

GAMSAT SIMMOCK EXAM



Reasoning in Biological
and Physical Sciences

Questions: 55

Time: 85 minutes

AceGamsat

GAMSAT SIII Mock Exam

Reasoning in Biological and Physical Sciences

Questions: 55

Time: 85 minutes

Instructions:

Allow 85 minutes for this mock test paper. Do not attempt questions individually. It is crucial to sit this exam under strict timed conditions so students can gauge their level of competency in the GAMSAT based on their results. Timing is crucial, so students must keep an eye on the time throughout the exam. Every 15 minutes, students should have approximately 10 questions completed.

Unit 1

A pH indicator is a halochromic chemical compound added in small amounts to a solution to visually determine the pH. In a titration reaction an indicator will react with excess acid or base to change from one form to another. Indicators have a pK_a value that determines the pH at which a colour change will occur.

Indicators, colours, and K_a values are shown in the following table.

Indicator	K_a	Colour	
		Acidic form	Basic form
Indicator X			
Bromophenol Blue	1.26×10^{-4}	yellow	blue
Methyl red	1.00×10^{-5}	red	yellow
Phenol red	1.26×10^{-8}	yellow	red
Phenolphthalein	4.00×10^{-10}	colourless	pink
Alizarin	2.00×10^{-12}	red	purple

Notes:

$$pH = -\log_{10}[H^+]$$

$$pK_a = -\log_{10}K_a$$

$$pH = pK_a + \log_{10}\left\{\frac{[base]}{[acid]}\right\}$$

$$\log_{10}1.26 = 0.1$$

Question 1

What are the colours of bromophenol blue and phenol red when placed separately in aqueous solution of 0.0005 M H_2SO_4 . Assume H_2SO_4 completely dissociates.

- A yellow and yellow
- B yellow and red
- C blue and yellow
- D blue and red

Question 2

Which of the following indicators is the weakest acid in aqueous solution?

- A Bromophenol blue
- B Methyl red
- C Phenol red
- D Phenolphthalein

Questions 3

Indicator X has a K_a of 1.00×10^{-9} . What percentage of indicator X is in its basic form in aqueous solution of pH 9?

- A <10%
- B 25%
- C 50%
- D >75%

Unit 2

Capacitors store electric energy. When capacitors are connected in series the total capacitance C is given by

$$1/C = 1/C_1 + 1/C_2 + 1/C_3 \dots$$

When capacitors are connected in parallel the total capacitance C is given by

$$C = C_1 + C_2 + C_3 \dots$$

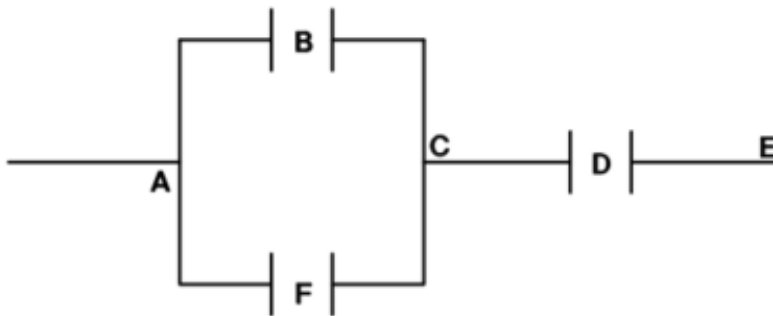


Figure 1

Question 4

Three capacitors, each $30 \mu\text{F}$, are connected as shown above. What is the effect on the total capacitance if the segments AFC are removed?

- A** falls by $10 \mu\text{F}$
- B** falls by $5 \mu\text{F}$
- C** rises by $10 \mu\text{F}$
- D** falls by $2.5 \mu\text{F}$

Question 5

In this question B, D, F are of equal capacitance. The charge stored in capacitor B

- A** is half that stored in capacitor D
- B** equals that stored in capacitor D
- C** is twice that stored in capacitor D
- D** is equal to zero

Unit 3

When examining the theory of relativity a mass (m), its energy (E), its momentum (p), its speed (v) and the speed of light (c) are related by the following equation.

