28/06/2022
Evening

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Memory Based
Answers & Solutions

Time : 3 hrs. *for* M.M. : 300

JEE (Main)-2022 (Online) Phase-1

(Physics, Chemistry and Mathematics)

IMPORTANT INSTRUCTIONS:

(1) The test is of **3 hours** duration.

(2) The Test Booklet consists of 90 questions. The maximum marks are 300.

(3) There are **three** parts in the question paper consisting of **Physics, Chemistry** and **Mathematics** having 30 questions in each part of equal weightage. Each part (subject) has two sections.

(i) **Section-A:** This section contains 20 multiple choice questions which have only one correct answer. Each question carries **4 marks** for correct answer and **–1 mark** for wrong answer.

(ii) **Section-B:** This section contains 10 questions. In Section-B, attempt any **five questions out of 10.** The answer to each of the questions is a numerical value. Each question carries **4 marks** for correct answer and **–1 mark** for wrong answer. For Section-B, the answer should be rounded off to the nearest integer.

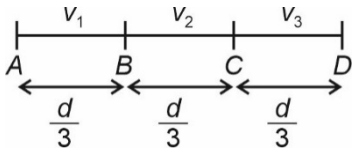
PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. A particle moves such that it moves $\frac{1}{3}$rd distance with speed v_1, the next $\frac{1}{3}$rd distance with speed v_2 and remaining $\frac{1}{3}$rd distance with speed v_3. Then its average speed throughout motion is



(1) $\frac{2(v_1v_2+v_2v_3+v_3v_1)}{v_1+v_2+v_3}$

(2) $\frac{(v_1+v_2+v_3)}{3}$

(3) $\frac{v_1+v_2}{2}+\frac{v_2+v_3}{2}+\frac{v_3+v_1}{2}$

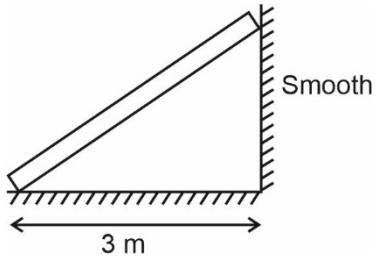
(4) $\frac{3v_1v_2v_3}{v_1v_2+v_2v_3+v_3v_1}$

Answer (4)

Sol. $v_{av}=\frac{d}{\frac{d}{3}+\frac{d}{3}+\frac{d}{3}}$

$=\frac{3v_1v_2v_3}{v_1v_2+v_2v_3+v_3v_1}$

2. A uniform rod of length $\sqrt{34}$m is inclined against the wall as shown. Floor is sufficiently rough to prevent slipping. Then the ratio of normal force on floor to normal force on wall is



(1) $\frac{10}{3}$

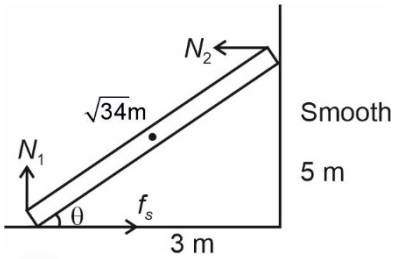
(2) $\frac{5}{2}$

(3) $\frac{3}{5}$

(4) $\frac{10}{7}$

Answer (1)

Sol.



$\therefore \quad f_s = N_2$

$\Rightarrow \quad N_2\frac{\ell\sin\theta}{2}+f_s\frac{\ell\sin\theta}{2}$

$=N_1\frac{\ell\cos\theta}{2}$

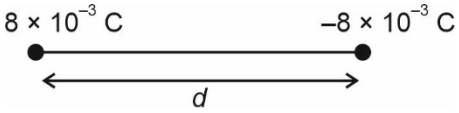
$\Rightarrow \quad \frac{N_2}{2}+\frac{N_2}{2}=\frac{N_1}{2}\times\cot\theta$

$\Rightarrow \quad N_2+N_2=N_1\times\left(\frac{3}{5}\right)$

$\Rightarrow \quad 2N_2=N_1\times\frac{3}{5}$

$\Rightarrow \quad \frac{N_1}{N_2}=\frac{10}{3}$

3. Two opposite charges are placed at a distance d as shown. Electric field strength at mid-point is 6.4×10^4 N/C, then the value of d is



(1) 42.1 m

(2) 89.4 m

(3) 72.2 m

(4) 62.8 m

Answer (2)

Sol. E at mid point $=\frac{Kq}{\left(\frac{d}{2}\right)^2}+\frac{Kq}{\left(\frac{d}{2}\right)^2}$

$=2\frac{Kq^2}{d^2}\times4$

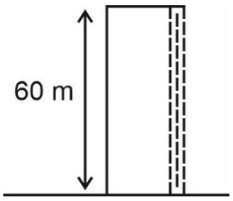
$\Rightarrow 6.4\times10^4 = \frac{8\times10^9\times(8\times10^{-3})^2}{d^2}$

$\Rightarrow 6.4\times10^4 = \frac{8\times10^9\times64\times10^{-6}}{d^2}$

$\Rightarrow d^2 = 10^3 \times 8$

$\Rightarrow d = 89.4$ m

4. Water falls at a rate of 600 kg/s is from a height of 60 m as shown. How many bulbs of capacity 100 W each will glow from the energy produced at the bottom of the fall. Assume full conversion of energy of falling water and all bulbs glowing at 100 W each.



(1) 25
(2) 50
(3) 100
(4) None

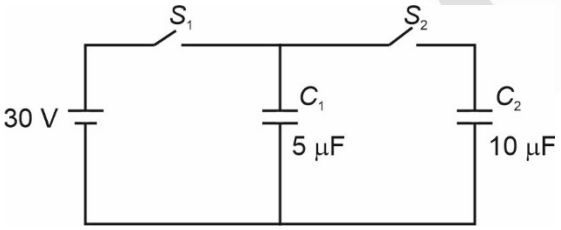
Answer (4)

Sol. $\frac{(mgh)}{\Delta t} = N\times P$

$\Rightarrow \frac{(600)\times10\times60}{1} = N\times100$

$\Rightarrow N = 3600$

5. The switch S_1 is kept closed for long now at $t = 0$ switch S_1 is opened and S_2 is closed. The charge on capacitor C_2 finally is



(1) 100 μC
(2) 120 μC
(3) 50 μC
(4) 80 μC

Answer (1)

Sol. $Q_0 = 5 \times 30 = 150$ μC

$\therefore q_2 = \frac{C_2}{C_1+C_2}\times Q_0$

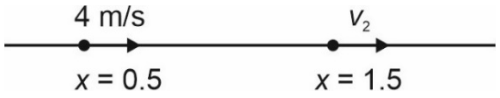
$= \frac{10}{10+5}\times(150) = 100$ μC

6. A mass of 2 kg crosses $x = 0.5$ m with 4 m/s. The force acting on the mass is $F = -kx$ where k is 12 N/m with what velocity will it cross $x = 1.5$ m

(1) 1 m/s (2) 3 m/s
(3) 2 m/s (4) 4 m/s

Answer (3)

Sol.



