Aakash
+BYJU'S

Memory Based
Answers & Solutions
for

Time : 3 hrs.

M.M. : 300

JEE (Main)-2023 (Online) Phase-2

(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.
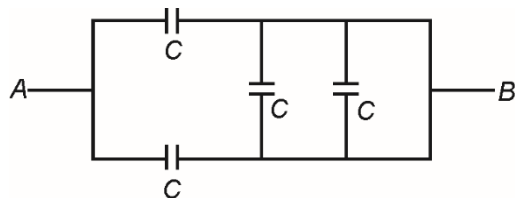
PHYSICS

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.
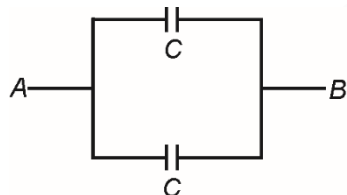
Choose the correct answer:

1. Find equivalent capacitance across points A and B in the given electrical circuit

(1) $\dfrac{C}{2}$ (2) $2C$

(3) $\dfrac{5C}{3}$ (4) $\dfrac{3C}{4}$

Answer (2)

Sol. Two capacitors will get short-circuited also,

$C_{AB} = 2C$

2. A particle of mass m moving with velocity v collides with a particle of mass $2m$ at rest and sticks to it. Velocity of combined mass is equal to

(1) v (2) $\dfrac{v}{2}$

(3) $\dfrac{v}{3}$ (4) $\dfrac{v}{4}$

Answer (3)

Sol. $mv = (m + 2m)v'$

$\Rightarrow \quad v' = \dfrac{v}{3}$

3. An object weighs 200 N at the surface of earth. Find the weight at a depth of $\dfrac{R}{2}$, where R is radius of earth.

(1) 100 N   (2) 300 N
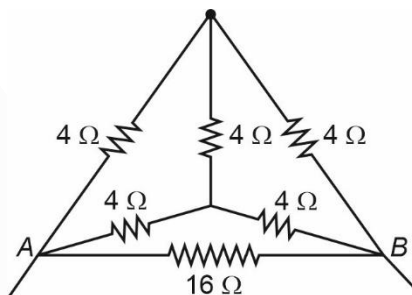
(3) 50 N   (4) 150 N

Answer (1)

Sol. $g' = g\left[1 - \dfrac{d}{R}\right]$

$= g\left[1 - \dfrac{R/2}{R}\right]$

$= \dfrac{g}{2}$

$\Rightarrow W' = \dfrac{W}{2} = 100$ N.

4. Find the equivalent resistance across A and B for given circuit.

(1) $6.4\ \Omega$ (2) $4\ \Omega$

(3) $3.2\ \Omega$ (4) $8\ \Omega$

Answer (3)

Sol. $R_{eq} = \dfrac{16 \times 4}{20} = \dfrac{64}{20} = \dfrac{32}{10} = 3.2\ \Omega$

5. For an object radiating heat at 300 K, the wavelength corresponding to maximum intensity is λ. If the temperature of body is increased by 300 K, the new wavelength corresponding to maximum intensity will be

(1) $\dfrac{\lambda}{2}$ (2) 2λ

(3) λ (4) $\dfrac{5\lambda}{2}$

Answer (1)

Sol. λT = constant

$\therefore \quad \dfrac{\lambda_1}{\lambda_2} = \dfrac{T_2}{T_1}$

$\lambda_2 = \lambda\left(\dfrac{300}{600}\right) = \dfrac{\lambda}{2}$

6. A monoatomic gas initially at pressure P and volume V is compressed to $\dfrac{1}{8}$ th of its volume adiabatically. Final pressure of the gas is equal to

(1) $4P$ (2) $8P$

(3) $16P$ (4) $32P$

Answer (4)

Sol. $PV^\gamma = $ Constant

$\Rightarrow PV^{\frac{5}{3}} = P_f\left(\frac{V}{8}\right)^{\frac{5}{3}}$

$\Rightarrow P_f = P(8)^{\frac{5}{3}}$

$= 32P$

7. A projectile, when projected at 15° with horizontal, has a range of 50 m. Find the range when projected at 45° with horizontal.
   (1) 50 m (2) 100 m
   (3) 80 m (4) 120 m

Answer (2)

Sol. $R = \frac{U^2 \sin 2\theta}{g}$

$\Rightarrow 50 = \frac{U^2 \sin 30°}{g}$

and $R' = \frac{U^2 \sin 90°}{g}$

$\Rightarrow R' = 100$ m

8. **Statement (1):** An *LCR* circuit connected to an AC source has maximum average power at resonance.

   Statement (2): A resistor only circuit with zero phase difference has maximum average power.
   (1) (1) and (2) both are correct
   (2) (1) is correct but (2) is incorrect
   (3) (1) is incorrect but (2) is correct
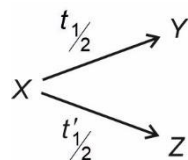   (4) Both (1) and (2) are incorrect

Answer (1)

Sol. $P_{avg} = \frac{I_{rms}V_{rms}}{2}\cos\phi$

For maximum P_{avg} $\cos\phi = 1$

$\Rightarrow \phi = 0$

or circuit is a resistive circuit or an *LCR* is at resonance.

9. A radioactive nuclei *X* decays simultaneously to two nuclei *Y* and *Z* as:

$t_{1/2}$ is 12 minutes while $t'_{1/2}$ is 3 minutes. Find the time in which nuclei *X* decays 50%.