$$E^2 = m^2c^4/(1-(v^2/c^2))$$

$$P^2 = m^2v^2/(1-(v^2/c^2))$$

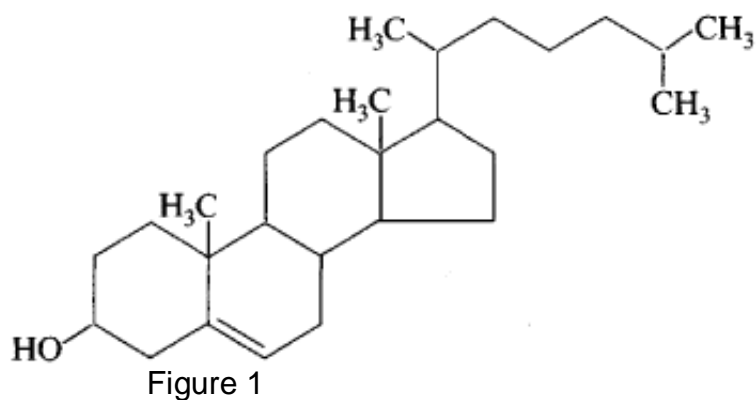
Question 6

If $E = 2mc^2/\sqrt{3}$ and $p = mc/\sqrt{3}$, find v

- A** $v = 2c$
- B** $v = 1/2c$
- C** $v = \sqrt{c}$
- D** $v = c^2$

Unit 4

Examine the following figure

**Question 7**

How many carbon atoms are in the molecule in figure 1?

- A 26
- B 27
- C 28
- D 29

Question 8

How many chiral centers are in figure 1?

- A <7
- B 7
- C 8
- D >8

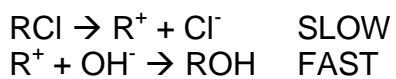
Question 9

How many hydrogen atoms are in figure 1?

- A 43
- B 44
- C 45
- D 46

Unit 5

The hydrolysis of RCl, where $\text{RCl} = (\text{CH}_3)_3\text{CCl}$ by hydroxide ion proceeds in two steps

**Question 10**

Which of the following rate equations is consistent with the scheme?

- A rate = $k[\text{RCl}]$
- B rate = $k[\text{RCl}]^2$
- C rate = $k[\text{RCl}][\text{OH}^-]$
- D rate = $k[\text{RCl}] [\text{OH}^-]$

Unit 6

Examine the following figure

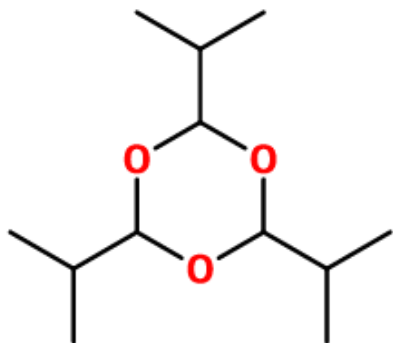


Figure 1

Question 11

Figure 1 is made up of identical units. How many identical units does it contain?

- A 2
- B 3
- C 4
- D >4

Unit 7

The measurements shown in the figure were taken during mammalian research on the movement of fluid between the interstitial fluid and plasma.

The effective filtration pressure = (blood hydrostatic pressure + interstitial fluid osmotic pressure) – (interstitial fluid hydrostatic pressure + blood osmotic pressure)

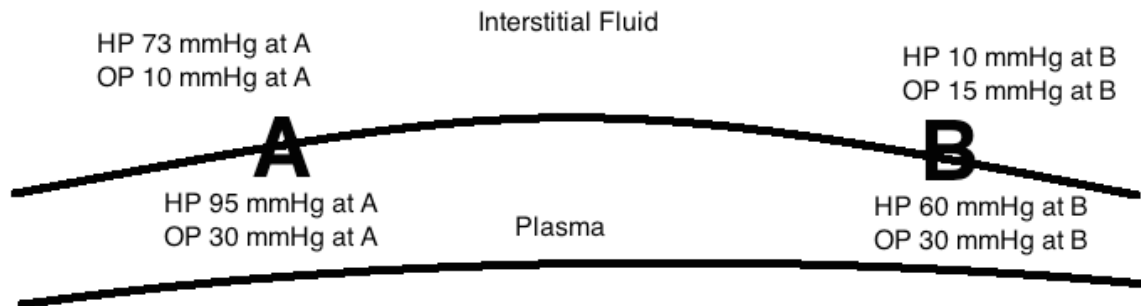


Figure 1

Question 12

What is the effective filtration at point B?