$\Delta KE = \Delta U$

$\Rightarrow \frac{1}{2}m(v_1^2 - v_2^2) = \frac{1}{2}k(x_2^2 - x_1^2)$

$\Rightarrow 2(4^2 - v_2^2) = 12(1.5^2 - 0.5^2)$

$\Rightarrow 16 - v_2^2 = \frac{12}{2}(2.25 - 0.25)$

$\Rightarrow v_2^2 = 16 - 12 = 4$

$\Rightarrow v_2 = 2$ m/s

7. A resistor has a resistance of 2 Ω at temperature 10°C and a resistance of 3 Ω at temperature 30°C. Find the temperature co-efficient of resistance.

(1) 0.050/°C (2) 0.025/°C
(3) 0.0025/°C (4) 0.006/°C

Answer (2)

Sol. $R_t = R_0(1 + \alpha\Delta T)$

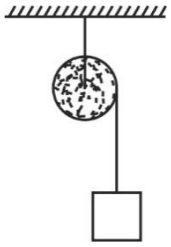
$\Rightarrow 3 = 2\ (1 + \alpha \times 20)$

$\Rightarrow 1.5 - 1 = \alpha \times 20$

$\Rightarrow \alpha = \frac{0.5}{20}$

$= 0.025$/°C

8. A block of mass m and a pulley of mass m are arranged as shown:



The string connecting the block and the string does not slip on the pulley as the block comes down. Find the tension in the string.

(1) $\frac{mg}{4}$ (2) $\frac{mg}{2}$
(3) $\frac{mg}{3}$ (4) $\frac{2mg}{3}$

Answer (3)

Sol. $a_b = \dfrac{mg}{\left[m + \dfrac{mR^2}{2 \times R^2}\right]}$

$= \dfrac{2g}{3}$

$\therefore \quad T = m(g - a)$

$= m\left[g - \dfrac{2g}{3}\right]$

$= \dfrac{mg}{3}$

9. de Broglie wavelength of two identical particles are related as $\lambda_1 = 3\lambda_2$ then the kinetic energy K_1 and K_2 of particle respectively are related as

(1) $K_2 = 3K_1$ (2) $K_2 = 9K_1$

(3) $K_1 = 3K_2$ (4) $K_1 = 2K_2$

Answer (2)

Sol. $\lambda_1 = \dfrac{h}{\sqrt{2mK_1}}$

and, $\lambda_2 = \dfrac{h}{\sqrt{2mK_2}}$

$\Rightarrow \quad \dfrac{\lambda_1}{\lambda_2} = \sqrt{\dfrac{K_2}{K_1}}$

$\Rightarrow \quad 3 = \sqrt{\dfrac{K_2}{K_1}}$

$\Rightarrow \quad K_2 = 9K_1$

10. Time period of simple pendulum of length l when placed in a lift which is accelerating upwards with the acceleration $\dfrac{g}{6}$ is

(1) $2\pi\sqrt{\dfrac{6l}{7g}}$ (2) $2\pi\sqrt{\dfrac{7l}{6g}}$

(3) $2\pi\sqrt{\dfrac{3l}{2g}}$ (4) $2\pi\sqrt{\dfrac{5l}{6g}}$

Answer (1)

Sol. $\because \quad T = 2\pi\sqrt{\dfrac{l}{g + a}}$; a = upward acceleration

$\Rightarrow \quad T = 2\pi\sqrt{\dfrac{l}{g + \dfrac{g}{6}}}$

$\Rightarrow \quad T = 2\pi\sqrt{\dfrac{6l}{7g}}$

11. In a resonance column experiment, water level is decreased. First resonance is observed with a turning fork of frequency 340 Hz when air column is of length 125 cm. Find how much further the water level should go down to observe the next resonance. (v_{sound} = 340 m/s)

(1) 25 cm (2) 50 cm

(3) 100 cm (4) 75 cm

Answer (2)

Sol. $\lambda = \dfrac{340}{340} = 1\text{ m}$

$\therefore \quad l_1 = \dfrac{\lambda}{4} = 25\text{ cm}$

$l_2 = 3\left(\dfrac{\lambda}{4}\right) = 75\text{ cm}$

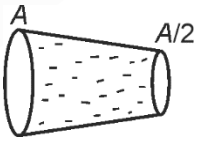
$l_3 = 5\left(\dfrac{\lambda}{4}\right) = 125\text{ cm}$

$l_4 = 7 \times \left(\dfrac{\lambda}{4}\right) = 175\text{ cm}$

$\therefore \quad \Delta l = l_4 - l_3$

$= 50\text{ cm}$

12. Water is flowing through a frustum like section of a pipe as shown in the diagram. Pressure difference across the ends is 4000 N/m^2. Area of cross-section $A = \sqrt{6}$ m^2. Find the volume flow rate through the pipe.

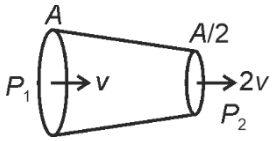


(1) 4 m^3/s (2) 2 m^3/s

(3) 1 m^3/s (4) 8 m^3/s

Answer (1)

Sol.