(1) 4.8 minutes (2) 15 minutes
(3) 2.4 minutes (4) 9 minutes

Answer (3)

Sol. $\left(t_{1/2}\right)_{Eff} = \frac{t_{1/2}\cdot t'_{1/2}}{t_{1/2} + t'_{1/2}}$

$= 2.4$ minutes.

10. What is the maximum percentage error in the measurement of quantity *l*, if it is given by $l = \frac{a^2 b^3}{c\sqrt{d}}$.

   Given the percentage error in the calculation of *a*, *b*, *c* and *d* are 1%, 2%, 3% and 4% respectively.
   (1) 11% (2) 12%
   (3) 9% (4) 13%

Answer (4)

Sol. $\frac{\Delta l}{l}\times 100 = \pm\left(\frac{2\Delta a}{a} + \frac{3\Delta b}{b} + \frac{\Delta c}{c} + \frac{1}{2}\frac{\Delta d}{d}\right)\times 100$

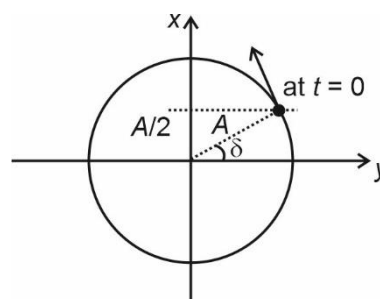$= \left[2(1) + 3(2) + (3) + \frac{1}{2}(4)\right]$

$= 13\%$

11. For a particle performing linear SHM, its position (*x*) as a function of time (*t*) is given by x = Asin($\omega t + \delta$). Given that, at $t = 0$, particle is at $+\frac{A}{2}$ and is moving towards $x = +A$. Find δ
   (1) $\frac{\pi}{3}$ rad (2) $\frac{\pi}{6}$ rad
   (3) $\frac{\pi}{4}$ rad (4) $\frac{5\pi}{6}$ rad

Answer (2)

Sol.

In the phasor diagram

$\sin\delta = \frac{\frac{A}{2}}{A} = \frac{1}{2}$

$\delta = \frac{\pi}{6}$ radian

12. A solenoid having 60 turns and length 15 cm produces magnetic field of 2.4×10^{-3} T, Find the current in the solenoid.

(1) $\dfrac{90}{2\pi}$ A

(2) $\dfrac{30}{2\pi}$ A

(3) $\dfrac{10}{\pi}$ A
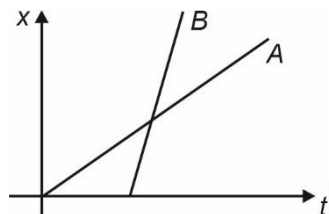
(4) $\dfrac{20}{\pi}$ A

Answer (2)

Sol. $B = \mu_0 n i$

$\Rightarrow \quad 2.4 \times 10^{-3} = 4\pi \times 10^{-7} \times \dfrac{60}{0.15} \times i$

$\Rightarrow \quad 2.4 \times 10^{-3} = 16\pi \times 10^{-5} \times i$

$i = \left(\dfrac{240}{16\pi}\right) = \dfrac{60}{4\pi} = \left(\dfrac{30}{2\pi}\right)$ A

13. The given graph shows the position (x)–time (t) relation for two students, A and B from school to their home. Consider the following statements

a. A is faster than B

b. B is faster than A

c. B lives further away than A

d. A live further away than B

Correct statements are

(1) a, d

(2) b, c

(3) b, d

(4) a, c

Answer (2)

Sol. (Slope of x-t)$_B$ – (Slope of x-t)$_A$

$V_B > v_A$

Also, (x of home)$_B$ > (x of home)$_A$

14. Angular momentum of an e$^-$ in first Bohr's orbit is L. The change in angular momentum if this electron jumps to the second orbit will be

(1) L

(2) $2L$

(3) $3L$

(4) $1.5L$

Answer (1)

Sol. $L_i = L = \dfrac{L}{2\pi}$

$L_f = \dfrac{2h}{2\pi} = 2L$

$\therefore \Delta L = L$

15. The mass and radius of orbit for two satellites are (m, r) and ($3m$, $3r$) respectively. Find the ratio of their orbital velocity about earth.

(1) $\sqrt{3} : 1$

(2) $1 : \sqrt{3}$

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

(4) $1 : 2$

Answer (1)

Sol. $v_1 = \sqrt{\dfrac{Gm}{r}}, \qquad v_2 = \sqrt{\dfrac{Gm}{3r}}$

$\therefore \dfrac{v_1}{v_2} = \dfrac{\sqrt{3}}{1}$

16. Decay constant for a radioactive nuclide is given to be 2×10^3. If molar mass of sample is 60 gm then activity of 0.3 μgm sample is equal to (in disintegration/seconds)

(1) 6.023×10^{15}

(2) 6.023×10^{18}

(3) 6.023×10^{12}

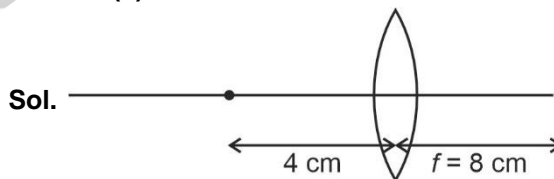(4) 3.012×10^{12}

Answer (2)

Sol. λN

$= 2 \times 10^3 \times \dfrac{3 \times 10^{-7}}{60} \times 6.023 \times 10^{23}$

$= 6.023 \times 10^{18}$

17. An point sized object is placed 4 cm from the double convex lens of focal length 8 cm. The change in the position of image, when the object is moved 2 cm towards the lens, is

(1) 8 cm

(2) $\dfrac{8}{3}$ cm

(3) $\dfrac{16}{3}$ cm

(4) $\dfrac{32}{3}$ cm

Answer (3)

Sol.

