# NJC 2019 H1 Chemistry Promo Solutions for P1

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
С	С	D	A	В	С	С	А	D	D
11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
С	В	А	D	А	A	D	В	В	Α

1

Use of the Data Booklet is relevant to this question.

What is the number of atoms in 500 cm<sup>3</sup> of oxygen under room conditions?

**A**  $1.25 \times 10^{22}$  **B**  $1.34 \times 10^{22}$  **C**  $2.50 \times 10^{22}$  **D**  $2.68 \times 10^{22}$ 

Amount of  $O_2 = \frac{0.500}{24} = 0.02083 mol$ 

No. of O atoms =  $0.02082 (2)(6.02 \times 10^{23}) = 2.50 \times 10^{22}$ 

Ans: C

2 Gallium nitride, GaN, could revolutionise the design of electric light bulbs because only a small length used as a filament gives excellent light at low cost.

GaN is an ionic compound containing the Ga<sup>3+</sup> ion.

Which statements about GaN are correct?

- 1 The outer electronic configuration of Ga atom is 4s<sup>2</sup>4p<sup>1</sup> since Ga is a Group 13 element.
- 2 The electron arrangement of the nitrogen ion in GaN is 1s<sup>2</sup>2s<sup>2</sup>2p<sup>3</sup>.
- **3** Ga<sup>3+</sup> ion deflects less than  $A^{\beta+}$  ion in an electric field.

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

Statement 1: True

Statement 2: N in GaN exists as N<sup>3-</sup>, electronic configurations 1s<sup>2</sup> 2s<sup>2</sup> 2p<sup>6</sup>

Statement 3: True. Angle of deflection  $\alpha \frac{Charge}{size}$ . Ga<sup>3+</sup> ion has same charge but large Ar than A<sup>β+</sup> ion. Hence Ga<sup>3+</sup> ion deflects less

Ans: C

**3** Oxygen has two isotopes, <sup>16</sup>O and <sup>18</sup>O.

An oxide ion,  ${}_{8}^{x}O^{y-}$ , has the same number of neutrons and electrons. What could be the values of x and y?

	x	у	Neutrons	<b>Electrons</b>
Α	16	1	16-8 = 8	8+1 = 9
В	16	2	16-8 = 8	8+2 = 10
С	18	1	18-8 = 10	8+1 = 9
D	18	2	18-8 = 10	8+2 = 10
Anos D				

4 Methyl mercaptan, CH<sub>3</sub>SH, is a substance often used to impart a smell to natural gas in a pipeline.

The chemical equation for the combustion of CH<sub>3</sub>SH is as shown below.

$$CH_3SH + 3O_2 \rightarrow CO_2 + SO_2 + 2H_2O$$

A 10 cm<sup>3</sup> sample of CH<sub>3</sub>SH is exploded with 60 cm<sup>3</sup> of oxygen and the resultant gas mixture is passed into excess NaOH(aq).

What is the percentage of the volume of the resultant gas mixture dissolved in NaOH?

[All gas volumes are measured at room temperature and pressure.]

Α	40.0%	В	28.5%		С	20.0%	D	14.3%
	CH₃S	SH +	$3O_2 \rightarrow$	CO <sub>2</sub> +	SO <sub>2</sub> + 2	2H <sub>2</sub> O		
Vinitial / cn	n <sup>3</sup> 10		60	0	0			
V <sub>final</sub> / cm	<sup>3</sup> 0		30	10	10			

Both acidic CO<sub>2</sub> + SO<sub>2</sub> are absorbed by NaOH(aq)  $\therefore$  % vol decrease =  $\frac{20}{50} \times 100 = 40.0\%$ Ans: **A** 

5 Which sketch show the correct trend in the stated property for the elements in Period 3 of the Periodic Table?

# 1 atomic radius



This graph shows the trend of the ionic radius instead. Atomic radius decreases across a period due to increase nuclear charges, but insignificant increase in shielding effect.

# 2 first ionisation energy



This graph shows the correct trend of 1<sup>st</sup> IE's of period 3 elements.



**6 G** is an element in period 4 of the Periodic Table. The first thirteen ionisation energies of **G** are plotted against the order of the removal of electrons as shown below.