$P_1 + \dfrac{1}{2}\rho v^2 = P_2 + \dfrac{1}{2}\rho \times \left(4v^2\right)$

$\Rightarrow \quad (P_1 - P_2) = \dfrac{1}{2}\rho \times \left(3v^2\right)$

$\Rightarrow \quad 4000 = \dfrac{1}{2}\rho \times 3 \times v^2$

$\Rightarrow \quad v = \sqrt{\dfrac{8}{3}}$

$\therefore \quad Q = Av = \sqrt{6} \times \sqrt{\dfrac{8}{3}}$

$= 4\text{ m}^3/\text{s}$

13. In a YDSE experiment if a slab of thickness $x\lambda$ and refractive index (μ = 1.5) is inserted in front of slit then intensity of previous central maxima remains unchanged, then the minimum value of x is,

(1) 2 (2) 1

(3) 0.5 (4) 1.5

Answer (2)

Sol. $(\mu - 1)t = \frac{\lambda}{2}$

$(1.5 - 1) \times (x\lambda) = \frac{\lambda}{2}$

$\Rightarrow x = 1$

14. Choose the correct statement

(1) In radioactive decay, λ depends on physical and chemical environment

(2) ln$N$ vs t graph slope is proportional to inverse of mean life

(3) Number of nuclei remaining is linearly related with time

(4) ln$N$ vs ln$t$ graph slope is proportional to inverse of mean life.

Answer (2)

Sol. $\because \quad N = N_0 e^{-\lambda t}$

$\Rightarrow \ln N = \ln N_0 - \lambda t$

$\Rightarrow$ Slope = $\lambda \propto \frac{1}{\text{Mean life}}$

15. A drop of water of radius 1 mm is falling through air. Find the terminal speed of the drop knowing that density of air is negligible as compared to density of water. ($\eta_{air} = 2 \times 10^{-3}$ Ns/m^2, g = 10 m/s^2).

(1) 2.2 m/s (2) 1.1 m/s

(3) 1.6 m/s (4) 2.8 m/s

Answer (2)

Sol. $\therefore \quad U_T = \frac{2r^2(\rho - \sigma)g}{9\eta}$

$= \frac{2 \times 10^{-6} \times 10^3 \times 10}{9 \times 2 \times 10^{-3}}$

$= \frac{10}{9}$

= 1.1 m/s

16. For an amplitude modulated wave given by $y(t) = 10[1 + 0.4\cos(2\pi \times 10^4 t]\sin(2\pi \times 10^7 t)$, find the bandwidth.

(1) 10 kHz (2) 20 MHz

(3) 20 kHz (4) 10 MHz

Answer (3)

Sol. Bandwidth $= 2 \times \left(\frac{2\pi \times 10^4}{2\pi}\right)$ Hz

= 20 kHz

17. The temperature of a sample of gaseous O_2 is doubled such that O_2 dissociates into O. Find the ratio of new V_{rms} to old V_{rms}.

(1) 2 (2) $\sqrt{2}$

(3) 4 (4) $\frac{1}{2}$

Answer (1)

Sol. Ratio of rms speeds

$\frac{V_1}{V_2} = \sqrt{\frac{T_1}{T_2} \times \frac{M_2}{M_1}}$

$= \sqrt{\frac{T}{2T} \times \frac{M}{\frac{2}{M}}}$

$= \frac{1}{2}$

$\Rightarrow \frac{V_2}{V_1} = 2$

18.

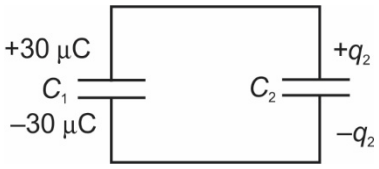
19.

20.

SECTION - B

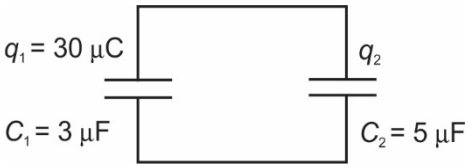
Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, –00.33, –00.30, 30.27, –27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. A capacitor (C_1) of capacity 3 μF and another capacitor (C_2) of capacity 5 μF are connected as shown. Find the value of q_2 (in μC)



Answer (50)

Sol.

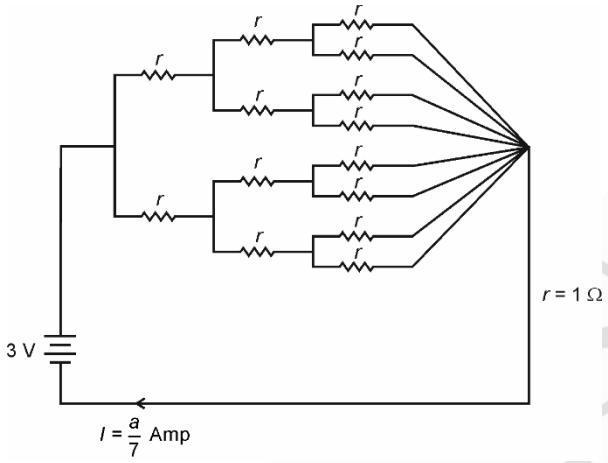


$\because \dfrac{q_2}{C_2} = \dfrac{q_1}{C_1}$

$\Rightarrow \dfrac{q_2}{5} = \dfrac{30}{3}$

$\Rightarrow q_2 = 50\ \mu C$

22.



In the circuit shown above, find the valve of '*a*'.

Answer (24)

Sol. $R_{eq} = \dfrac{1}{2} \times \left[r + \dfrac{\left(\dfrac{r}{2} + r\right)}{2} \right]$

$= \dfrac{1}{2} \times \left(\dfrac{7r}{4}\right)$

at $r = 1\ \Omega$

$R_{eq} = \dfrac{7}{8}\ \Omega$

$\therefore\ I = \dfrac{3 \times 8}{7} = \dfrac{24}{7}$ A

$\Rightarrow\ a = 24$

23. Consider two particles of equal mass and at separation *r*. How many times the force between them becomes when mass of one of the particles becomes 3 times maintaining same separation?

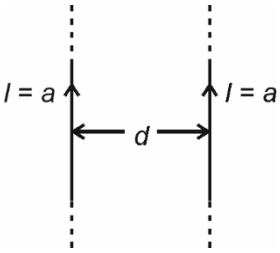
Answer (3)

Sol. $\because\ F_1 = \dfrac{Gm_1m_2}{r^2} = \dfrac{Gm^2}{r^2}$

$F_2 = \dfrac{Gm \times (3m)}{r^2} = \dfrac{3Gm^2}{r^2}$

$\Rightarrow\ F_2 = 3F_1$

24.



Two parallel wires carry same magnitude current that is *a*. Distance between two wires is given as *d*. The force per unit length experienced by the wires (in 10^{-7} N) is equal to _____.