- A 65
- B 45
- C 25
- D 35

Question 13

Fluid within a vessel near A moves

- A in the general direction towards point B and from the interstitial fluid into the plasma
- B in the general direction towards point B and from the plasma into the interstitial fluid
- C in the general direction away from point B and from the interstitial fluid into the plasma
- D in the general direction away from point B and from the plasma into the interstitial fluid

Unit 8

The half-life (T) of a radioactive substance is the time taken (t) for one-half of the original number (N_0) of nuclei in the substance to undergo radioactive decay. The number of nuclei left (N) after time (t) is given by the equation

$$N = N_0 \times e^{-\lambda t}$$

Question 14

The half-life of isotope X is 6×10^3 years. What fraction of the original X atoms will be present after 4.8×10^4 years?

- A 1/64
- B 1/256
- C 1/128
- D 1/8

Question 15

A radioactive element has two isotopes X and Y, with a half-life of 10 and 40 minutes respectively. An experiment starts with 8 times as many atoms of X than Y. How long will it be before the number of atoms left of X equals the number of atoms left of Y?

- A 10 minutes
- B 20 minutes
- C 30 minutes
- D 40 minutes

Question 16

The λ of compound X is 0.03/year, estimate the half life of compound X ($\ln 2 = 0.69$)

- A 13 years
- B 23 years
- C 43 years
- D 66 years

Unit 9

Archimedes' principle states that the buoyancy force on an object floating, or submerged, in a fluid is equal to the weight of the dispersed fluid.

$$F = \rho_f \cdot V_s \cdot g$$

where:

ρ_f is the density of the fluid.

V_s is that volume of the object which is submerged in the fluid.

The volume of the fluid displaced by the object is equal to that volume of the object which is submerged in the fluid.

Question 17

A piece of timber 4 meters in length, with a rectangular cross-section of 40 cm x 20 cm floats vertically in water of density 1000 kg/m^3 with 40 cm protruding above the surface. Which of the following is closest to the average density of the timber?

- A 850 kg/m^3
- B 900 kg/m^3
- C 950 kg/m^3
- D 975 kg/m^3

A piece of timber 4 meters in length and of rectangular cross section 40cm x 20 cm and of average density 800 kg/m^3 floats vertically with 80cm of its length out of the water. A metallic mass m of density $10\,000 \text{ kg/m}^3$ is attached to the timber so that the timber becomes full submerged.

Question 18

Which of the following is closest to the value of m if the mass is placed on top of the timber so that the timber is fully submerged but the metal is not.

- A 16 kg
- B 32 kg
- C 64 kg
- D 128 kg

Question 19

The density of pure water at 4°C is 1000 kg/m^3 , of ice at 0°C is 917 kg/m^3 , and of sea-water at 4°C is 1024 kg/m^3 .

What fraction of an iceberg is above the surface when it floats in a 4°C sea.

- A 2.3%
- B 8.3%
- C 10.4%
- D 18.4%

Unit 10**Question 20**

Hooke's law states that the force needed to extend or compress a spring by some distance is proportional to that distance. What are the dimensions of K?

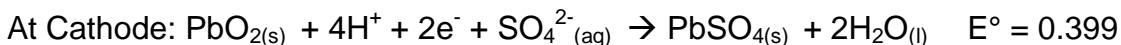
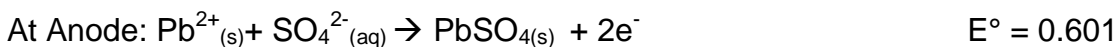
$$F = -ks$$

F = force, s = displacement

- A** MT^{-2}
- B** L^{-2}
- C** $MT^{-1}L^{-2}$
- D** ML^{-2}

Unit 11

A rechargeable lead-acid Galvanic cell is driven by the following half reactions.

**Question 21**

The Gibbs free energy for the cell's spontaneous reaction is given by

$$\Delta G^\circ = -nFE^\circ \quad \text{where } F = 96.5 \text{ KJ / v . mol } e^-$$

- A - 386 000 J
- B - 48 250 J
- C - 96 500 J
- D - 193 000 J

Question 22

Lead-acid cells can be recharged by being run as electrolytic cells. Which of the following represents, during this recharging process, the reaction in the half-cell called the cathode above?

