

29 PVC is used as a packaging material.

What holds the different polymer strands together in a piece of solid PVC?

- A covalent bonds
- B hydrogen bonds
- C ionic bonds
- D van der Waals' forces

7 Two compounds of boron are sodium borohydride, NaBH_4 , and boron trifluoride, BF_3 .

What are the shapes of the borohydride ion and the boron trifluoride molecule?

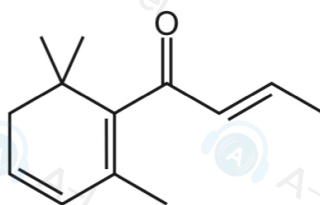
	borohydride ion	boron trifluoride
A	square planar	pyramidal
B	square planar	trigonal planar
C	tetrahedral	pyramidal
D	tetrahedral	trigonal planar

8 Which statement about the properties associated with the different types of bonding involved is correct?

- A Any covalent compound that contains both oxygen and hydrogen in its molecule forms hydrogen bonds.
- B Ionic bonds and covalent bonds cannot both occur in the same compound.
- C Ionic compounds differ from metals in that ionic compounds do not conduct electricity in the solid state.
- D The only covalent compounds with high melting points are those in which hydrogen bonds occur.

26 The structure of damascenone is shown.

damascenone



Including damascenone, how many stereoisomers exist with this structural formula?

- A 1
- B 2
- C 4
- D 8

21 How many tertiary alcohols have the molecular formula $\text{C}_6\text{H}_{14}\text{O}$?

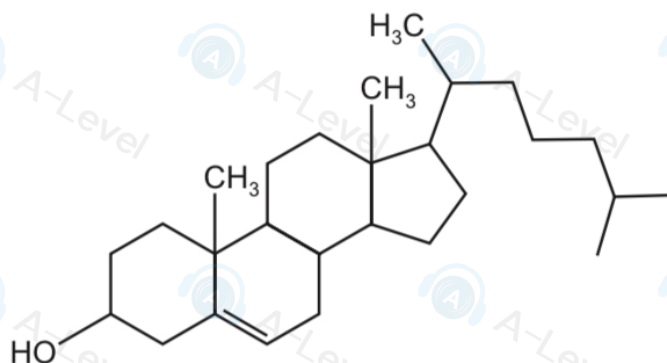
- A 1
- B 2
- C 3
- D 4

32 The strong hydrogen bonding present in liquid water causes an increase in which properties?

- 1 viscosity
- 2 boiling point
- 3 surface tension

25 The diagram shows the structure of the naturally occurring molecule cholesterol.

cholesterol



Student X stated that the 17 carbon atoms in the 4 rings all lie in the same plane.

Student Y stated that this molecule displays cis/trans isomerism at the C=C double bond.

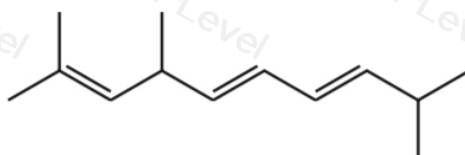
Which students are correct?

- A both student X and student Y
- B neither student X nor student Y
- C student X only
- D student Y only

8 In which change are **only** temporary dipole-induced dipole forces overcome?

- A $\text{C}_2\text{H}_5\text{OH}(\text{l}) \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{g})$
- B $\text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\text{l})$
- C $\text{O}_2(\text{s}) \rightarrow \text{O}_2(\text{l})$
- D $\text{C}_4\text{H}_{10}(\text{l}) \rightarrow \text{C}_4\text{H}_{10}(\text{s})$

26 A skeletal formula is shown.



What is the total number of stereoisomers including the one shown?

- A 4
- B 6
- C 8
- D 16

12 The compound $(\text{CH}_3)_3\text{NAlCl}_3$ has a simple molecular structure.

Which statement about $(\text{CH}_3)_3\text{NAlCl}_3$ is correct?

- A $(\text{CH}_3)_3\text{NAlCl}_3$ molecules attract each other by hydrogen bonds.
- B The Al atom in $(\text{CH}_3)_3\text{NAlCl}_3$ has an incomplete valence shell of electrons.
- C The bonds around the Al atom are planar.
- D The molecules contain coordinate bonding.