What is the formula of the compound formed when G reacts with oxygen?

Α	GO	В	<b>G</b> O <sub>2</sub>	С	<b>G</b> <sub>2</sub> O	D	<b>G</b> <sub>2</sub> O <sub>3</sub>
1 <sup>st</sup> s	harp increase occurs	betwee	en 1 <sup>st</sup> & 2 <sup>nd</sup> IE, G	has 1	valence elect	ron	
⇒	<b>3</b> is in Group <b>1</b>						
Ans:	C						

7 In which pair of compounds is the first member less volatile than the second one?

Α	CO <sub>2</sub>	CS <sub>2</sub>	Both are non-polar & linear in shape with weak intermolecular td-id interactions. $CO_2$ has a smaller e cloud & thus weaker td-id interactions; hence a lower bp.
В	PH <sub>3</sub>	NH <sub>3</sub>	PH <sub>3</sub> is non-polar with weaker intermolecular td-id interactions while NH <sub>3</sub> is polar with stronger intermolecular H bonding. Thus PH <sub>3</sub> has a lower bp.



*Cis*-but-2-ene is **slightly polar** while trans-but-2-ene is nonpolar. Thus, *cis*-but-2-ene has slightly stronger intermolecular forces of attraction & a higher bp.

More energy is required to overcome the more extensive hydrogen bonding between H<sub>2</sub>O molecules than the less extensive hydrogen bonding between NH<sub>3</sub> molecules.

## Ans:C

8 The shapes of three species **P**, **Q**, and **R** are bent, square planar and trigonal pyrimidal respectively.

Which of the following can be **P**, **Q** and **R**?

Candidates need only to check on those familiar ones to verify that they do not have the stated shape to rule out the choice. E.g.  $F_2O$  is similar to  $H_2O$ ;  $CS_2$  is similar to  $CO_2$ .

	Р	Q	R
Α	$CCl_2$ (1lp + 2 bp; bent)	BrF₄⁻ (2 lp + 4 bp; sq planar)	SbF <sub>3</sub> (1 lp + 3 bp; trig pyramidal)
В	CS <sub>2</sub> (2 bp only; linear)	BH₄⁻ (4 bp only; Td)	IC <i>l</i> <sub>3</sub> (2 lp + 3 bp; T-shape)
С	$F_2O$ (2 lp + 2 bp; bent)	$ICl_4^-$ (2 lp + 4 bp; sq planar)	BCl <sub>3</sub> (3 bp only; trig planar)
D	$ICl_{2}^{-}$ (3 lp + 2 bp; linear	) XeF <sub>4</sub> (2 lp + 4 bp; sq planar)	$SO_3^{2-}$ (1 lp + 3 bp; trig pyramidal)
Ans: <b>A</b>			

**9** The thyroid gland concentrates iodine and uses it to produce thyroxine, which is a hormone that controls the metabolic rate.



#### Thyroxine

What are the values of the bond angles *p*, *q*, *r* and *s*?

	ρ	q	r	S		
Α	180°	90°	180°	<b>90</b> °		
В	105°	90°	107°	180°		
С	180°	90°	120°	180°		
D	105°	109.5°	107°	120°		
	p – oxygen l	nas 2 b.p, 2 <i>l</i> .p, bon	d angle = 105°			
	q – carbon has 4 b.p, no <i>l</i> .p, bond angle = $109.5^{\circ}$					
	r – nitrogen has 3 b.p, 1 <i>l</i> .p, bond angle = 107°					
s – carbon has 3 b.p, no <i>l</i> .p, bond angle = 120°						
	Ans: (D)					

10 Ice is the crystalline form of water. The diagram below shows part of the structure of ice.





—— Covalent bond

Which of the following statements is not true about ice?

- A Ice has a lower density than water at 0 °C due to its open structure. True
- **B** The bond angle about oxygen in ice is 109.5°. True
- **C** Ice does not conduct electricity. True
- **D** The hydrogen bonds are stronger than the O-H covalent bond. False.

