series i.e., the term which includes h^2 is: $-\frac{h^2}{2(\sin(x))^2}$
d) Third term in the Taylor's series i.e., the term which includes h^2 is: $\frac{2h^2}{(\sin(x))^2}$

43) Enzymes with the class of enzymes are listed in the table. (*GATE ES* 2025)

Enzyme	**Class of Enzyme**
(a) Lactate dehydrogenase	(i) Isomerases
(b) Alanine racemase	(ii) Transferases
(c) Lipase	(iii) Oxidoreductases
(d) Hexokinase	(iv) Hydrolases

Select the correct match(es)

a) (a) - (iii); (b) - (i)
b) (c) - (iv); (d) - (ii)
c) (a) - (ii); (b) - (iv)
d) (c) - (iii); (d) - (i)

44) With reference to disinfection, which of the following statement(s) is/are CORRECT? (*GATE ES* 2025)

a) Ethanol damages lipid structures in the bacterial cell membrane.

b) Mercuric chloride inactivates cellular enzymes containing sulfhydryl groups.
c) Glutaraldehyde inactivates protein.
d) Isopropyl alcohol cannot be used as a disinfectant.

45) Which of the following statement(s) is/are CORRECT? (*GATE ES* 2025)
a) DNA is composed of nucleotides.
b) Five types of nitrogenous bases occur in DNA.
c) Each phosphate is attached to two deoxyribose units in a single strand of DNA.
d) The ratio of adenine to guanine is always 1:1 in a double stranded DNA.

46) The Streeter-Phelp's oxygen sag equation for a river is based on a few assumptions. The correct assumption(s) is/are (*GATE ES* 2025)
a) At any instant the deoxygenation rate is directly proportional to the amount of oxidizable organic material present.
b) At any instant the deoxygenation rate is inversely proportional to the amount of oxidizable organic material present.
c) The reoxygenation rate is directly proportional to the dissolved oxygen deficit.
d) The reoxygenation rate and deoxygenation rate are directly proportional to the saturation concentration of dissolved oxygen.

47) Water is flowing **FULL** through a rectangular tunnel of size 3 m (width) $\times$ 2 m (height). The average velocity of flow is $1 m/s$. The frictional head loss is observed to be 1 m per km. Consider acceleration due to gravity (g) as $10 m/s^2$. The correct statement(s) is/are (*GATE ES* 2025)
a) Hydraulic radius is 0.6 m
b) Darcy-Weisbach friction factor is 0.048
c) Hydraulic radius is 2 m
d) Darcy-Weisbach friction factor is 0.024

48) Based on the ISO 14040 methodology for Life Cycle Assessment, match the terms with the descriptions in the table. (*GATE ES* 2025)

Term	**Description**
(a) Goal and Scope	(i) Based on the product or system, the comparative unit must be carefully defined and be same for all scenarios
(b) Functional Unit	(ii) The problem is described, and the objective of the study are defined
(c) Life Cycle Inventory	(iii) Evaluates the environmental implications due to the inventorized emissions
(d) Impact Assessment	(iv) Process based approach and input-output approach

The correct match(es) is/are
a) (a)-(ii); b-(i);
b) (a)-(iii), b-(i)
c) (c)-(iii), (d)-(iv)
d) (c)-(iv), (d)-(iii)

49) Consider the equation for a curve, $y = f(x) = x^2 + x$. The area enclosed by the curve, the x-axis ($y = 0$ line); the vertical lines passing through $x = 1$ and $x = 2$ is _____ *(rounded off to 2 decimal places).* (*GATE ES* 2025)

50) The pH of a solution containing 0.1M of acetic acid and 0.05 M of sodium acetate is _____ *(rounded off to 2 decimal places).* The pK_a value of ionization of acetic acid is 4.76. (*GATE ES* 2025)

51) The ionic strength of a solution containing 0.01M of $CaCl_2$ and 0.001M of Na_2SO_4 is _____ M *(rounded off to 3 decimal places).* (*GATE ES* 2025)

52) The concentration of Ozone corresponding to a mixing ratio of 120 ppbv at pressure of 1 atmosphere and temperature of 25°C is _____ $\mu g/m^3$ *(rounded off to 1 decimal place).* Atomic weight of oxygen = 16; R= 8.314 J/K-g.mole. (*GATE ES* 2025)

53) One million liters per day (MLD) of wastewater with a soluble BOD of 200 mg/L is treated in an activated sludge process. The BOD of treated wastewater is 20 mg/L. The observed yield coefficient of the biological system is 0.35. The daily biomass generation in the system is _____ kg *(an integer value).* (*GATE ES* 2025)

54) An industry discharges 2 million liters per day (MLD) of wastewater with a temperature of 45°C and a pH of 2, whereas the neighboring industry produces 3 MLD of wastewater with a temperature of 30°C and pH of 8. If both the wastewaters are mixed and carried through a pipeline, then the resultant pH of mixed wastewater is _____ *(rounded off to 2 decimal places).* Neglect buffering capacity of the system and the temperature effect on pH. (*GATE ES* 2025)