For $u = -4$ cm $\Rightarrow \dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{f}$

$\Rightarrow \dfrac{1}{v} + \dfrac{1}{4} = \dfrac{1}{8} \Rightarrow \dfrac{1}{v} = \dfrac{1}{8} - \dfrac{1}{4}$
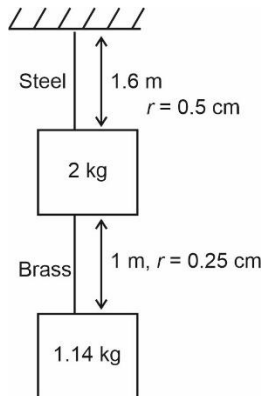
$v = -8$ cm

For $u = -2$ cm

$\dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{f}$

$\dfrac{1}{v} + \dfrac{1}{2} = \dfrac{1}{8}$

$v = \dfrac{-8}{3} \Rightarrow \Delta v = \left|\dfrac{16}{3}\right|$ cm

18. Two blocks of mass 2 kg and 1.14 kg are hanged by steel and brass wire respectively as shown in figure. The change in length for steel wire will be ($Y_{steel} = 2 \times 10^{11}$ N/m^2, $Y_{brass} = 1 \times 10^{10}$ N/m^2)

(1) 3.2 μm

(2) 1.6 μm

(3) 0.8 μm

(4) 4.8 μm

Answer (1)

Sol. $\Delta l = l\left(\dfrac{\text{Stress}}{Y_{steel}}\right)$

$= 1.6 \times \dfrac{3.14 \times 10}{3.14\left(0.5 \times 10^{-2}\right)^2 \times 2 \times 10^{11}}$

$= 3.2 \times 10^{-6}$ m

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. The equation of progressive wave is given as $y = 5 \sin(6t + 0.03x)$. Find the speed of wave. (Assume all units in SI unit)

Answer (200)

Sol. $\dfrac{dx}{dt} = v = \dfrac{6}{0.03} = \dfrac{600}{3} = 200$ m/s

22. Earth shrinks to $\dfrac{1}{64}$ times of its initial volume. Time period of earth rotation is found to be $\dfrac{24}{x}$ hrs.

Answer (16)

Sol. $V = \left(\dfrac{V_0}{64}\right)$

$\dfrac{4}{3}\pi R^3 = \dfrac{1}{64} \times \dfrac{4}{3}\pi R_0^3$

$R = \left(\dfrac{R_0}{4}\right)$

M Remains same,

$I\omega$ = constant

$\Rightarrow \dfrac{2}{5}M(R_0^2)\dfrac{2\pi}{(24\ hr)} = \dfrac{2}{5} \times M \times \dfrac{R_0^2}{16} \times \dfrac{2\pi}{T}$

$T = \left(\dfrac{24}{16}\ hr\right)$ so, $\boxed{x = 16}$

23. 10 resistors each of 10 Ω resistance when connected together give minimum equivalent resistance R_1 and maximum equivalent resistance R_2 among various possible combinations.

So $\dfrac{R_2}{R_1}$ is equal to

Answer (100)

Sol. $R_{min} = \dfrac{R}{10} = 1\ \Omega$ (when all resistors are placed in parallel)

$R_{max} = 10\ R = 100\ \Omega$ (when all resistors are placed in series)

$\Rightarrow \dfrac{R_{max}}{R_{min}} = 100$

24. A conducting rod of length 1 m is moved across a magnetic field of 0.15 T, with constant speed of 4 m/s. Find force (in N) on rod.
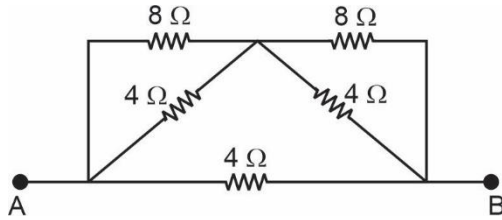
Answer (0)

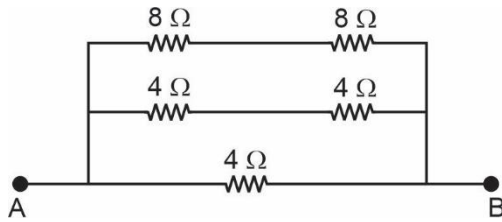**Sol.** Since system is open

$\Rightarrow$ Current $i = 0$

$\Rightarrow$ Force $= i\ell B$

$= 0$

25. Equivalent resistance of the following circuit (in ohms) is equal to $x/7$. Value of x is equal to _____.
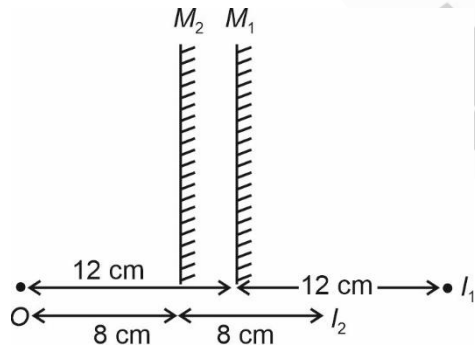

Answer (16)

Sol. Equivalent circuit

$R_{eq} = \left(\dfrac{1}{4} + \dfrac{1}{8} + \dfrac{1}{16} \right)^{-1} \Omega$

$= \dfrac{16}{7} \Omega$

26. An object is placed Infront of a plane mirror 12 cm away from it. The object is kept fixed while the plane mirror is shifted towards the object by a distance of 4 cm. The length of shift in the position of image is equal to _____ cm.

