

PAPER-1(B.E./B. TECH.)

JEE (Main) 2021

Questions & Solutions

Date : 26 February, 2021 (SHIFT-2) Time ; (3.00 pm to 6.00 pm)

Duration : 3 Hours | Max. Marks : 300

SUBJECT : CHEMISTRY

1. Which of the following forms of hydrogen emits low energy β^- particles?
 (1) Deuterium ${}^2_1\text{H}$ (2) Tritium ${}^3_1\text{H}$
 (3) Protium ${}^1_1\text{H}$ (4) Proton H^+

Ans. (2)

Sol. Fact Based

${}^3_1\text{H}$ (tritium) is radio active

Its $\frac{n}{p} = \frac{2}{1}$ (Higher), Hence

It emits β particle

2. Given below are two statements :one is labelled as Assertion A and the other is labelled as Reason R
Assertion A : In TlI_3 , isomorphous to CsI_3 , the metal is present in +1 oxidation state.

Reason R : Tl metal has fourteen f electrons in its electronic configuration.

In the light of the above statements, choose the most appropriate answer from the options given below:

- (1) **A** is correct but **R** is not correct
 (2) Both **A** and **R** are correct and **R** is the correct explanation of **A**.
 (3) **A** is not correct but **R** is correct
 (4) Both **A** and **R** are correct but **R** is NOT the correct explanation of **A**.

Ans. (4)

Sol. $\text{TlI}_3 \rightarrow \text{Tl}^{+1} \text{I}_3^-$

$\text{CsI}_3 \rightarrow \text{Cs}^{+1} \text{I}_3^-$

Both have same formula type therefore both are isomorphous

Electronic configuration of Tl $[\text{Xe}] 4f^{14} 5d^{10} 6s^2 6p^1$

3. Match List-I with List-II

List-I

- (a) Sucrose
 (b) Lactose
 (c) Maltose

List-II

- (i) β -D-Galactose and β -D-Glucose
 (ii) α -D-Glucose and β -D-Fructose
 (iii) α -D-Glucose and α -D-Glucose

Choose the correct answer from the options given below :

Options :

- (1) (a) \rightarrow (i), (b) \rightarrow (iii), (c) \rightarrow (ii)
 (2) (a) \rightarrow (iii), (b) \rightarrow (i), (c) \rightarrow (ii)
 (3) (a) \rightarrow (ii), (b) \rightarrow (i), (c) \rightarrow (iii)
 (4) (a) \rightarrow (iii), (b) \rightarrow (ii), (c) \rightarrow (i)

Ans. (3)

Sol. (a) Sucrose – α -D-Glucose and β -D-Fructose

(b) Lactose – β - D-Galactose and β - D-Glucose

(c) Maltose – α - D-Glucose and α - D-Glucose

4. A. Phenyl methanamine
B. N,N-Dimethylaniline
C. N-Methyl aniline
D. Benzenamine

Choose the correct order of basic nature of the above amines.

- (1) $A > C > B > D$ (2) $D > C > B > A$
(3) $D > B > C > A$ (4) $A > B > C > D$

Ans. (4)

Sol. In Phenyl methanamine lone pair of nitrogen is localised so it is most basic among the given amines. Benzenamine is least basic because lone pair of nitrogen is delocalised.

5. The correct order of electron gain enthalpy is

- (1) $S > Se > Te > O$ (2) $Te > Se > S > O$
(3) $O > S > Se > Te$ (4) $S > O > Se > Te$

Ans. (1)

Sol. Electron gain enthalpy decreases down the group but for oxygen it is minimum in its group. Therefore order of electron gain enthalpy of 16 group element is $S > Se > Te > O$

6. In ${}^1\text{CH}_2 = {}^2\text{C} = {}^3\text{CH} - {}^4\text{CH}_3$ molecule, the hybridization of carbon 1,2,3 and 4 respectively are :

- (1) sp^3, sp, sp^3, sp^3 (2) sp^2, sp^2, sp^2, sp^3
(3) sp^2, sp, sp^2, sp^3 (4) sp^2, sp^3, sp^2, sp^3

Ans. (3)

Sol.