(a = 1 Amp, d = 4 cm)

Answer (50)

Sol. $\because \dfrac{F}{l} = \dfrac{\mu_0 I_1 I_2}{2\pi d}$

$= \dfrac{\left(2 \times 10^{-7}\right) \times a \times a}{d}$

$= \dfrac{2 \times 10^{-7} \times (1)^2}{0.04}$

$= 50 \times 10^{-7}$

25. Half-life of radio-active substance is 200 days, then the percentage of substance remaining after 83 days is $\left(\dfrac{1}{2^{0.415}} = 0.75\right)$.

Answer (75)

Sol. $N = \dfrac{N_0}{2^{t/T_{1/2}}}$

$N = \dfrac{N_0}{2^{83/200}} = 0.75\ N_0$

$\Rightarrow$ remaining amount = 75%

26.

27.

28.

29.

30.

CHEMISTRY

SECTION – A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

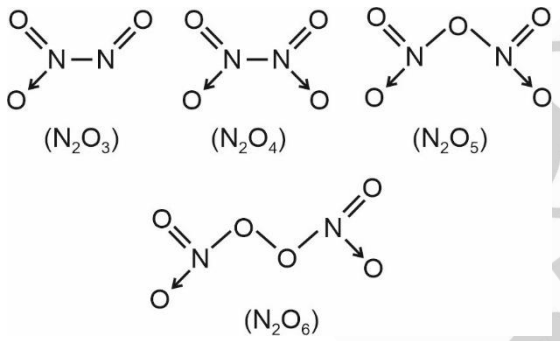
1. Out of N_2O_3, N_2O_4, N_2O_5 and N_2O_6, how many of them contain N – N bond?

(1) 1 (2) 2

(3) 3 (4) 4

Answer (2)

Sol. The structures of the given oxides of nitrogen are



$\therefore$ Compounds having N – N bond = 2

2. Photochemical smog contains

(1) O_3 (2) N_2

(3) SF_4 (4) F_2

Answer (1)

Sol. Photochemical smog contains O_3, PAN, nitric oxide, acrolein, formaldehyde.

3. Which of the following is a basic oxide?

(1) Al_2O_3 (2) SiO_2

(3) Na_2O (4) NO_2

Answer (3)

Sol. NO_2, SiO_2 are acidic oxides

Al_2O_3 is an amphoteric oxide

Na_2O is a basic oxide

4. Which of the following set of quantum number is valid?

	n	l	m	s
(1)	4	3	0	$\frac{1}{2}$
(2)	3	3	2	$\frac{1}{2}$
(3)	2	1	–2	$\frac{1}{2}$
(4)	1	1	0	$\frac{1}{2}$

Answer (1)

Sol. In atoms, the possible values of l, m and s for a given value of n are

l = 0, ….. (n – 1)

m = –l, ….. 0 ….. +l (2l + 1)

$s = +\frac{1}{2}$ or $-\frac{1}{2}$

$\therefore$ The possible values of given quantum numbers are n = 4, l = 3, m = 0 and $s = \frac{1}{2}$

5. There are three isotopes of hydrogen, identify the difference between them.

(1) Number of protons

(2) Number of electrons in neutral state

(3) Electronic configuration in neutral state

(4) Number of neutron

Answer (4)

Sol. Hydrogen has three isotopes ${}_1^1H$, ${}_1^2H$, ${}_1^3H$. The number of neutrons in these isotopes are 0, 1, 2 respectively.

6. $FeO + SiO_2 \longrightarrow FeSiO_3$

SiO_2 and $FeSiO_3$ are respectively (considering the extraction of copper)

(1) Flux and slag (2) Slag and flux

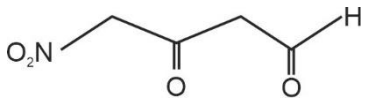
(3) Gauge and flux (4) Gauge and slag

Answer (1)

Sol. During extraction of copper, iron oxide present as impurity is removed by adding SiO_2 and converting it into $FeSiO_3$.

$$\underset{\text{flux}}{FeO + SiO_2} \longrightarrow \underset{\text{slag}}{FeSiO_3}$$

7. The correct IUPAC name of the compound



(1) 1-formyl-4-nitro butanal

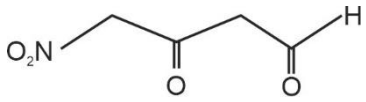
(2) 4-nitro-3-oxo-butanal

(3) 4-oxo-3-nitrobutanal

(4) 3-oxo-4-nitropropanal

Answer (2)

Sol. The correct IUPAC name of the compound



Is 4-nitro-3-oxo-butanal

8. In which of the following compounds sulphur shows two different oxidation states?

(1) $H_2S_2O_3$

(2) $H_2S_2O_6$

(3) $H_2S_2O_7$

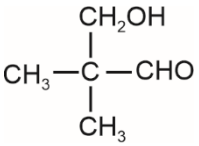
(4) $H_2S_2O_8$

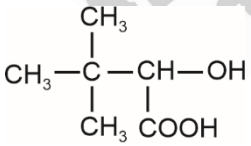
Answer (1)

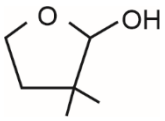
Sol. In $H_2S_2O_3$, sulphur exhibits two different oxidation states (+6 and –2).

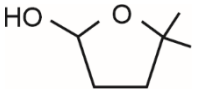
9. Isobutaldehyde $\xrightarrow[K_2CO_3]{HCHO}$ A $\xrightarrow{CN^-}$ B $\xrightarrow{H_3O^+}$ P.

The product P is

(1) 

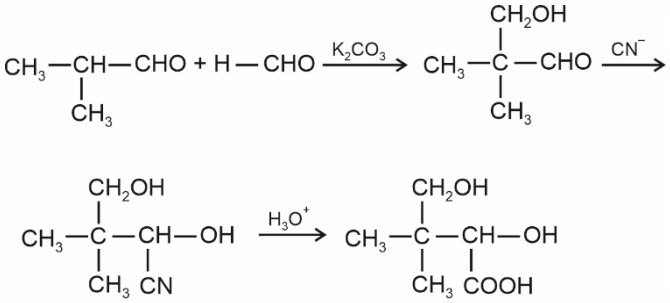
(2) 

(3) 

(4) 

Answer (2)

Sol.