36 What is the least number of carbon atoms in a non-cyclic alkane molecule that has a chiral centre?

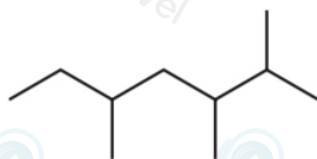
- A 7
- B 8
- C 9
- D 10

6 Why does ICl have a higher boiling point than Br_2 ?

- A because of the difference in the bond energies of the covalent bonds within ICl and Br_2
- B because of the difference in the polar nature of ICl and Br_2
- C because of the difference in the number of electrons contained within ICl and Br_2
- D because of the difference in the relative molecular mass of ICl and Br_2

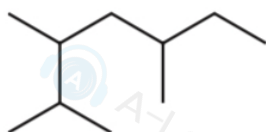
32 Compound T has the skeletal formula shown.

compound T

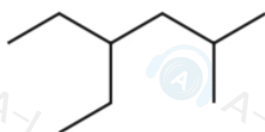


Which structure is a structural isomer of compound T?

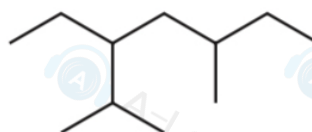
A



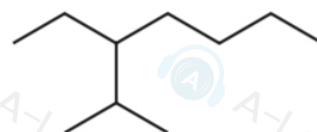
B



C

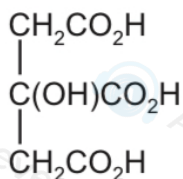


D

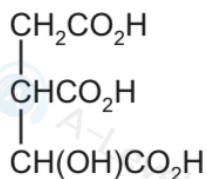


20 The structures of citric acid and isocitric acid are shown.

citric acid



isocitric acid



How many chiral centres does each acid possess?

	citric acid	isocitric acid
A	1	1
B	1	2
C	0	1
D	0	2

24 In the general formula of which class of compound is the ratio of hydrogen atoms to carbon atoms the highest?

- A alcohols
- B aldehydes
- C carboxylic acids
- D halogenoalkanes

5 In which substance are the only intermolecular forces temporary dipole-induced dipole attractions?

- A hydrogen chloride
- B methanol
- C octane
- D water

26 In this question, alkenes and cyclic alkanes should be considered.

How many **structural** isomers of C_4H_8 are there?

- A 3 B 4 C 5 D 6

3 Which molecule does **not** have any 90° or 180° bond angles?

- A C_2H_6 B CO_2 C PF_5 D SF_6

- 6 The boiling points of some hydrogen halides are shown.

hydrogen halide	boiling point/K
H-Cl	188
H-Br	206
H-I	238

What is the explanation for the trend in boiling point for the hydrogen halides from HCl to HI?

- A The bond energies of the hydrogen halides increase from HCl to HI.
B There is an increase in the strength of the intermolecular forces of attraction from HCl to HI.
C The intermolecular hydrogen bonds become stronger from HCl to HI.
D There is an increase in the bond polarity from HCl to HI.

- 25 Structural isomerism and stereoisomerism should be considered when answering this question.

How many non-cyclic isomers have the molecular formula C_5H_{10} ?

- A 3 B 4 C 5 D 6

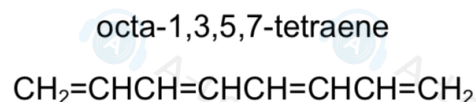
- 7 Which row is correct?

	molecule	shape	total number of pairs of electrons in the valence shell of the central atom
A	CO ₂	linear	two
B	BF ₃	trigonal planar	three
C	NH ₃	regular tetrahedral	four
D	PF ₅	octahedral	six

- 4 For which molecule is the dipole moment zero?

- A CH₃Cl B CH₂Cl₂ C CHCl₃ D CCl₄

- 20 The unsaturated hydrocarbon octa-1,3,5,7-tetraene, C₈H₁₀, can display geometric isomerism.

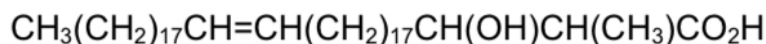


How many isomers exist?

- A 2 B 3 C 4 D 8

- 26 Compound X is found in cell walls of some bacteria. Its structural formula is shown.

compound X

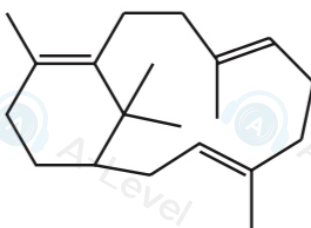


How many stereoisomers are there with this structural formula?

- A 2 B 4 C 6 D 8

- 20 Compound P is treated with an excess of hydrogen gas in the presence of a nickel catalyst. The product Q is fully saturated.

compound P



What is the number of chiral carbon atoms in the product Q?