Carbon	Steric Number	Hybridisation
C1	3	sp^2
C2	2	sp
C3	3	sp^2
C4	4	sp^3

7. Seliwanoff test and Xanthoproteic test are used for the identification of _____ and _____ respectively

- (1) Aldoses, ketoses (2) Proteins, ketoses
(3) Ketoses, proteins (4) Ketoses, aldoses

Ans. (3)

Sol. Seliwanoff test and xanthoprotic test are used for the identification of ketoses and proteins respectively.

8. 2,4-DNP test can be used to identify :

- (1) Amine (2) Aldehyde (3) Ether (4) Halogens

Ans. (2)

Sol. 2,4-DNP test can be used to identify aldehyde and ketones.

9. Ceric ammonium nitrate and CHCl_3 / alc. KOH are used for the identification of functional groups present in _____ and ____ respectively.

- (1) Alcohol, phenol (2) Amine, alcohol
(3) Alcohol, amine (4) Amine, phenol

Ans. (3)

Sol. Alcohols give positive test with ceric ammonium nitrate and primary amines give carbyl amine test with CHCl_3 / alc.KOH.

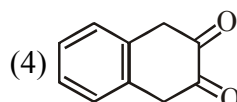
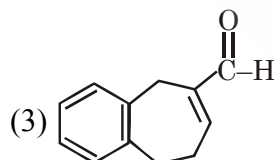
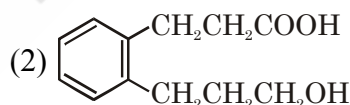
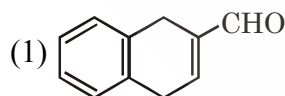
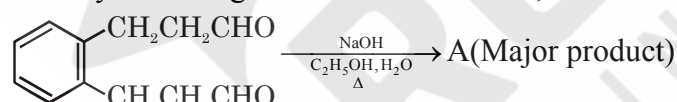
10. Which pair of oxides is acidic in nature?

- (1) B_2O_3 , CaO (2) B_2O_3 , SiO_2 (3) N_2O , BaO (4) CaO, SiO_2

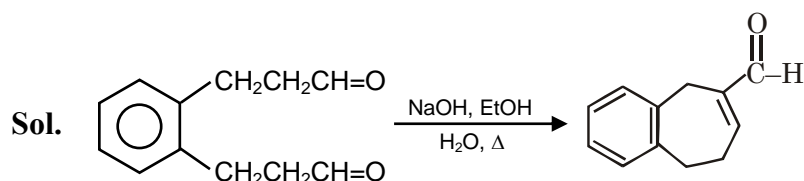
Ans. (2)

Sol. Oxide	Nature
CaO	Basic
B_2O_3	Acidic
SiO_2	Acidic
ZnO	Amphoteric

11. Identify A in the given chemical reaction,

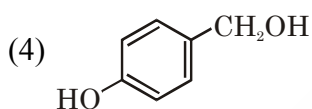
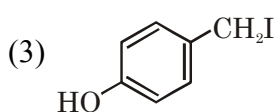
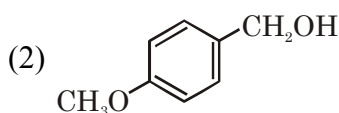
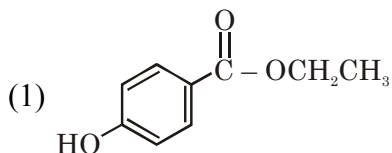
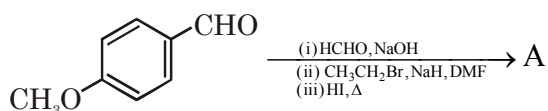


Ans. (3)

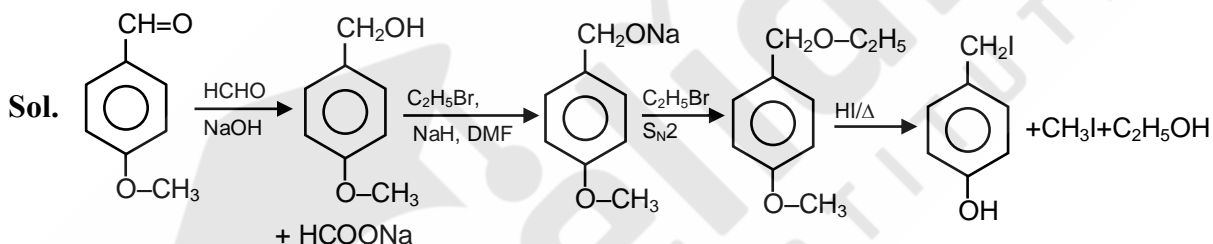


It is intramolecular aldol condensation reaction.