- A $\text{Pb}^{2+}_{(s)} + \text{SO}_4^{2-}_{(aq)} \rightarrow \text{PbSO}_{4(s)} + 2e^-$
- B $\text{PbSO}_{4(s)} + 2\text{H}_2\text{O}_{(l)} \rightarrow \text{PbO}_{2(s)} + 4\text{H}^+ + 2e^- + \text{SO}_4^{2-}_{(aq)}$
- C $\text{PbSO}_{4(s)} + 2e^- \rightarrow \text{Pb}^{2+}_{(s)} + \text{SO}_4^{2-}_{(aq)}$
- D $\text{PbO}_{2(s)} + 4\text{H}^+ + 2e^- + \text{SO}_4^{2-}_{(aq)} \rightarrow \text{PbSO}_{4(s)} + 2\text{H}_2\text{O}_{(l)}$

Unit 12

If u is the initial velocity of an object of mass m , v is its velocity after the lapse of time t , and it has been accelerated by a force F to a uniform acceleration of a , and s is the displacement of the object from its original position, then

$$\begin{array}{ll} s = \frac{1}{2}(u + v)t & v = u + at \\ s = ut + \frac{1}{2}at^2 & v^2 = u^2 + 2as \\ s = vt - \frac{1}{2}at^2 & F = ma \end{array}$$

Question 23

A mass of 6 kg is accelerated from rest by a steady force of 6 N. What is closest to the speed when it has traveled a distance of 10 m?

- A 7.2 m/s
- B 3.6 m/s
- C 36 m/s
- D 4.5 m/s

Question 24

A boy drops an apple from a hot air balloon, which is descending vertically at a constant speed of 6 m/s. The apple strikes the ground 10 seconds later. Assuming no air resistance and $g = 10$, how far does the apples drop?

- A 500 m
- B 560 m
- C 620 m
- D 680 m

Question 25

A cannon-ball is projected horizontally from the top of a castle with velocity V . The direction of the velocity of the cannon ball is 45° to the horizontal 6 seconds after projection. Assuming no air resistance and taking the acceleration of gravity to be 10 m/s^2 , the value of the projection velocity V in m/s is?

- A 60
- B 45
- C 30
- D 15

Question 26

A block of mass 5 kg is held at rest on a friction-free surface inclined at 30° to the horizontal ($\sin 30^\circ = 0.5$ and $\cos 30^\circ = 0.87$). Four seconds after the block is released, the distance traveled by the block is?

- A 30 m
- B 40 m
- C 45 m
- D 55 m

Unit 13**Question 27**

If the equilibrium concentration of the cation in $\text{Mg}_3(\text{PO}_4)_2$ is s , K_{sp} for $\text{Mg}_3(\text{PO}_4)_2$ is best represented by:

- A** $54s^5$
- B** s^5
- C** $27s^5/9$
- D** $4s^5/9$

Unit 14

α -amino acids contain a COOH and a NH_2 group. These groups are termed the acidic carboxylic acid group and the basic amino group respectively.

Amino acids can exist as zwitterions with a positive charge on one atom (NH_3^+) and a negative charge on another atom (COO^-). The side chains can be ionized if they contain acidic (COOH) or basic (NH_2) groups.

The α -amino acids in figure 1 are referred to in the questions that follow

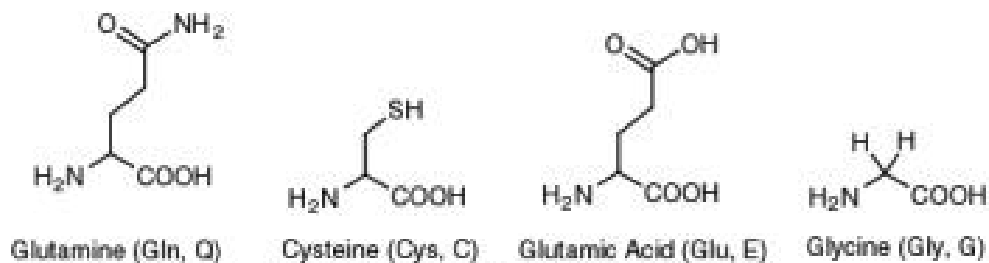


Figure 1

Question 28

At pH of 10, which of the following will exhibit the greatest negative charge?

- A glutamic acid
- B glycine
- C cysteine
- D glutamine

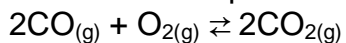
Question 29

Which of the following will not be produced as a racemic mixture when synthesized?