10. Find empirical formula of a compound which contains 74% C, 17.3% N and 8.7% H by mass

(1) C_4H_6N (2) C_5H_7N

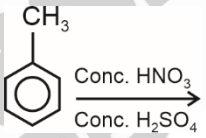
(3) C_3H_5N (4) $C_4H_5N_2$

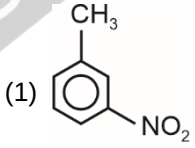
Answer (2)

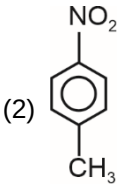
Sol.

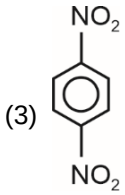
Elements	% by mass	moles	whole no. ratio
C	74	$\frac{74}{12} = 6.17$	5
H	8.7	$\frac{8.7}{1} = 8.7$	7
N	17.3	$\frac{17.3}{14} = 1.24$	1

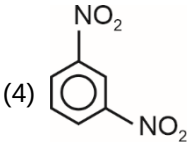
Hence empirical formula of compound is C_5H_7N

11. 

(1) 

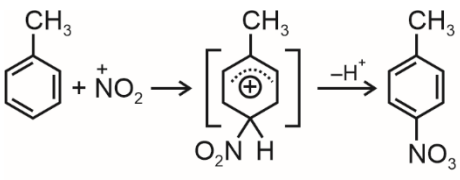
(2) 

(3) 

(4) 

Answer (2)

Sol. $HNO_3 + H_2SO_4 \rightarrow NO_2^+ + HSO_4^- + H_2O$

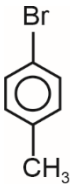


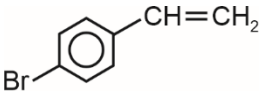
(major product)

12. Consider the following reaction

$$A \xrightarrow[2.\ KCN]{1.\ Cl_2/h\nu} \underset{3.\ H_3O^+/\Delta}{} \text{4-Bromophenylacetic Acid}$$

(1) 

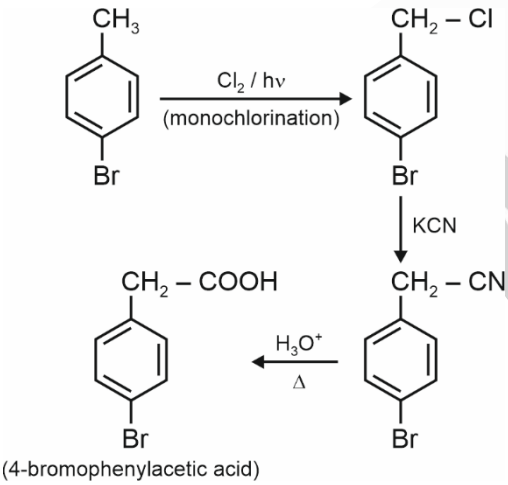
(2) 

(3) 

(4) 

Answer (2)

Sol.



(4-bromophenylacetic acid)

13. A sugar 'X' is hydrolysed forms isomers one of the compound form is laevorotatory then 'X' can be

(1) Maltose

(2) Sucrose

(3) Lactose

(4) Dextrose

Answer (2)

Sol. Sucrose is a disaccharides, which on hydrolysis gives equimolar mixture of D-(+)-glucose and D-(–)-fructose

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \longrightarrow \underset{\text{D-(+)-Glucose}}{C_6H_{12}O_6} + \underset{\text{D-(–)-Fructose}}{C_6H_{12}O_6}$$

Reaction is called inversion reaction.

14. The correct statement about photochemical smog is

(1) It is caused by chemical reaction of hydrocarbon

(2) Reducing in nature

(3) It is caused by SO_2 dust

(4) Humid climate

Answer (1)

Sol. Photochemical smog occurs in warm, dry and sunny climate. It is oxidising in nature.

$$CH_4 + 2O_3 \longrightarrow \underset{\text{Formaldehyde}}{2CH_2=O} + 3H_2O$$

And it is formed by chemical reaction of hydrocarbon.

15 The pH of a buffer solution of acetic acid is 4. Find the value of $\dfrac{[CH_3COO^-]}{[CH_3COOH]}$

Given K_a of acetic acid = 1.3×10^{-5}

(A) 2.3 (B) 10.2

(C) 0.13 (D) 1.5

Answer (3)

Sol. $pH = pK_a + \log \dfrac{[CH_3COO^-]}{[CH_3COOH]}$

$$4 = 5 - \log 1.3 + \log \frac{[CH_3COO^-]}{[CH_3COOH]}$$

$$\log (1.3\times10^{-1}) = \log \frac{[CH_3COO^-]}{[CH_3COOH]}$$

on comparing both the sides

Ratio = 0.13

16. Nature of colloidal sol of $Fe(OH)_3$ is,

(1) Neutral

(2) Positive

(3) Negative

(4) Amphoteric

Answer (2)

Sol. $Fe(OH)_3$ sol is obtained by hydrolysis of $FeCl_3$.

$FeCl_3 \rightarrow Fe^{3+} + 3Cl^-$

$Fe^{3+} + 3H_2O \rightarrow Fe(OH)_3 + 3H^+$

$Fe(OH)_3 + Fe^{3+} \rightarrow \underset{\text{Positive colloid}}{Fe(OH)_3 / Fe^{3+}}$

$Fe(OH)_3$ sol adsorbs Fe^{3+} ions to become a positive colloid.

17. Consider the structure of SF_4, the no. of lone pair(s), position of lone pair and no. of lone pair-bond pair repulsions respectively are

(1) 1, equatorial position, 4

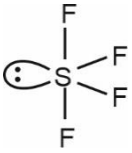
(2) 2, axial position, 4

(3) 1, axial position, 3

(4) 1, equatorial position, 6

Answer (1)

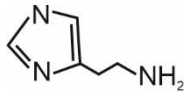
Sol. The geometry of SF_4 as

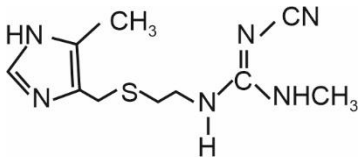


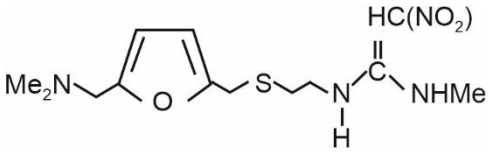
lone pair is at equatorial position

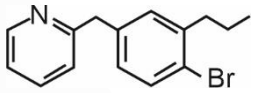
No. of lone pair-bond pair repulsions is 4

18. The structure of tegamet (cimetidine)

(1) 

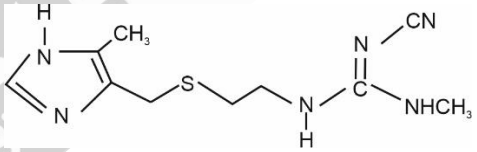
(2) 

(3) 

(4) 

Answer (2)

Sol. The structure of tegamet (cimetidine) is



19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, –00.33, –00.30, 30.27, –27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. Consider the following complexes

$[Fe(CN)_6]^{3-}$, $[Ni(CN)_4]^{2-}$ and $[Fe(CN)_6]^{4-}$

How many complex(es) is/are paramagnetic?