Answer (8)

Sol.

$\Rightarrow I_1 I_2 = 24 \text{ cm} - 16 \text{ cm}$

$= 8 \text{ cm}$

27. In an AM wave, amplitude of modulating wave = 3 units and amplitude of carrier wave = 15 units. Find the ratio of maximum to minimum intensity $\dfrac{I_{max}}{I_{min}}$.
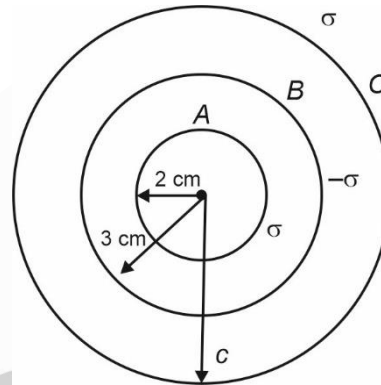
Answer (02.25)

Sol. $A_{max} = 15 + 3 = 18$

$A_{min} = 15 - 3 = 12$

$\Rightarrow \dfrac{I_{max}}{I_{min}} = \left(\dfrac{18}{12} \right)^2 = 2.25$

28. Three concentric shells A, B and C having surface charge density σ, $-\sigma$ and σ respectively. The radii of A and B are 2 cm and 3 cm respectively. Electric potential at surface A is V_A and at C is V_C. If $V_A = V_C$ then find the radius of C in cm

Answer (5)

Sol. $V_A = \dfrac{K(\sigma \times 4\pi a^2)}{a} - \dfrac{K(4\pi b^2)\sigma}{b} + \dfrac{K}{c}(4\pi c^2)\sigma$

$V_C = \dfrac{K}{c}(4\pi a^2 \sigma - 4\pi b^2 \sigma) + \dfrac{K}{c}(4\pi c^2)\sigma$

$V_A = V_C$

$\Rightarrow a - b = \left(\dfrac{a^2 - b^2}{c} \right)$

$\Rightarrow a - b = \dfrac{(a-b)(a+b)}{c}$

$\Rightarrow c = a + b$
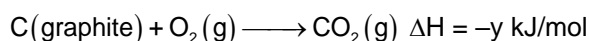
$\Rightarrow c = 5 \text{ cm}$

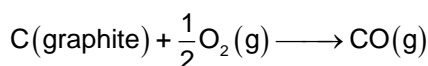29.

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. Select the correct option

   $$2CO(g) + O_2(g) \longrightarrow 2CO_2(g) \quad \Delta H = -x \text{ kJ/mol}$$

   $$C(graphite) + O_2(g) \longrightarrow CO_2(g) \quad \Delta H = -y \text{ kJ/mol}$$

   Then ΔH for

   $$C(graphite) + \frac{1}{2}O_2(g) \longrightarrow CO(g)$$

   (1) $x - \dfrac{y}{2}$
   (2) $\dfrac{x-2y}{2}$

   (3) $\dfrac{x + 2y}{2}$
   (4) $\dfrac{x - y}{2}$

Answer (2)

Sol. ΔH for $C(graphite) + \dfrac{1}{2}O_2(g) \longrightarrow CO(g)$ will be

$-y + \dfrac{1}{2}x$ or $\dfrac{x-2y}{2}$ kJ/mol

2. Stabiliser used for concentration of sulphide ore is

   (1) Fatty acids
   (2) Pine oil

   (3) Cresol
   (4) Xanthates

Answer (3)

Sol. • Cresol and aniline is used as stabiliser.

   • Pine oils, fatty acids, xanthates are used as collectors.

3. That one which does not stabilise secondary and tertiary protein?

   (1) H–H linkage

   (2) S–S linkage

   (3) Van Der Waal's Force

   (4) Hydrogen bonding

Answer (1)

Sol. The secondary and tertiary protein are stabilised by hydrogen bonds, disulphide linkages, Van Der Waal's and electrostatic forces of attraction.

4. Which of the following is diamagnetic with low spin?

   (1) $[Co(NH_3)_6]^{3+}$
   (2) $[CoF_6]^{3-}$

   (3) $[CoCl_6]^{3-}$
   (4) $[Fe(H_2O)_6]^{3+}$

Answer (1)

Sol. Co^{3+} with NH_3 will form low spin complex

   n = 0 for $[Co(NH_3)_6]^{3+}$

5. The compound which does not exist

   (1) BeH_2
   (2) NaO_2

   (3) $PbEt_4$
   (4) $(NH_4)_2BeF_4$

Answer (2)

Sol. Lithium forms oxide, sodium forms peroxide and the K, Rb, Cs forms superoxide.

6. Number of molecules & moles in 2.8375 litre of O_2 in STP

   (1) 1.505×10^{23} & 0.250

   (2) 7.625×10^{23} and 0.250

   (3) 7.625×10^{22} and 0.126

   (4) 7.527×10^{22} and 0.125

Answer (4)

Sol. No. of moles $= \dfrac{2.8375}{22.7}$

   = 0.125 moles

   No. of molecules = $0.125 \times 6.023 \times 10^{23}$

   $= 0.7527 \times 10^{23}$

7. Enthalpy of adsorption and enthalpy of micelle formation is respectively

   (1) + +
   (2) + –

   (3) – +
   (4) – –

Answer (3)

Sol. Enthalpy of adsorption is (–ve) and Enthalpy of micelle formation is (+ve)

8. Prolonged heating of Ferrous ammonium sulphate is avoided to prevent?

   (1) Oxidation
   (2) Reduction

   (3) Hydrolysis
   (4) Breaking

Answer (1)

Sol. Prolonged heating results in oxidation of Fe^{+2} to Fe^{+3} ions.