### Ans: (D)

- 11 In which of the following substances, must covalent bonds break on melting?
  - A Phosphorus(V) chloride, PC*l*<sub>5</sub> Simple covalent molecules, tdid interactions between molecules break on melting
  - **B** Aluminium chloride, Al<sub>2</sub>Cl<sub>6</sub> Simple covalent molecules, tdid interactions between molecules break on melting
  - **C** Silicon carbide, SiC Giant covalent structure, covalent bonds between atoms break on melting
  - Iron(II) hydroxide, Fe(OH)<sub>3</sub>
    Giant ionic structure, metallic bonds between cations and sea of delocalised electrons break on melting

# Ans: (D)

12 What is the most likely  $\Delta H$  value for KOH(aq) + HCl (aq)  $\rightarrow$  KCl(aq) + H<sub>2</sub>O(l)?

Given that NaOl	$H(aq) + H_2SO_4(aq) \rightarrow I$	Na <sub>2</sub> SO <sub>4</sub> (aq) + 2H <sub>2</sub> O( <i>I</i> )		$\Delta H = -114 \text{ kJ mol}^{-1}$
A –54 kJ mol⁻¹	<b>B</b> −57 kJ mol <sup>-1</sup>	C –114 kJ mol <sup>−1</sup>	D	–228 kJ mol <sup>-1</sup>

when 2 mol of  $H_2O(l)$  are formed from a strong acid-strong base reaction; -114 kJ are given off.

As KOH(aq) + HCl (aq)  $\rightarrow$  KCl(aq) + H<sub>2</sub>O(l) is also a strong acid-strong base reaction; but for for 1 mole of water. Half amount of heat should be released.

Hence  $\Delta H = -(114/2) = -57 \text{ kJ kJ mol}^{-1}$ Ans: (B) **13** The reaction shown is a first-order reaction.

$$N_2O_5(g) \rightarrow 2NO_2(g) + \frac{1}{2}O_2(g)$$

Which graph shows how the concentration of N<sub>2</sub>O<sub>5</sub> varies with time?



First-order reaction means conc of N2O5 must decrease with a constant half-life. Ans: A

Graph B shows that concentration of N<sub>2</sub>O<sub>5</sub> does not decrease with time. It is not used up at all.

Graph B shows that conc of  $N_2O_5$  decrease linearly with time. i.e. Rate is constant. Rate is independent of conc. Of  $N_2O_5$  Zero order with respect to  $N_2O_5$ 

14 The Maxwell–Boltzmann distribution for gas **E** at a given temperature is shown below.



Which statement is correct for the number of molecules with molecular energies A, B and C?

- A nc decreases when more gas **E** is added at the same temperature.
- **B** n<sub>A</sub> decreases when temperature is lowered.
- $\mathbf{C}$  n<sub>A</sub> and n<sub>B</sub> increases when temperature is increased.
- **D** Addition of catalyst at the same temperature has no effect on n<sub>A</sub>, n<sub>B</sub> and n<sub>C</sub>.

Area under the graph represents total number of molecules in sample.

A is incorrect because when more gas is added to sample, no. of molecules at all energies will increase.

B is incorrect because when temperature decreases, curve shifts to the left and has a higher peak. i.e. na will increase. (check graph below)

C is incorrect because when temperature increases, curve shifts to the right and has a lower peak. i.e. n<sub>a</sub> and n<sub>b</sub> will decrease (check graph below)

D is correct because the presence of a catalyst does not shift the curve at all. It only provides an alternative pathway with a lowered  $E_a$  ( $E_a$ '). Hence there is no effect on  $n_a$ ,  $n_b$  and  $n_c$ .