Answer (01.00)

Sol. $[Fe(CN)_6]^{3-} \Rightarrow Fe(III) = 3d^5$

(Valence shell configuration)

Since, CN^- is a strong field ligand. Hence pairing will take place. Since there are unpaired electrons $\Rightarrow$ Paramagnetic

$[Ni(CN)_4]^{2-} \Rightarrow Ni(II) - 3d^8$ (Valence shell configuration)

Here, also CN^- is a strong field ligand, pairing takes place.

No unpaired electrons $\Rightarrow$ Diamagnetic

$[Fe(CN)_6]^{4-} \Rightarrow Fe(II) = 3d^6$ (Valence shell configuration)

Pairing takes place $\Rightarrow$ No unpaired electron $\Rightarrow$ Diamagnetic

Hence, only one complex is paramagnetic.

22. IF for $Sn^{+4} + 4e^- \longrightarrow Sn$, $E^\circ_{Sn^{+4}/Sn} = 0.0203V$

and for $Sn^{+2} + 2e^- \longrightarrow Sn$, $E^\circ_{Sn^{+2}/Sn} = -0.14V$

What is the value of $E^\circ_{Sn^{+4}/Sn^{+2}}$ (in V)?

Answer (0.18)

Sol. $E^\circ_{Sn^{+4}/Sn^{+2}} = \dfrac{0.0203 \times 4 + 0.14 \times 2}{2}$

$\simeq 0.18\,V$

23. The half life of a substance is 200 days. Find the % activity of remaining substance after 83 days if decays through first order kinetics. [Round off to the nearest integer]

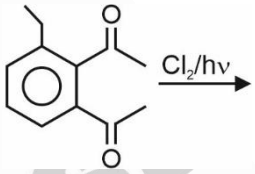
Answer (75)

Sol. $\dfrac{0.693}{200} \times 83 = \ln\left(\dfrac{N_0}{N_t}\right)$

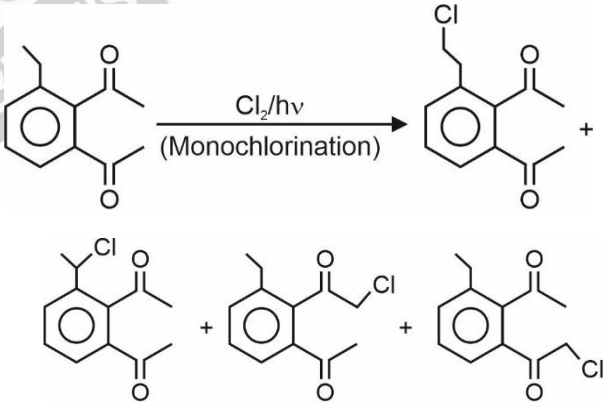
$10^{0.125} = \log\left(\dfrac{N_0}{N_t}\right)$

$\left(\dfrac{N_0}{N_t}\right) = \dfrac{4}{3}$

There remaining activity is 75%

24.  Number of carbon atoms to which Cl is attached

Answer (4)

Sol. 

$\therefore$ Number of C-atoms to which Cl is attached = 4

25.

26.

27.

28.

29.

30.

MATHEMATICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. $6\tan\left(\lim\limits_{n\to\infty}\sum\limits_{r=1}^{n}\tan^{-1}\dfrac{1}{r^2+3r+3}\right)$

(1) 3 (2) 4

(3) 6 (4) 8

Answer (1)

Sol. $6\tan\left(\lim\limits_{n\to\infty}\sum\limits_{r=1}^{n}\tan^{-1}\left(\dfrac{(r+2)-(r+1)}{1+(r+1)(r+2)}\right)\right)$

$=6\tan\left(\lim\limits_{n\to\infty}\sum\limits_{r=1}^{n}\left(\tan^{-1}(r+2)-\tan^{-1}(r+1)\right)\right)$

$=6\tan\left(\lim\limits_{n\to\infty}\tan^{-1}(n+2)-\tan^{-1}2\right)$

$=6\tan\left(\dfrac{\pi}{2}-\cot^{-1}\dfrac{1}{2}\right)$

$=6\cot\left(\cot^{-1}\dfrac{1}{2}\right)=6\times\dfrac{1}{2}=3$

2. $\left(1-x^2+3x^3\right)\left(\dfrac{5}{2}x^3-\dfrac{1}{5x^2}\right)^{11}$. Find the coefficient of the term independent of x.

(1) $-\dfrac{43}{200}$ (2) $\dfrac{17}{100}$

(3) $-\dfrac{17}{200}$ (4) $\dfrac{33}{200}$

Answer (4)

Sol. General term of $\left(\dfrac{5}{2}x^3-\dfrac{1}{5x^2}\right)^{11}$ is

$T_{r+1}={}^{11}C_r\left(\dfrac{5}{2}x^3\right)^{11-r}.\left(-\dfrac{1}{5x^2}\right)^{r}$

$={}^{11}C_r(-1)^r.\dfrac{5^{11-2r}}{2^{11-r}}.x^{33-5r}$

Coefficient of term independent of x = coefficient of x° in $\left(\dfrac{5}{2}x^3-\dfrac{1}{5x^2}\right)^{11}$

Coefficient of x^{-2} in $\left(\dfrac{5}{2}x^3-\dfrac{1}{5x^2}\right)^{11}$ + 3 coefficient of x^{-3} in $\left(\dfrac{5}{2}x^3-\dfrac{1}{5x^2}\right)^{11}$