12. Identify A in the following chemical reaction



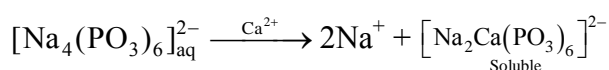
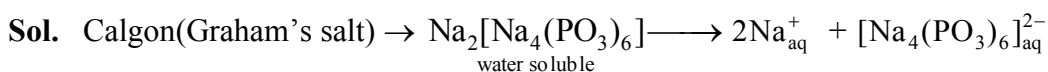
Ans. (3)



13. Calgon is used for water treatment. Which of the following statement is NOT true about Calgon?

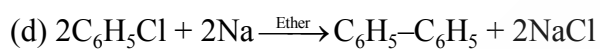
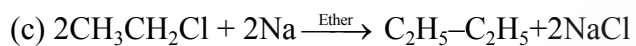
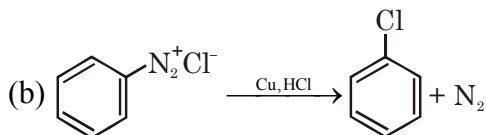
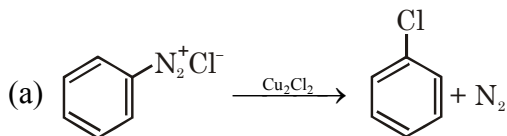
- (1) Calgon contains the 2nd most abundant element by weight in the Earth's crust.
- (2) It is polymeric compound and is water soluble.
- (3) It is also known as Graham's salt
- (4) It does not remove Ca^{2+} ion by precipitation.

Ans. (1)



14. Match List-I with List-II

List-I



List-II

(i) Wurtz reaction

(ii) Sandmeyer reaction

(iii) Fittig reaction

(iv) Gatterman reaction

Choose the correct answer from the options given below :

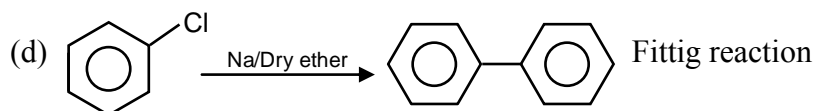
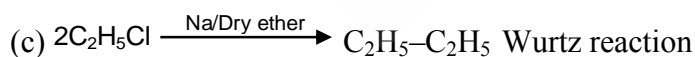
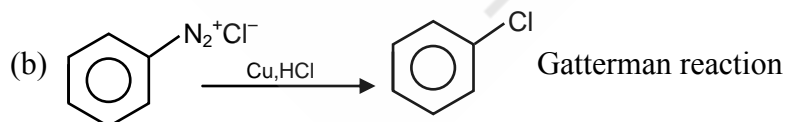
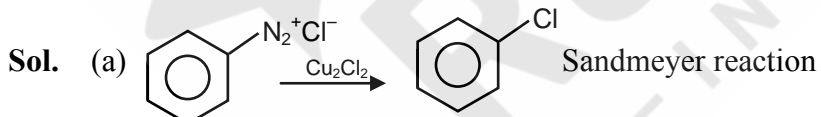
(1) (a) → (iii), (b) → (i), (c) → (iv), (d) → (ii)

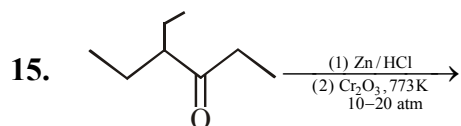
(2) (a) → (ii), (b) → (i), (c) → (iv), (d) → (iii)

(3) (a) → (ii), (b) → (iv), (c) → (i), (d) → (iii)

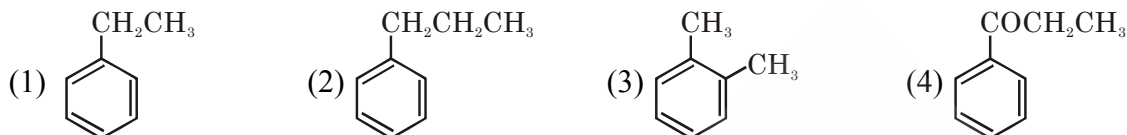
(4) (a) → (iii), (b) → (iv), (c) → (i), (d) → (ii)