9. Read the following two statements

   Statement I: Potassium dichromate is used in volumetric analysis.

   Statement II: $K_2Cr_2O_7$ is more soluble in water than $Na_2Cr_2O_7$.

   (1) Both statements I and II are correct

   (2) Both statements I and II are incorrect

   (3) Statement I is correct and II is incorrect

   (4) Statement I is incorrect and II is correct

Answer (3)

Sol. Sodium dichromate is more soluble than $K_2Cr_2O_7$.

10. Match the column

	Column-I		Column-II
(A)	Dacron	(P)	Thermosetting
(B)	Urea formaldehyde resin	(Q)	Biodegradable
(C)	Nylon-2, Nylon-6	(R)	Polyester
(D)	Nylon-6, 6	(S)	Used for making bristles of brushes

   (1) A → R; B → P; C → S; D → Q

   (2) A → P; B → R; C → Q; D → S

   (3) A → R; B → P; C → Q; D → S

   (4) A → P; B → R; C → S; D → Q
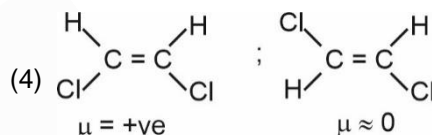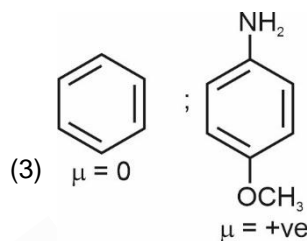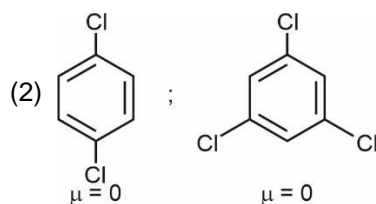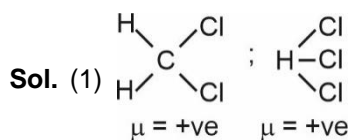
Answer (3)

Sol. • Dacron is polyester.

   • Urea formaldehyde resin is thermosetting.

   • Nylon-2, Nylon-6 is biodegradable.

   • Nylon-6, 6 is used in making bristles for brushes.

11. The pair of compounds from the following pairs having both the compounds with net zero dipole moment is

   (1) CH_2Cl_2 ; $CHCl_3$

   (2) 1,4-dichlorobenzene; 1,3,5-trichlorobenzene

   (3) Benzene; p-Anisidine

   (4) Cis-dichloroethene; trans-dichloroethene

Answer (2)

Sol. (1)

$\mu = +ve$; $\mu = +ve$

(2)

$\mu = 0$; $\mu = 0$

(3)

$\mu = 0$; $\mu = +ve$

(4)

$\mu = +ve$; $\mu \approx 0$

12. Consider the following reaction

$\xrightarrow[\text{H}_3\text{O}^\oplus, \ \Delta]{\text{hot KMnO}_4}$ P (major)

   The product P is

   (1)

   (2)

   (3)

   (4)
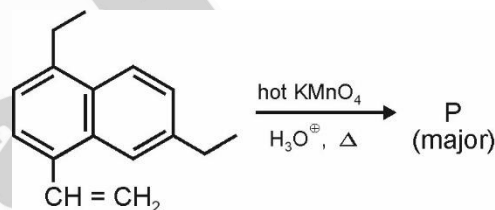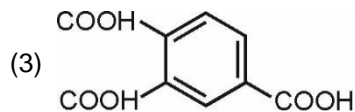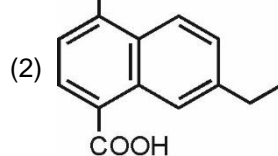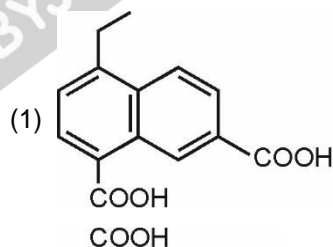
Answer (3)

Sol. Oxidation of benzene ring towards left takes place.

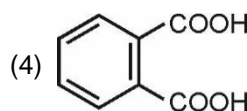13. $FeO_4^{2-} \xrightarrow{E_1^o = +2.20\ V} Fe^{3+} \xrightarrow[E_2^o = 0.77\ V]{} Fe^{2+} \xrightarrow{(E_3^o = -0.44\ V)} Fe$

$E_4^o = ??$
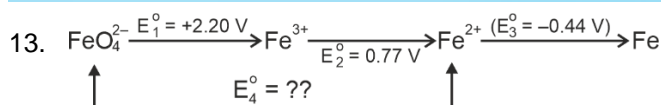
Value of E_4^o is close to

(1) 1.00 V (2) 2.00 V

(3) 2.50 V (4) 0.50 V

Answer (2)

Sol. $E_4^o = \dfrac{(2.20 \times 3) + (0.77 \times 1)}{4}$

$1.84 \approx 2.0$ V

14. Mixture of A, B and C is added to column containing adsorbent for separation. Using solvent, A is eluted first and B eluted last, then B has

(1) High R_f, less adsorption

(2) Low R_f, strongly adsorbed

(3) High R_f, strong adsorption

(4) Low R_f, weakly adsorbed

Answer (2)

Sol. Those substances which are strongly adsorbed more slowly will be eluted late.