- 15 A chemical plant illegally dumped two radioactive isotopes P and Q in a landfill. The amount of P is 4 times the amount of Q. The radioactive decay of isotopes follows first-order kinetics. The half-life of P is 2 days whereas that of Q is 8 days. By the time the authorities found out about this illegal dumping and analysed a sample of the waste, the ratio of P to Q was found to be 1:2. How long was the waste in the landfill before the authorities arrived?
  - A 8 days
  - **B** 16 days
  - C 32 days
  - D 64 days

 $\begin{array}{l} 4\mathsf{P}\rightarrow 2\mathsf{P}\rightarrow 1\mathsf{P}\rightarrow 1/2\;\mathsf{P}\rightarrow 1/4\;\mathsf{P}\\ =4\;\text{half-lives}=4\;x\;2=8\;\text{days}\\ \mathsf{Q}\rightarrow 1/2\;\mathsf{Q}=1\;\text{half-lives}=1\;x\;8=8\;\text{days}\\ \text{Ratio of }\mathsf{P}:\mathsf{Q}=1/4\text{: }1/2=1\text{: }2\\ \text{Ans}:(\mathsf{A}) \end{array}$ 

**16** A catalytic converter is part of the exhaust system of many modern cars.

Which reactions occur in a catalytic converter?

 $1 \sqrt{2CO + 2NO} \rightarrow 2CO_2 + N_2$   $2 \times CO_2 + NO \rightarrow CO + NO_2$   $3 \times 2SO_2 + 2NO \rightarrow 2SO_3 + N_2$ A  $\sqrt{1}$  only B 1 & 2 only C 1 & 3 D 1, 2 & 3

Catalytic converters are to convert harmful to less harmful gases before they leave the exhaust pipes. As CO is very toxic & SO<sub>3</sub> is responsible for acid rain, they should not be formed. Ans: **A**  17 Which statement is **incorrect** for the compound shown below?



- **A** There are  $6 \pi$  bonds.
- **B** There are  $8 \sigma$  bonds.
- **C** There are two different bond angles.
- **D** There are three sp<sup>2</sup> hybridised carbons.

# Answer: D



- 18 A halogenoalkane has the formula of C<sub>3</sub>H<sub>5</sub>C*l*<sub>3</sub>.Which of the isomers have the correct IUPAC name?
  - **1** 1,1,1-trichloropropane
  - **2** 1,2,2-trichloropropane
  - **3** 2,2,3-trichloropropane
  - A 1 only
  - **B** 1 and 2
  - C 2 and 3
  - **D** 1, 2 and 3

2,2,3- trichloropropane is the same as 1,2,2-trichloropropane. Smaller numbers are preferred on the IUPAC name.

Ans: (B)

- **19** The Russian composer Borodin was widely respected for his work as a chemist. In 1869, he discovered a reaction in which two ethanol molecules combine to form a new β-hydroxy carbonyl compound. A similar reaction is shown below.
  - I  $2CH_3COCH_3 \rightarrow CH_3COCH_2C(OH)(CH_3)_2$
  - II  $CH_3COCH_2C(OH)(CH_3)_2 \rightarrow CH_3COCH=C(CH_3)_2 + H_2O$

Which of the following best describes reactions I and II?

	I	II
Α	subsitution	elimination
В	addition	elimination
С	addition	reduction
D	condensation	elimination

I is an <u>addition</u> reaction as the first propanone molecule is added across the C=O double bond of the second propanone molecule to produce an alcohol:



II is an <u>elimination</u> reaction as an unsaturated alkene is formed with the elimination of a water molecule from the alcohol:

$$\begin{array}{cccc} O & H & OH & O \\ \parallel & \parallel & \parallel & \\ H_3C - C - C - C - CH_3 & \longrightarrow & H_3C - C - C = C - CH_3 + H_2O \\ \parallel & & \parallel & \\ H & CH_2 & & H & CH_3 \end{array}$$

### Answer: A

- 20 Which molecules do not have all the carbon atoms lying in one plane?
  - 1  $\sqrt{}$  benzene 2  $\times$  cyclohexene 3  $\sqrt{}$  ethene 4  $\sqrt{}$  methylbenzene
  - A 2 only
  - B 2 and 4 only
  - C 1, 3 and 4
  - D 2, 3 and 4

All C atoms in benzene & ethene are  $sp^2$  hybridised & hence lie in 1 plane (trigonal planar). Methylbenzene have ONE  $sp^3$  hybridised C atom on the same plane as the benzene ring. Cyclohexene has more than 1  $sp^3$  hybridised C, thus cannot have all C atoms lying in a plane. Ans: **A** 

#### End of paper