Ans. (3)

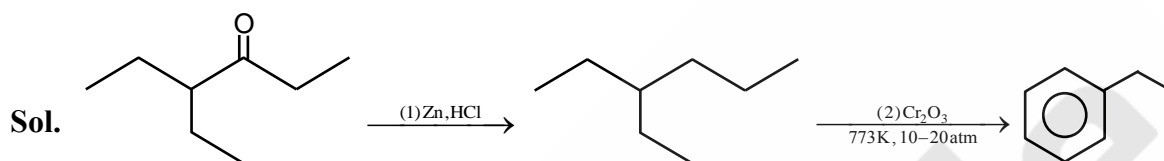




considering the above reaction, the major product among the following is :



Ans. (1)



In first step ketonic group is reduced by Clemmensen reduction, in second step aromatisation takes place.

16. Match List-I with List-II.

List-I (Molecule)	List-II (Bond order)
(a) Ne ₂	(i) 1
(b) N ₂	(ii) 2
(c) F ₂	(iii) 0
(d) O ₂	(iv) 3

Choose the correct answer from the options given below :

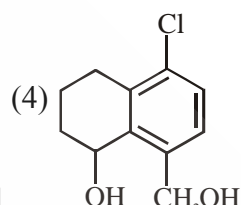
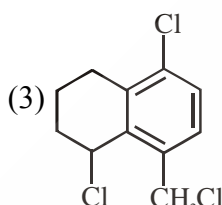
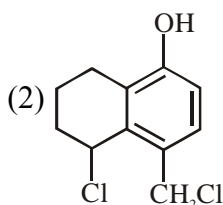
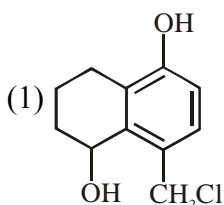
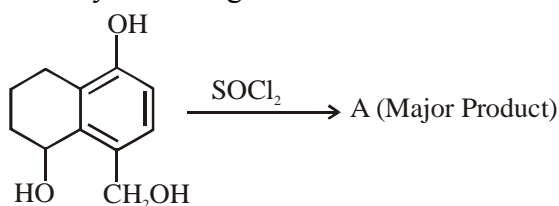
- (1) (a)→(iii), (b)→(iv), (c)→(i), (d)→(ii)
 (2) (a)→(i), (b)→(ii), (c)→(iii), (d)→(iv)
 (3) (a)→(ii), (b)→(i), (c)→(iv), (d)→(iii)
 (4) (a)→(iv), (b)→(iii), (c)→(ii), (d)→(i)

Ans. (1)

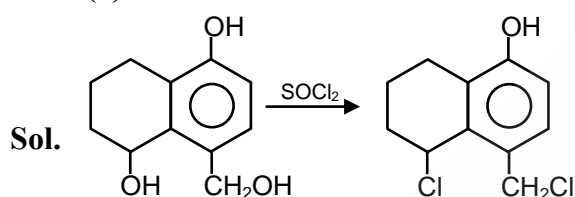
Sol.

Species	Bond order
Ne ₂	0
N ₂	3
O ₂	2
F ₂	1

17. Identify A in the given reaction.



Ans. (2)



Phenolic OH group does not give substitution reaction with SOCl_2 , as lone pair of oxygen is delocalised with benzene hence double bond character in C–O bond.

18. Match List-I with List-II.

List-I	List-II
(a) Siderite	(i) Cu
(b) Calamine	(ii) Ca
(c) Malachite	(iii) Fe
(d) Cryolite	(iv) Al
	(v) Zn

Choose the correct answer from the options given below :

- (1) (a)→(iii), (b)→(i), (c)→(v), (d)→(ii)
 (2) (a)→(i), (b)→(ii), (c)→(v), (d)→(iii)
 (3) (a)→(iii), (b)→(v), (c)→(i), (d)→(iv)
 (4) (a)→(i), (b)→(ii), (c)→(iii), (d)→(iv)

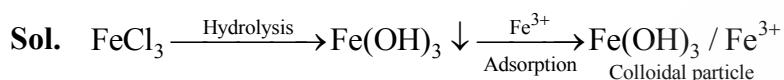
Ans. (3)