15. Solution of 0.1 Molal Weak Acid HA is present.

T_1 : Freezing point of solution assuming no dissociation of acid.

T_2 : Freezing point of solution assuming degree of dissociation $(\alpha) = 0.3$

Find out $|T_1 - T_2|$ if K_F of water = 1.86 K kg/mole.

(1) 0.0324 (2) 0.0558

(3) 0.0257 (4) 0.8742

Answer (2)

Sol. $\Delta T_1 = (1)(1.86)(0.1) = 0.186$

$\Delta T_2 = (1.3)(1.86)(0.1) = 0.2418$

$(T_1 - T_2) = 0.0558$

16. Statement-1: Reduction potential M^{3+}/M^{2+} is more for Fe than Mn

Statement-2: V^{2+} has magnetic moment between 4.4 – 5.2 B.M.

Select the correct option

(1) Statement 1 and 2, both are correct

(2) Statement 1 and 2, both are incorrect

(3) Statement 1 is correct but statement 2 is incorrect

(4) Statement 1 is incorrect but statement 2 is correct

Answer (2)

Sol. $E^o_{Mn^{3+}/Mn^{2+}} = 1.57$ V

$E^o_{Fe^{3+}/Fe^{2+}} = 0.77$ V

Therefore statement 1 is incorrect

$V^{2+} = d^3 \Rightarrow \mu = \sqrt{3(3+2)}$ B.M.

$= \sqrt{15}$

$= 3.92$ B.M.

Therefore statement 2 is incorrect

Hence option (2) is the correct answer.

17. Match column-I with Column-II.

Industry	Waste/pollution
(i) Cotton mills	(a) Biodegradable waste
(ii) Paper mills	(b) Gypsum
(iii) Fertilizer	(c) Non biodegradable waste
(iv) Thermal power plant	(d) Fly ash

(1) i → c; ii → a, b; iii → c, iv → b

(2) i → a; ii → a; iii → b; iv → d

(3) i → a, c; ii → b; iii → b, iv → a

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

Answer (2)

Sol. Cotton mills → Biodegradable waste

Paper mills → Biodegradable waste

Fertilizer → Gypsum

Thermal power plants → Fly ash

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.

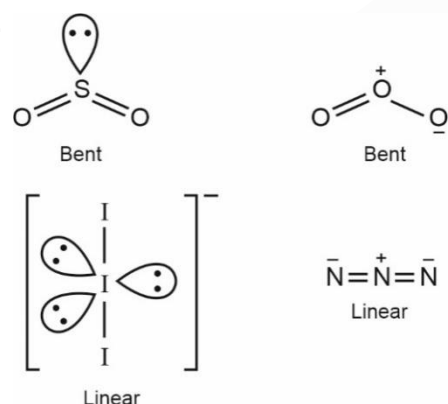21. Sum of number of lone pairs in central atom in IF_5 and IF_7 is

Answer (01.00)

Sol.
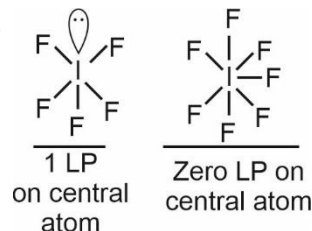
22. How many of the following are bent in shape

$SO_2, O_3, I_3^{\ominus}, N_3^{\ominus}$?

Answer (02)

Sol.

23. The pressure value of a gas is 930.2 mm Hg. The volume is then reduced to 40% of its initial value at constant temperature then what is the final pressure (in mm Hg)?

Answer (2325.5)

Sol. $P_1V_1 = P_2V_2$

$930.2 \times V_1 = P_2 \times (0.4)V_1$

$P_2 = \dfrac{930.2}{0.4} = 2325.5$ mm Hg.

24. The degree of dissociation of a monobasic acid is 0.3. By what percent is the observed depression in freezing point greater than the calculated depression in freezing point?

Answer (30.00)

Sol. $HA \quad \rightleftharpoons \quad H^+ + A^-$

$\quad 1-\alpha \qquad \alpha \qquad \alpha$

$i = 1 + \alpha$

$\alpha = 0.3$

$i = 1.3$

$(\Delta T_f)_{obs} = 1.3 \times k_f \times m$

$(\Delta T_f)_{cal} = 1 \times k_f \times m$

$\dfrac{(\Delta T_f)_{obs} - (\Delta T_f)_{cal}}{(\Delta T_f)_{cal}} \times 100 = \dfrac{0.3}{1} \times 100 = 30\%$

25. Consider a reaction
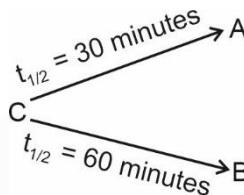
Overall half-life of C is (in minutes):

Answer (20)

Sol. $\dfrac{1}{\left(t_{\frac{1}{2}}\right)_C} = \dfrac{1}{\left(t_{\frac{1}{2}}\right)_A} + \dfrac{1}{\left(t_{\frac{1}{2}}\right)_B} = \dfrac{1}{30} + \dfrac{1}{60} = \dfrac{90}{1800}$

$\dfrac{1}{\left(t_{\frac{1}{2}}\right)_C} = \dfrac{1}{20} \Rightarrow \left(t_{\frac{1}{2}}\right)_C = 20$ minutes