$=0-{}^{11}C_7(-1)^7.\dfrac{5^{-3}}{2^4}+0$

$=\dfrac{330}{5^3.2^4}=\dfrac{33}{200}$

3. Find the area enclosed by x-axis and $y=3-|x+1|-\left|x-\dfrac{1}{2}\right|$

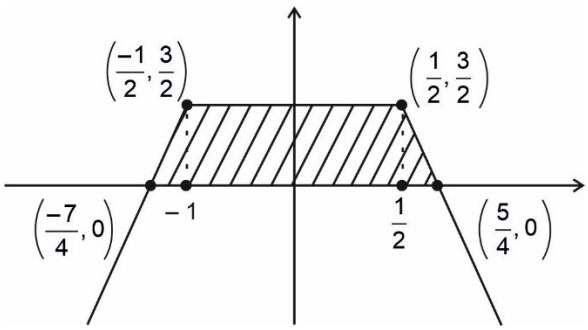
(1) $\dfrac{27}{8}$ (2) $\dfrac{23}{8}$

(3) $\dfrac{25}{8}$ (4) $\dfrac{27}{4}$

Answer (1)

Sol. $f(x)=3-|x+1|-\left|x-\dfrac{1}{2}\right|$

$\therefore\quad f(x)=\begin{cases}\dfrac{5}{2}-2x & x\ge\dfrac{1}{2}\\ \dfrac{3}{2} & -1<x<\dfrac{1}{2}\\ 2x+\dfrac{7}{2} & x\le -1\end{cases}$



$\Rightarrow$ Required Area $=\dfrac{1}{2}\cdot\dfrac{(9)}{2}\cdot\dfrac{3}{2}=\dfrac{27}{8}$

4. If vertex of parabola is (2, –1) and the equation of its directrix is $4x - 3y = 21$, then find the length of latus rectum.

(1) 2

(2) 8

(3) 3

(4) 4

Answer (2)

Sol. The vertex of parabola = (2, –1).

Equation of directrix is $4x - 3y = 21$.

Let semi latusrectum = l

$\therefore \quad a = \frac{l}{4} = \frac{|8+3-2l|}{5}$

$\therefore \quad l = 8$

5. If $\cot\alpha = -1$, $\sec\beta = \frac{-5}{3}$, where $\alpha \in \left(\frac{\pi}{2}, \pi\right)$ and $\beta \in \left(\pi, \frac{3\pi}{2}\right)$

Find $\tan(\alpha + \beta)$.

(1) $\frac{1}{7}$ (2) $-\frac{1}{3}$

(3) $\frac{1}{3}$ (4) $-\frac{1}{7}$

Answer (1)

Sol. Clearly $\tan\alpha = -1$ and $\tan\beta = \frac{4}{3}$

So $\tan(\alpha+\beta) = \frac{\tan\alpha + \tan\beta}{1 - \tan\alpha\tan\beta}$

$= \frac{-1+\frac{4}{3}}{1+\frac{4}{3}} = \frac{1}{7}$

6. In a quadratic polynomial $f(-2) + f(3) = 0$ and $f(-1) = 0$.

Find the sum of the roots

(1) $\frac{14}{3}$ (2) $\frac{11}{3}$

(3) $-\frac{11}{3}$ (4) $-\frac{14}{3}$

Answer (2)

Sol. $\because \quad f(-1) = 0$ so let $f(x) = a(x+1)^2 + b(x+1)$

$\because \quad f(-2) + f(3) = 0$

$\Rightarrow \quad (a - b) + (16a + 4b) = 0$

$\Rightarrow \quad 17a + 3b = 0$

So $f(x) = a\left[(x+1)^2 - \frac{17}{3}(x+1)\right]$

$= a(x+1)\left(x - \frac{14}{3}\right)$

Sum of roots $= +\frac{11}{3}$

7. Find the equation of plane passing through the points (2, –1, 0) and perpendicular to the plane $2x - 3y + z = 0$ and $2x - y - 3z = 0$

(1) $5x + 4y + 2z = 0$ (2) $2x - y + z = 3$

(3) $5x + 4y + 2z - 6 = 0$ (4) $2x + y - z = 3$

Answer (3)

Sol. Let the equation of the plane passing through (2, –1, 0) and with (a, b, c) as the *d.r's* of the normal is

$a(x-2) + b(y+1) + cz = 0 \quad \ldots(i)$

It is perpendicular to

$2x - 3y + z = 0$

and $2x - y - 3z = 0$

$\therefore \quad 2a - 3b + c = 0$

and $2a - b - 3c = 0$

$\therefore \quad (a, b, c) = (5, 4, 2)$

$\Rightarrow$ Equation of the required plane is

$5(x-2) + 4(y+1) + 2z = 0$

$\Rightarrow \quad 5x + 4y + 2z - 6 = 0$

8. n arithmetic means are inserted between 'a' & 100. If the ratio of first & n^{th} arithmetic mean is 1 : 7 & $a + n = 33$, then the value of n will be

(1) 21

(2) 22

(3) 23

(4) 24

Answer (3)

Sol. $\because \quad \frac{a+d}{100-d}=\frac{1}{7}$

$\Rightarrow \quad 7a + 8d = 100 \qquad \ldots(i)$

Where d be the common difference.

Also $d=\frac{100-a}{n+1}=\frac{100-a}{34-a} \qquad \ldots(ii)$

From (i) and (ii)

$7a+8\left(\frac{100-a}{34-a}\right)=100$

So $a = 10$ or $\frac{260}{7}$

Clearly $a = 10$ so $n = 23$

9. Image of point $P(3, 2, 3)$ with respect to the line $\frac{x-3}{3}=\frac{y-2}{4}=\frac{z-1}{5}$ is S. If a point $Q(\alpha, \beta, \gamma)$ divides PS internally in the ratio 1 : 3, then find (α, β, γ).