Sol. Ore	Formula
Siderite	FeCO_3
Calamine	ZnCO_3
Malachite	$\text{Cu}(\text{OH})_2 \cdot \text{CuCO}_3$
Cryolite	$\text{Na}_3[\text{AlF}_6]$

19. The nature of charge on resulting colloidal particles when FeCl_3 is added to excess of hot water is :

- (1) Positive
- (2) Sometimes positive and sometimes negative
- (3) Neutral
- (4) Negative

Ans. (1)



20. Match List-I with List-II.

List-I

- (a) Sodium Carbonate
- (b) Titanium
- (c) Chlorine
- (d) Sodium hydroxide

List-II

- (i) Deacon
- (ii) Castner-Kellner
- (iii) Van-Arkel
- (iv) Solvay

Choose the correct answer from the options given below :

- (1) (a)→(iv), (b)→(iii), (c)→(i), (d)→(ii)
- (2) (a)→(i), (b)→(iii), (c)→(iv), (d)→(ii)
- (3) (a)→(iv), (b)→(i), (c)→(ii), (d)→(iii)
- (4) (a)→(iii), (b)→(ii), (c)→(i), (d)→(iv)

Ans. (1)

Sol. Compound	Method of manufacturing
Na_2CO_3	Solvay process
Ti	Van Arkel process
Cl_2	Deacon process
NaOH	Castner kellner

NUMERICAL

1. The NaNO_3 weighed out to make 50 mL of an aqueous solution containing 70.0 mg Na^+ per mL is _____ g. (Rounded off to the nearest integer)

[Given : Atomic weight in g mol^{-1} – Na : 23 ; N : 14 ; O : 16]

Ans. (13)

Sol. Mass of Na^+ in 50ml = $70 \times 50 = 3500$ mg

23000mg of Na^+ is present in 85000 mg NaNO_3

$$\therefore 3500 \text{ mg } \text{Na}^+ \text{ will be present in } \frac{85000}{23000} \times 3500 = 12934.78 \text{ mg}$$

$$= 12.93478 \text{ gm.} \approx 13 \text{ gm}$$

2. Emf of the following cell at 298 K in V is $x \times 10^{-2}$.



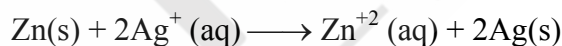
The value of x is _____. (Rounded off to the nearest integer)

[Given : $E_{\text{Zn}^{2+}/\text{Zn}}^0 = -0.76\text{V}$; $E_{\text{Ag}^+/\text{Ag}}^0 = +0.80\text{V}$; $\frac{2.303RT}{F} = 0.059$]

Ans. 147

Sol. $E_{\text{Cell}}^0 = [E_{\text{Ag}^+/\text{Ag}}^0]_{\text{cathode}} - [E_{\text{Zn}^{2+}/\text{Zn}}^0]_{\text{anode}}$

$$= 0.8 + 0.76 = 1.56 \text{ V}$$



$$E_{\text{cell}} = E_{\text{Cell}}^0 - \frac{0.0591}{2} \log_{10} \left[\frac{[\text{Zn}^{+2}]}{[\text{Ag}^+]^2} \right]$$

$$= 1.56 - \frac{0.0591}{2} \log_{10} \left[\frac{0.1}{10^{-4}} \right]$$

$$= 1.56 - \frac{0.0591}{2} \times 3$$

$$= 1.56 - 0.088 = 1.472 \text{ V}$$

$$= 147 \times 10^{-2} \text{ C}$$

$$X = 147$$

3. When 12.2 g of benzoic acid is dissolved in 100 g of water, the freezing point of solution was found to be -0.93°C ($K_f(\text{H}_2\text{O}) = 1.86\text{K kg mol}^{-1}$). The number (n) of benzoic acid molecules associated (assuming 100% association) is _____.

Ans. 2

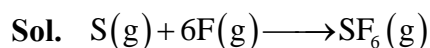
Sol. $\Delta T_f = i \times K_f \times m$

$$0.93 = i \times 1.86 \times 1 \quad \therefore i = \frac{1}{2}$$

$$\therefore \frac{1}{2} = 1 + \left(\frac{1}{n} - 1\right) \times 1 \quad \therefore n = 2$$

4. The average S–F bond energy in kJ mol^{-1} of SF_6 is _____. (Rounded off to the nearest integer)
[Given : The values of standard enthalpy of formation of $\text{SF}_6(\text{g})$, $\text{S}(\text{g})$ and $\text{F}(\text{g})$ are -1100 , 275 and 80 kJ mol^{-1} respectively.]