- A 4 B 5 C 6 D 7

- 20 Which pair of compounds are functional group isomers of each other?

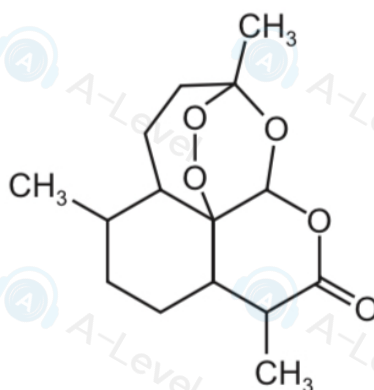
- A butan-1-ol and butanal
B ethylpropanoate and pentanoic acid
C hex-1-ene and hex-2-ene
D propylamine and propanenitrile

- 37 What is the same for a pair of optical isomers?

- 1 their empirical formula
2 their functional groups
3 their structural formula

- 27 Artemisinin is a powerful anti-malarial drug.

artemisinin

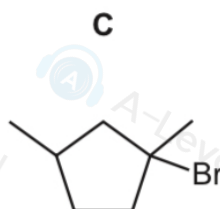
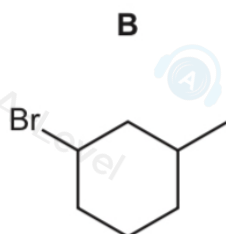
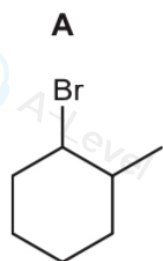


How many chiral centres are there in each molecule of artemisinin?

- A 4 B 6 C 7 D 8
- 28 Compound Z, $C_7H_{13}Br$, has two chiral centres. A sample of Z contains all four possible optical isomers.

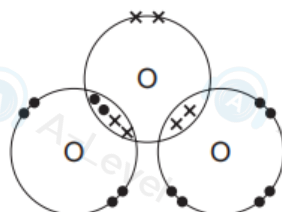
This sample of Z reacts with hot ethanolic NaOH to produce a mixture of **only** three isomers. Two of these isomers are optical isomers of each other.

What could be the formula of Z?



- 13 VSEPR theory should be used in answering this question.

The dot-and-cross diagram for an ozone, O_3 , molecule is shown.

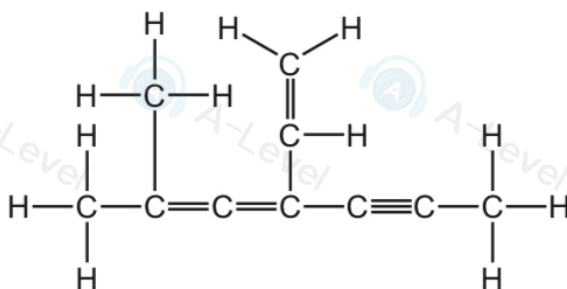


What is the predicted bond angle in this molecule?

- A 107° B 109.5° C 117° D 120°

- 25 The diagram shows the structural formula of a hydrocarbon molecule Q.

molecule Q



How many of the carbon atoms in molecule Q are sp^2 hybridised?

- A 3 B 4 C 7 D 10

- 7 The strength of hydrogen bonding increases as the electronegativity of the element bonded to hydrogen increases.

Some information for a range of hydrides is given.

hydride	boiling point / K
PH_3	185
HCl	188
HF	293
H_2O	373

Which statement and reason about these hydrides is correct?

- A The boiling point of PH_3 is much lower than the boiling point of H_2O because PH_3 does not form hydrogen bonds or instantaneous dipole-induced dipole forces between its molecules.
- B The boiling point of HF is higher than the boiling point of HCl because the bond energy of H-F is greater than the bond energy of H-Cl .
- C The boiling point of H_2O is higher than the boiling point of HF because each hydrogen bond between the H_2O molecules is stronger than each hydrogen bond between HF molecules.
- D The boiling points of PH_3 and HCl are similar because the molecules of PH_3 and HCl have the same number of electrons and similar intermolecular forces.

- 22 Structural and stereoisomerism should be taken into account when answering this question.

Y is a gaseous hydrocarbon which decolourises aqueous bromine. It contains no rings.

10.0 g of Y occupies a volume of 3.43 dm^3 under room conditions.

How many isomeric structures are possible for Y?

- A 4 B 5 C 6 D 7