(1) $\left(\frac{33}{10},\frac{12}{5},\frac{5}{2}\right)$

(2) $\left(\frac{33}{10},\frac{5}{2},\frac{12}{5}\right)$

(3) $\left(\frac{12}{5},\frac{33}{10},\frac{5}{2}\right)$

(4) (1, 0, 1)

Answer (1)

Sol. Let a point on line be λ *i.e.* $(3\lambda + 3, 4\lambda + 2, 5\lambda + 1)$

Finding foot of perpendicular :

$\langle 3\lambda, 4\lambda, 5\lambda -2\rangle$ & $\langle 3, 4, 5\rangle$ are perpendicular

$\Rightarrow \quad 9\lambda + 16\lambda + 25\lambda - 10 = 0 \Rightarrow \lambda=\frac{1}{5}$

$\therefore \quad$ Foot of perpendicular $\equiv\left(\frac{18}{5},\frac{14}{5},2\right)$

Point dividing P & S in ratio 1 : 3 will be mid-point of P & foot of perpendicular,

i.e. $\left(\frac{\frac{18}{5}+3}{2},\frac{\frac{14}{5}+2}{2},\frac{2+3}{2}\right)$

$\equiv\left(\frac{33}{10},\frac{12}{5},\frac{5}{2}\right)$

10. If $f(x) + f(x + k) = x$ and $I_1=\int_0^{4k} f(x)dx$ and $I_2=\int_{-k}^{3k} f(x)dx$, then $I_1 + I_2$ equals

(1) nk (2) $2nk$

(3) $3nk$ (4) $4nk$

Answer (4)

Sol. $\because \quad f(x) + f(x + k) = n \qquad \ldots(i)$

$\because \quad I_1=\int_0^{4k} f(x)dx$

and $I_2=\int_{-k}^{3k} f(x)dx$

Let $x = t - k$

$\therefore \quad dx = dt$

$\therefore \quad I_2=\int_0^{4k} f(t-k)dt$

$=\int_0^{4k}(n-f(t))dt \cdot \qquad \{f(t-k)=n-f(t)\}$

$=\int_0^{4k} ndt-\int_0^{4k} f(t)dt$

$= 4nk - I_1$

$I_1 + I_2 = 4nk$

11. If $2xye^{\frac{x^2}{y}}dx+\left(y-x^2e^{\frac{x^2}{y}}\right)dy=0$ then

(1) $e^{\frac{x^2}{y}}+\ln y=c$

(2) $e^{\frac{x^2}{y}}+\frac{y^2}{2}=c$

(3) $x\cdot e^{\frac{x^2}{y}}+y=c$

(4) $y\cdot e^{\frac{x^2}{y}}-\ln y=c$

Answer (1)

Sol. $e^{\frac{x^2}{y}}\left[2xydx - x^2dy\right] = -ydy$

$$= e^{\frac{x^2}{y}}\left[\frac{yd\left(x^2\right) - x^2dy}{y^2}\right] = -\frac{dy}{y}$$

$$= e^{\frac{x^2}{y}}d\left(\frac{x^2}{y}\right) + \frac{dy}{y} = 0$$

$$\Rightarrow \quad e^{\frac{x^2}{y}} + \ln y = c$$

12. One of the diameter of circle $\left(x-\sqrt{2}\right)^2 + \left(y-3\sqrt{2}\right)^2 = 6$ is chord of other circle $\left(x-2\sqrt{2}\right)^2 + \left(y-2\sqrt{2}\right)^2 = r^2$ then r is equal to

(1) $\sqrt{10}$

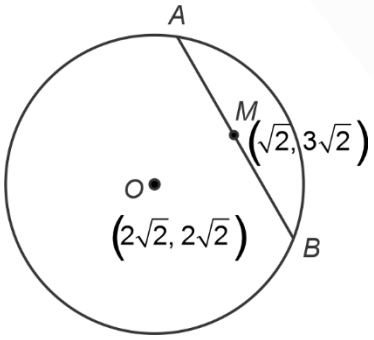
(2) $\sqrt{5}$

(3) 2

(4) $\sqrt{8}$

Answer (1)

Sol.



If diameter of first circle is chord of second circle, then mid-point of this chord will be centre of the first circle.

Also, length of chord = Diameter of first circle

$$= 2\sqrt{6}$$

$\because \quad OM = \sqrt{2+2} = 2$

$AM = \sqrt{6}$

So, $OA = r = \sqrt{2^2 + \left(\sqrt{6}\right)^2} = \sqrt{10}$

13.

14.

15.

16.

17.

18.

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, –00.33, –00.30, 30.27, –27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. 30 identical candies are distributed among 4 students S_1, S_2, S_3, and S_4.

S_2 can get atleast 4 and atmost 7

S_3 can get atleast 2 and atmos 6

No restrictions on S_1 and S_4. Then number of ways in which the candies can be distributed.

Answer (430)

Sol. Required number of ways =

Coefficient of x^{30} in the expansion of $(x^4 + x^5 + x^6 + x^7)(x^2 + x^3 + x^4 + x^5 + x^6)(x^0 + x^1 + x^2 + \ldots)^2$

= Coefficient of x^{30} in $x^6(1 + x + x^2 + x^3)(1 + x + \ldots + x^4)(1 + x + x^2 + \ldots)^2$

$$= \text{Coefficient of } x^{24} \text{ in } \left(\frac{1-x^4}{1-x}\right)\left(\frac{1-x^5}{1-x}\right)\left(\frac{1}{1-x}\right)^2$$

= Coefficient of x^{24} in $(1 - x^4 - x^5 + x^9)(1 - x)^{-4}$

= Coefficient of x^{24} in $(1 - x^4 - x^5 + x^9)(1 + {}^4C_1x + {}^5C_2x^2 + \ldots)$

$= {}^{27}C_{24} - {}^{23}C_{20} - {}^{22}C_{19} + {}^{18}C_{15}$

= 430

22. Vector $\vec{a}$ is perpendicular to $\left(3\hat{i}+\frac{1}{2}\hat{j}+2\hat{k}\right)$ and $\left(2\hat{i}+2\hat{j}+\hat{k}\right)$. Find the projection of $\vec{a}$ along $\left(2\hat{i}+2\hat{j}+\hat{k}\right)$.

Answer (0.00)

Sol. $\because$ $\vec{a}$ is perpendicular to $\left(2\hat{i}+2\hat{j}+\hat{k}\right)$,

so projection of $\vec{a}$ on it will be zero.

23. There are seven students in a class with average score 62. A student fails if he gets less than 50. What is the worst case that maximum number of students fail in the class if the given variance is 30?

Answer (01.00)

Sol. $\because$ $\frac{\sum_{i=1}^{7} x_i}{7} = 62 = \bar{x}$

Variance $= \frac{1}{7}\sum_{i=1}^{7}\left(\bar{x}-x_c\right)^2 = 30$

$\sum_{i=1}^{7}\left(62-x_i\right)^2 = 210$

So, atmost one student can score less than 50.

24.

25.

26.

27.

28.

29.

30.

❑ ❑ ❑