26. How many compounds can be easily prepared by Gabriel pthalamide synthesis, which on reaction with Hinsberg reagent produces a compound which is soluble in KOH
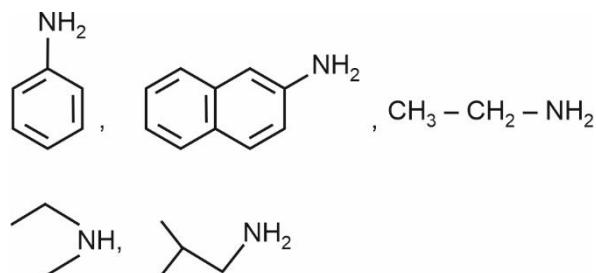
Answer (02)

Sol. 1⁰ aliphatic amines can be easily prepared by Gabriel pthalamide synthesis and produce soluble adducts in KOH

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. 3, 8, 13, ……, 373 are in arithmetic series. The sum of numbers not divisible by three is

   (1) 9310   (2) 8340

   (3) 9525   (4) 7325

Answer (3)

Sol. $3 + 8 + 13 + 18 + \ldots 373 = \dfrac{75}{2}[3 + 373] = 14100$

   Now, $\underbrace{3 + 18 + \ldots}_{25 \text{ terms}} = \dfrac{25}{2}[6 + 24.15] = 4575$
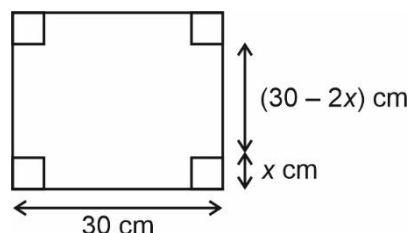
   ∴ Required sum = 14100 − 4575

   = 9525

2. From a square of side 30 cm the squares of side x cm is cut off to make a cuboid of maximum volume. The surface area of cuboid with open top is

   (1) 400 cm²   (2) 464 cm²

   (3) 800 cm²   (4) 900 cm²

Answer (3)

Sol.

   Volume of cuboid = $(30 - 2x)^2 \cdot x = V(x)$

   $\dfrac{dV}{dx} = (30 - 2x)^2 + 2x(30 - 2x)(-2) = 0$

   ⟹ $(30 - 2x)(30 - 2x - 4x) = 0$

   ⟹ $x = 5, x = 15$ (not possible)

   ∴ Surface area = $(30 - 2x)(x) \times 4 + (30 - 2x)^2$

   = $20 \times 5 \times 4 + (20)^2$

   = 800 cm²

3. The negation of the statement $(p \vee q) \wedge \sim r$ is

   (1) $(\sim p \wedge \sim q) \vee r$ (2) $(\sim p \wedge \sim q) \wedge r$

   (3) $(\sim p \vee q) \vee r$ (4) $(p \vee \sim q) \wedge r$

Answer (1)

Sol. $\sim \left[(p \vee q) \wedge \sim r \right]$

   ∴ $\sim (p \vee q) \vee r$

   $(\sim p \wedge \sim q) \vee r$

4. Slope of tangent to a curve at a variable point is $\dfrac{x^2 + y^2}{2xy}$ and $y(2) = 0$, then $y(8) = 0$

   (1) $\sqrt{3}$ (2) $2\sqrt{2}$

   (3) $4\sqrt{3}$ (4) 6

Answer (3)

Sol. $\dfrac{dy}{dx} = \dfrac{x^2 + y^2}{2xy}$

   $y = vx$ (let)

   $y' = v + x\dfrac{dv}{dx}$

   $v + x\dfrac{dv}{dx} = \dfrac{1}{2}\left(v + \dfrac{1}{v}\right) \Rightarrow x\dfrac{dv}{dx} = \dfrac{1}{2}\left(\dfrac{1}{v} - v\right) = \dfrac{1}{2}\left(\dfrac{1 - v^2}{v}\right)$

   ∴ $\int \dfrac{2v}{1 - v^2} dv = \int \dfrac{dx}{x} \Rightarrow -\log|1 - v^2| = \ln|x| + \ln c$

   $\Rightarrow k = x \cdot \left(1 - \dfrac{y^2}{x^2}\right) \Rightarrow k = \dfrac{x^2 - y^2}{x}$

   $y(2) = 0$

   $k = 2$

   $\Rightarrow 2 = \dfrac{x^2 - y^2}{x}$

   $x = 8$

   $2 = \dfrac{64 - y^2}{8} \Rightarrow y^2 = 64 - 16 = 48 = 4\sqrt{3}$

5. Using the number 1, 2, 3 … 7, total numbers of 7 digit number which does not contain string 154 or 2367 is (Repetition is not allowed)

   (1) 4897   (2) 4898

   (3) 4896   (4) 4899

Answer (2)

Sol. Total numbers – when 154 comes as a n string – when 2367 comes as + 2 a string

$7! - 5! - 4! + 2$

$5040 - 120 - 24 + 2$

$= 4898$

6. If the order of matrix A is 3×3 and $|A| = 2$, then the value of $|3\text{adj}(|3A|A^2)|$ is

(1) $3^{10} \cdot 2^{21}$

(2) $2^{10} \cdot 3^{21}$

(3) $2^{12} \cdot 3^{15}$

(4) $3^{12} \cdot 2^{15}$

Answer (2)

Sol. $|3A| = 3^3 \cdot |A| = 2 \cdot 3^3$

$\text{adj}(|3A|A^2) = \text{adj}(2 \cdot 3^3 \cdot A^2) = (2 \cdot 3^3)^2 (\text{adj}A)^2$