- A glutamic acid
- B glycine
- C cysteine
- D glutamine

Unit 15

Consider the equation at STP

**Question 30**

As the equation shifts to the right, entropy

- A increases
- B decreases
- C remains the same
- D cannot be predicted based on given information

Question 31

Assume the above forward reaction is spontaneous. The value of ΔG° will be

- A $\Delta G^\circ > 0$
- B $\Delta G^\circ < 0$
- C $\Delta G^\circ = 0$
- D cannot be predicted based on given information

Unit 16

$$K_{sp} = [A^{n+}]^x[B^{n-}]^y$$

The following solubility products are given at 25°C

$$PbSO_4 = 1.6 \times 10^{-8}$$

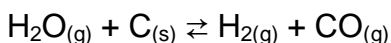
$$CaSO_4 = 2.4 \times 10^{-5}$$

Question 32

The K_{sp} of $PbSO_4$ at 110°C is 1.31×10^{-6} . The k_{sp} of $CaSO_4$ at 10°C is 2.3×10^{-5} . The dissolution of $PbSO_4$ and $CaSO_4$ is respectively

- A exothermic and endothermic
- B endothermic and exothermic
- C endothermic and endothermic
- D exothermic and exothermic

Carbon can be heated with steam to produce hydrogen gas and carbon monoxide. The reaction is as follows:



The equilibrium constant of this reaction can be written

$$K_{eq} = [H_{2(g)}][CO_{(g)}]/[H_2O_{(g)}]$$

At 100°C the equilibrium constant of this reaction is 5×10^{-7} .

Question 33

Calculate the $H_{2(g)}$ concentration at equilibrium if

$$[H_2O_{(g)}] = 3 \times 10^{-1}$$

$$[CO_{(g)}] = 1.5 \times 10^{-2}$$

- A 1×10^{-5}
- B 1×10^{-6}
- C 1×10^{-7}
- D 1×10^{-8}

Question 34

The rate of dissolution of certain substances can be increased by the presence of a suitable catalyst. Which of the following statements is/are correct?

1. A catalyst increases the rates of both the forward and reverse reactions.
2. The addition of a catalyst to a reaction changes the equilibrium constant.
3. A catalyst speeds up the reaction by changing the enthalpy of the reaction.

- A 1 only
- B 2 and 1 only
- C 2 only
- D 3 and 1 only

Unit 17

A buoy of volume 40 cm^3 is snagged by a vertical rope near the bottom of a river so that the entire buoy is under water. The average density of the buoy is 90 kg/m^3 . The density of water is 1000 kg/m^3 and g is 10 m/s^2 .

Question 35

Which of the following is closest to the tension of the rope?

- A 0.1 N
- B 0.3 N
- C 100 kN
- D 300 kN

If the rope snaps and the buoy comes to the surface, what percentage of the volume of the float will be above the surface of the water when it has settled into a state of equilibrium.

Question 36

- A 10% or less
- B more than 10% but less than or equal to 50%
- C more than 50% but less than 90%
- D 90% or more

Unit 18

The decay of radioactive Uranium-234 is in accord with the equation

$$\ln N_t/N_0 = -kt$$

where N_0 is a measure of the amount of radioactive substance initially, N_t is that at time t and k is a positive constant whose value depends on the units in which t is measured.

Question 37

Of 2.000 g of Uranium-234 1.906 g will remain after two years. How much will remain after four years?

$$(1.906^2 = 3.633 \text{ and } 0.953^2 = 0.908)$$

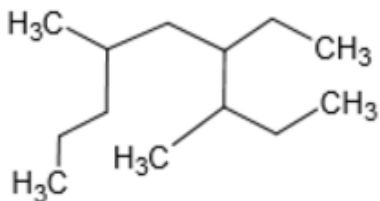
- A** 1.859 g
- B** 1.816 g
- C** 1.812 g
- D** 0.953 g

Unit 19

IUPAC rules for naming alkanes and alkenes include the following:

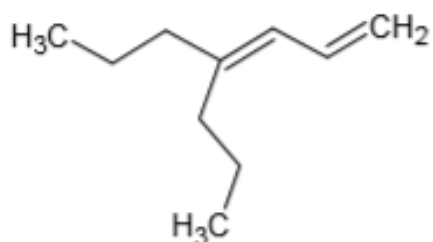
- 1 Find the longest continuous chain of carbon atoms and assign a name to this base chain.
- 2 If there is a functional group, assign numbers to the base chain by counting from the end of the base chain that has the functional group closest to that end.
- 3 If there is no functional group, find whatever substituent groups are *not* part of the base chain. Assign numbers to the base chain by counting from the end of the base chain that has a substituent closest to that end.
- 4 Arrange the substituents as prefixes in alphabetical order before the base chain name.
- 5 If the chain has a double bond and more than four carbons, the longest chain must include the double bond. Its position has priority in the numbering process and is indicated by the lower of the possible numbers.
- 6 In cycloalkanes, start at the point of attachment of a substituent and count clockwise or anticlockwise so as to give the lowest possible numbers. However, when two or more substituents are present, start at the one that has alphabetical priority.
- 7 In cycloalkanes containing only one double bond, the double bond goes from position 1 to position 2.
- 8 In cycloalkanes, as well as in cycloalkenes which contain one or more double bonds, the initial position and direction of rotation are chosen to give the lowest possible numbers.