55) Consider a watershed and isohyets as shown in Fig. **??**. The average rainfall in the watershed is _____ *mm (an integer value).* (*GATE ES* 2025)

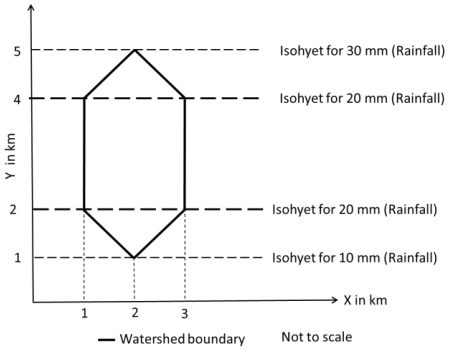


Fig. 3

56) With reference to the gate shown in Fig. **??**, the gate will start opening automatically when the water level 'h' above the hinge is _____ *m (rounded off to 2 decimal places).* (*GATE ES* 2025)

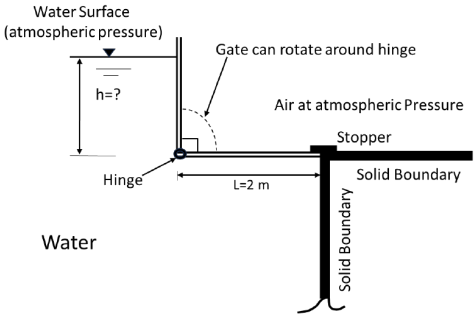


Fig. 4

57) In a cyclone separator of radius $25cm$, a particle is travelling with a gas stream at velocity of $18m/s$. The ratio of centrifugal force to the gravitational force acting on the particle is _____ *(rounded off to 2 decimal places)*. Consider acceleration due to gravity (g) as $9.8m/s^2$. (*GATE ES* 2025)

58) Two sources of noise, adjacent to each other in a room, have sound pressure levels of 30 and 40 decibel (dB). The combined sound pressure level in the room is _____ dB *(rounded off to 2 decimal places)*. Use reference sound pressure as 20 μPa. (*GATE ES* 2025)

59) An industrial stack emits $100g/s$ of CO at an effective height of 'H', where the wind speed is $5m/s$. At $3km$ distance downwind, the values of dispersion coefficient in y direction and z-direction are $50m$ and $25m$, respectively. The CO concentration at the centerline of the plume at $3km$ distance downwind is _____ mg/m^3 *(rounded off to 2 decimal places)*? Use Gaussian plume model and value of $\pi = 3.14$. Neglect reactions and the ground effect of plume in the calculations. (*GATE ES* 2025)

60) Two hypothetical organic waste streams A and B are mixed prior to the composting process. Waste-A has 2.16% of C and 1.20% of N. Waste-B has 19.10% of C and 0.14% of N. The quantity of Waste-B that should be mixed with per kg of Waste-A to achieve the desired $C : N$ ratio of 25 is _____ *kg (rounded off to 2 decimal places)*. Assume both the waste streams are completely dry. (*GATE ES* 2025)

61) Food waste, paper waste and plastic waste have typical densities of $280kg/m^3$, $80kg/m^3$, and $50kg/m^3$, respectively. The mixed waste is composed of 70% food waste, 20% paper waste and 10% plastic waste. The density of the mixed waste is _____ kg/m^3 *(rounded off to 2 decimal places)*. Neglect compaction effect. (*GATE ES* 2025)

62) For a biodegradable waste with a chemical formula $C_{50}H_{100}O_{40}N$, the maximum theoretical methane production per ton of waste is _____ *kg (rounded off to 2 decimal places)*. Assume 100% anaerobic conversion. Atomic weights of C-12; H-1; O-16; N-14. (*GATE ES* 2025)

63) A person consumes 2.5 liters of water per day. The water quality test indicated that the supplied water has a Pb concentration of $0.6mg/L$. If the weight of the person is $75kg$, the exposure level for Pb for this person from this drinking water source is _____ $mg/kg/day$ *(rounded off to 2 decimal places)*. (*GATE ES* 2025)

64) In a region, total annual consumption of gasoline is 30.6 million tons. The land required for growing sugarcane to produce enough bioethanol to replace the gasoline completely is _ _ _ _ _ _ _ km^2 *(an integer value)*. Ethanol energy equivalent is 67% of gasoline, gasoline density is $850 kg/m^3$, yield of bioethanol produced from sugarcane per hectare of land is $3750 L$, and $1 km^2$ = 100 hectares. ($GATE\ ES$ 2025)

65) Initially a bottle contained $400 g$ of ethanol. Half of ethanol was used by a student for preparing the stock solution in an environmental chemistry laboratory just before summer vacation of 90 days. After completing the procedure, the student left the bottle uncorked. If the unsealed bottle losses ethanol at a rate of $0.5 g/day$, the ethanol that will be left in the bottle at the end of the summer vacation is _ _ _ _ _ _ _ _ g *(an integer value)*. ($GATE\ ES$ 2025)

END OF THE QUESTION PAPER (3)