Ans. 309



$$\begin{aligned} \Delta H_R^\circ &= \Delta H_f^\circ(\text{SF}_6) - \Delta H_f^\circ(\text{S}) - 6\Delta H_f^\circ(\text{F}) \\ &= (-1100) - (275) - 6(80) = -1855 \end{aligned}$$

$$\Delta H_R^\circ = -1855 = 0 - 6 \times (\Delta H_{\text{S-F}}^\circ)$$

$$\Rightarrow \Delta H_{\text{S-F}}^\circ = \frac{1855}{6} = 309.16 \frac{\text{kJ}}{\text{mole}}$$

5. A ball weighing 10 g is moving with a velocity of 90 ms^{-1} . If the uncertainty in its velocity is 5%, then the uncertainty in its position is _____ $\times 10^{-33}\text{ m}$. (Rounded off to the nearest integer)
[Given : $h = 6.63 \times 10^{-34}\text{ Js}$]

Ans. 1

Sol. $\Delta x \times m\Delta v = \frac{h}{4\pi}$

$$\begin{aligned} \Delta x &= \frac{6.63 \times 10^{-34}}{4 \times 3.14 \times 10 \times 10^{-3} \times 4.5} \\ &= 1.17 \times 10^{-33} \end{aligned}$$

Ans. $\approx 1 \times 10^{-33}$

6. The number of octahedral voids per lattice site in a lattice is _____. (Rounded off to the nearest integer)

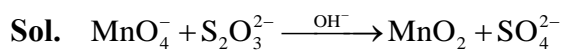
Ans. 1

Sol.	Effective Number of atoms per unit Cell	Number of octahedral voids
	FCC 4	4
	HCP 6	6

Hence one octahedral void per lattice site.

7. In mildly alkaline medium, thiosulphate ion is oxidized by MnO_4^- to "A". The oxidation state of sulphur in "A" is _____.

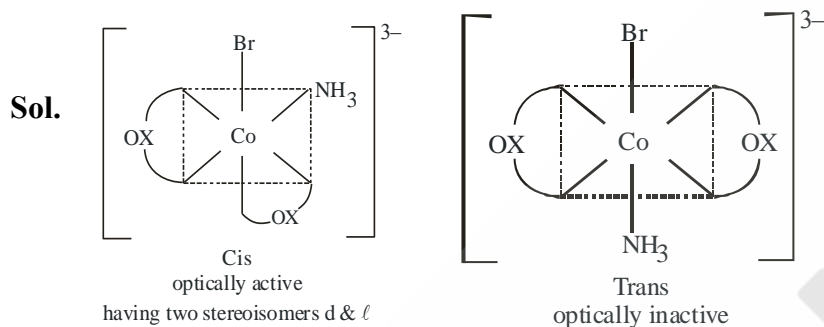
Ans. 6



Oxidation state of 'S' in SO_4^{2-} is 6

8. The number of stereoisomers possible for $[\text{Co}(\text{ox})_2(\text{Br})(\text{NH}_3)]^{2-}$ is _____. [ox = oxalate]

Ans. 3



Therefore total three stereoisomers are possible

9. If the activation energy of a reaction is 80.9 kJ mol^{-1} , the fraction of molecules at 700 K , having enough energy to react to form products is e^{-x} . The value of x is _____.

(Rounded off to the nearest integer)

[Use $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$]

Ans. (14)

Sol. Fraction (f) = $e^{-\frac{E_a}{RT}}$

$$= e^{-\frac{80.9 \times 10^3}{8.31 \times 700}}$$

$$= e^{-13.9}$$

$$\approx e^{-14}$$

10. The pH of ammonium phosphate solution, if pK_a of phosphoric acid and pK_b of ammonium hydroxide are 5.23 and 4.75 respectively, is _____.

Ans. 7

Sol. $\text{pH} = \frac{1}{2}(\text{pK}_w + \text{pK}_a - \text{pK}_b)$

$$= \frac{1}{2}(14 + 5.23 - 4.75)$$

$$= 7.24 \approx 7$$