What is the correct IUPAC name of each of the compounds in the following questions?

Question 38

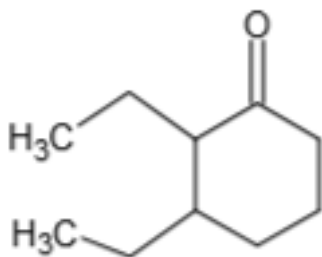
- A** 4-ethyl-2-propyl-5-methylheptane
B 2-propyl-4-secbutylhexane
C 6,7-diethyl-4-methyloctane
D 3,6-dimethyl-4-ethylnonane

Question 39



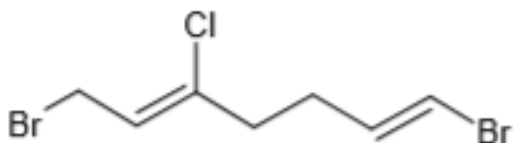
- A 4-propyl-4,6-heptadiene
- B 4-propyl-1,3-heptadiene
- C 4,4-dipropyl-1,3-butadiene
- D 1,1-dipropyl-1,3-butadiene

Question 40



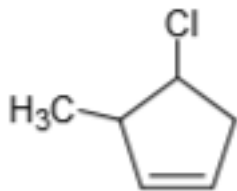
- A 1,2-diethyl-2-oxocyclohexane
- B 1,2-dimethylcyclohexane
- C 2,3-diethyl-1-oxocyclohexane
- D 2,3-diethylcyclohexanone

Question 41



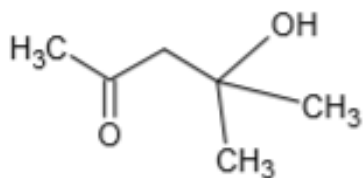
- A 5-chloro-1,7-dibromo-1,5-heptadiene
- B 3-chloro-1,7-dibromo-2,6-heptadiene
- C 4-chloro-1,9-dibromo-3,7-nonadiene
- D 6-chloro-1,9-dibromo-2,6-nonadiene

Question 42



- A 2-methyl-3-chlorocyclopentene
- B 3-chloro-4-ethylcyclopentene
- C 4-chloro-3-methylcyclopentene
- D 1-chloro-2-methylcyclopentene

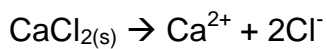
Question 43



- A 4,4-dimethyl-4-hydroxybutanone
- B 4-hydroxy-4-methylpentanone
- C 1,1-dimethyl-3-oxybutanol
- D 2-methyl-4-oxypentanol

Unit 20

Let the solubility constant (K_s) of CaCl_2 at 25°C equal to 1210.



The molar mass of CaCl_2 is 111g

Given $6.7129^3 = 302.5$

Question 44

Which of the following is closest to the mass of calcium chloride that can dissolve in 1 liter of water at 25°C ?

- A** 0.745 g/L
- B** 745 g/L
- C** 0.3725 g/L
- D** 372 g/L

Unit 21

When an object is projected at an angle θ to the horizontal, the vertical component (V_y) and the horizontal component (V_x) of its velocity at any time t are given by:

$$V_y = V_o \sin \theta - gt \quad \text{and} \quad V_x = V_o \cos \theta$$

Question 45

A golf ball is hit from the ground at an angle of 30° to the horizontal with an initial speed of 80 m/sec. How long does it take to reach its greatest height ($g = 10$) and what is its speed then?

($\sin 30^\circ = 0.5$, $\cos 30^\circ = 0.87$)

- A** 4 sec; 69.6 m/s
- B** 2 sec; zero
- C** 4 sec; zero
- D** 2 sec; 69.6 m/s

Unit 22

The ideal gas equation can be written as follows:

$$n/V = P/(RT)$$

Where P, V and T are the pressures (atm), volume (L) and temperature (K) of n moles of a gas and where the universal gas constant R = 0.0821 L.atm/(mol.K)

Question 46

Estimate the density of carbon dioxide (C = 12, O = 16) at 127°C and at 1 atm.

- A 1.3 g/L
- B 0.5 g/L
- C 13.5 g/L
- D 5.3 g/L

Unit 23

Two solutions are separated by a semipermeable membrane. Water will pass by osmosis into the solution with the higher osmolarity where

Osmolarity = molarity x number of particles / mol

Question 47

In which of the following will water pass from compartment A to compartment B if compartment A contains 0.1M CaCl_2 and compartment B contains

- A** 0.15 M KCl
- B** 0.075 M MgCl_2
- C** 0.175 M KClO_3
- D** 0.05 M $\text{Al}_2(\text{SO}_4)_3$

Unit 24**Question 48**

Of the following 3 mechanisms, which ones are possible for the passage of molecules through the cell membrane?

- I attaching to carrier proteins
 - II diffusing by osmosis through the lipid bilayer
 - III passing through integral transmembrane glycoproteins
-
- A** I only
 - B** II only
 - C** II and III only
 - D** I, II, and III

Unit 25

If A is the mass number of element X , and Z is the atomic number, the standard notation is A_ZX . Nuclei that exhibit NMR have either even mass numbers and odd atomic numbers or have odd mass numbers.

Question 49

The number of neutrons in a nucleus that exhibits NMR is always

- A even if mass number is even
- B even if mass number is odd
- C odd if mass number is odd
- D odd if mass number is even

Question 50

Out of the 3 isotopes of hydrogen ${}^1_1\text{H}$, ${}^2_1\text{H}$ and ${}^3_1\text{H}$, how many exhibit NMR?

- A 0
- B 1
- C 2
- D 3

Unit 26

Many gases such as oxygen (O_2) dissolve in water but do not react with it. The O_2 molecules fit between the molecules of water. The molar concentration (C) of the gas (mol/L) depends on the pressure (P) of the gas (atm) on the surface of the liquid. All of these variables are related by Henry's law.

$C = K_H \cdot P$ where K_H is Henry's constant.

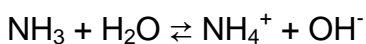
Question 51

When the pressure of oxygen is 1 atm, its solubility in water is 1.32×10^{-3} mol/L at 25°C . If the partial pressure of oxygen in the atmosphere is 0.6, which of the following is closest to the solubility of oxygen gas in water at 25°C .

- A 7×10^{-4} mol/L
- B 8×10^{-4} mol/L
- C 7×10^{-3} mol/L
- D 8×10^{-3} mol/L

Question 52

Ammonia dissolves in water to produce the equation



$$K_{\text{sp}} = [\text{NH}_4^+][\text{OH}^-]$$

If 0.3 mole of ammonia is dissolved in 750 ml of water, which of the following is closest to the value of the relevant K_{sp} ?

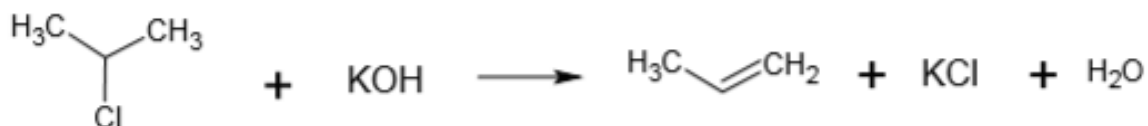
- A 15
- B 0.75
- C 7.5
- D 0.15

Unit 27

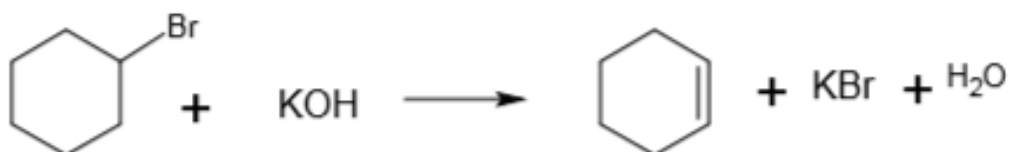
An elimination reaction occurs when a single reactant loses two groups from adjacent carbons. These two groups form 1 product. The other product has a double bond between the two carbons that each lost a group.

Example of elimination reactions

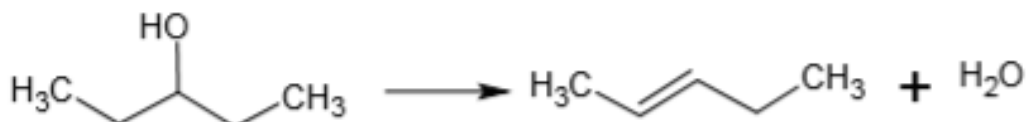
2-chloropropane reacts with a strong base to give propene



Bromocyclohexane reacts with strong base to give cyclohexene



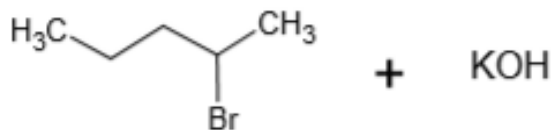
3-pentanol is heated in the presence of H_2SO_4 to form 2-pentene and water.



2-pentene can be either cis/trans configuration.

Question 53

How many products are likely from the following reaction?



- A 3
- B 4
- C 5
- D 6

Question 54

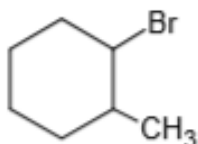
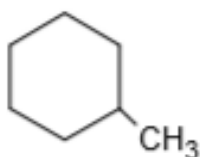
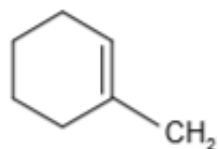
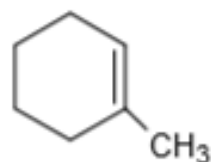
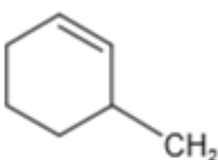
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}(\text{OH})-\text{C}(\text{CH}_3)_3$ is heated in the presence of sulfuric acid.

Which of the following is the resulting product.

- A 1,1,1-trimethyl-2-hexene
- B 2,2,2-trimethyl-3-hexene
- C 2,2-dimethyl-4-heptene
- D 2,2-dimethyl-3-heptene

Question 55

The following compound undergoes an elimination and reduces HBr. Which of the following is a possible product?

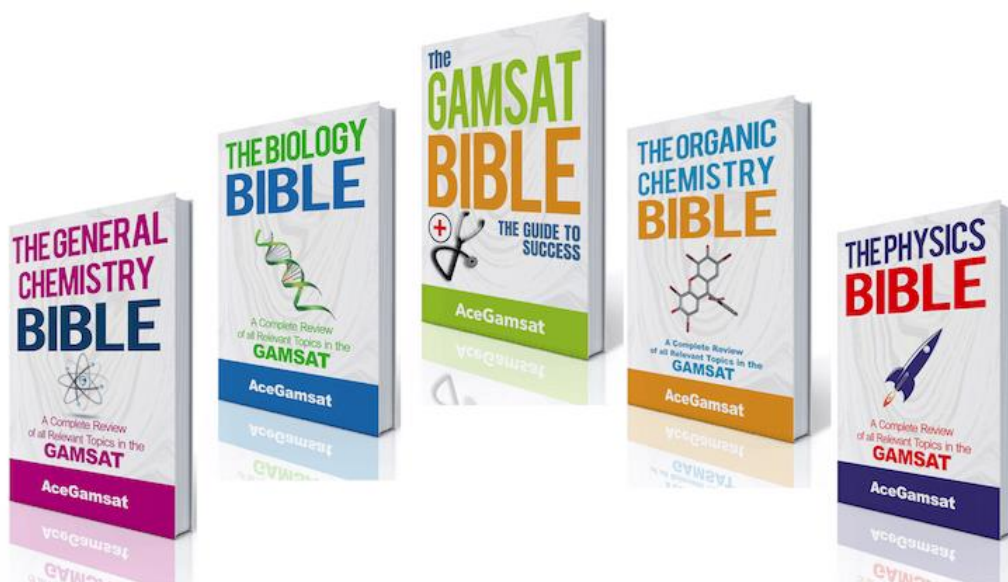
**A****B****C****D**

ANSWERS

- | | |
|-------|-------|
| 1. A | 29. B |
| 2. D | 30. B |
| 3. C | 31. B |
| 4. B | 32. C |
| 5. A | 33. A |
| 6. B | 34. A |
| 7. B | 35. B |
| 8. C | 36. D |
| 9. D | 37. B |
| 10. A | 38. D |
| 11. B | 39. B |
| 12. D | 40. D |
| 13. B | 41. A |
| 14. B | 42. C |
| 15. D | 43. B |
| 16. B | 44. B |
| 17. B | 45. A |
| 18. C | 46. A |
| 19. C | 47. C |
| 20. A | 48. D |
| 21. D | 49. D |
| 22. B | 50. D |
| 23. D | 51. B |
| 24. B | 52. D |
| 25. A | 53. C |
| 26. B | 54. D |
| 27. D | 55. C |
| 28. A | |

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