$\qquad\qquad = 2^2 \cdot 3^6 (\text{adj}A)^2$

$|3\text{adj}(|3A|A^2)| = |2^2 \cdot 3^7 (\text{adj}A)^2|$

$\qquad\qquad = (2^2 \cdot 3^7)^3 \cdot |\text{adj}A|^2$

$\qquad\qquad = 2^6 \cdot 3^{21} \cdot (|A|^2)^2$

$\qquad\qquad = 2^6 \cdot 3^{21} \cdot 2^4 = 2^{10} \cdot 3^{21}$

7. Find the value of

$96\cos\dfrac{\pi}{33}\cos\dfrac{2\pi}{33}\cos\dfrac{4\pi}{33}\ldots\cos\left(\dfrac{16\pi}{33}\right)$

(1) 0

(2) 1

(3) 2

(4) 3

Answer (4)

Sol. $96\cos\dfrac{\pi}{33}\cos\dfrac{2\pi}{33}\cos\dfrac{4\pi}{33}\ldots\cos\left(\dfrac{16\pi}{33}\right)$

$\dfrac{96 \cdot \sin\left(2^5\,\dfrac{\pi}{33}\right)}{2^5 \sin\left(\dfrac{\pi}{33}\right)} = \dfrac{96}{32} \cdot \dfrac{\sin\left(\dfrac{32\pi}{33}\right)}{\sin\left(\dfrac{\pi}{33}\right)} = 3$

8. The coefficient of x^7 in $(1 - 2x + x^3)^{10}$ is

(1) 5140

(2) 2080

(3) 4080

(4) 6234

Answer (3)

Sol. $(1 - 2x + x^3)^{10}$

$T_n = \dfrac{10!}{a!\,b!\,c!}(-2x)^b (x^3)^c = \dfrac{10!}{a!\,b!\,c!}(-2)^b \cdot x^{b+3c}$

$b + 3c = 7, \quad a + b + c = 10$

a	b	c
3	7	0
5	4	1
7	1	2

$\therefore$ Coefficient of

$x^7 = \dfrac{10!}{3!\,7!\,0!} \times (-2)^7 + \dfrac{10!}{5!\,4!\,1!} \times (-2)^4 + \dfrac{10!}{7!\,1!\,2!} \times (-2)^1$

$= 120 \times (-128) + 20160 + (-720)$

$= -15360 + 20160 - 720$

$= 4080$

9. 9. Find the number of integral values of x which satisfy the inequality $x^2 - 10x + 19 < 6$.

(1) 5

(2) 11

(3) 7

(4) 8

Answer (3)

Sol. $x^2 - 10x + 13 < 0$

$\alpha < x < \beta$ where $\alpha, \beta = \dfrac{10 \pm \sqrt{48}}{2}$

i.e., $\alpha = 5 - 2\sqrt{3}$

and $\beta = 5 + 2\sqrt{3}$

$\Rightarrow \quad 1.636 < x < 8.464$

$x = 2, 3, 4, 5, 6, 7, 8$

10. Shortest distance between lines $\dfrac{x+1}{7} = \dfrac{y+1}{-6} = \dfrac{z+1}{1}$

and $\dfrac{x-3}{1} = \dfrac{y-5}{-2} = \dfrac{z-3}{1}$ is

(1) $\sqrt{29}$

(2) $2\sqrt{29}$

(3) $3\sqrt{29}$

(4) $4\sqrt{29}$

Answer (2)

Sol. $\vec{a} = \langle -1, -1, -1 \rangle \qquad x_1 = 7\hat{i} - 6\hat{j} + \hat{k}$

$\vec{b} = \langle 3, 5, 7 \rangle \qquad x_2 = \hat{i} - 2\hat{j} + \hat{k}$

$d = \left| \dfrac{(\vec{a} - \vec{b}) \cdot (\vec{x}_1 \times \vec{x}_2)}{|\vec{x}_1 \times \vec{x}_2|} \right|$

$\left| \dfrac{(4\hat{i} + 6\hat{j} + 8\hat{k}) \cdot (4\hat{i} + 6\hat{j} + 8\hat{k})}{\sqrt{4^2 + 6^2 + 8^2}} \right|$

$d = \left| \dfrac{16 + 36 + 64}{\sqrt{16 + 36 + 64}} \right| = \sqrt{116}$

11. If $a^2 + (ar)^2 + (ar^2)^2 = 33033$, $(a, r \in N)$, then the value of $a + ar + ar^2$ is

   (1) 148

   (2) 249

   (3) 230

   (4) 231

Answer (4)

Sol. $a^2(1 + r^2 + r^4) = 33033$, $a, r \in N$

   $\Rightarrow$ $a = 11$

   $r = 4$

   sum $= a + ar + ar^2$

   $= 11 + 44 + 176$

   $= 231$

12.

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. If the coefficient of x^7 in expansion of $\left(ax - \dfrac{1}{bx^2}\right)^{13}$ is equal to coefficient of x^{-5} in expansion of $\left(ax + \dfrac{1}{bx^2}\right)^{13}$ then a^4b^4 is

Answer (22)

Sol. Coefficient of x^7 in $\left(ax - \dfrac{1}{bx^2}\right)^{13}$

$$T_{r+1} = {}^{13}C_r (ax)^{13-r}\left(-\dfrac{1}{bx^2}\right)^r$$

$13 - 3r = 7$

$\Rightarrow$ $r = 2$

Coeff $= {}^{13}C_2 \dfrac{a^{11}}{b^2}$

Coeff of x^{-5} in $\left(ax + \dfrac{1}{bx^2}\right)^{13}$

$$T_{r+1} = {}^{13}C_r (ax)^{13-r}\left(\dfrac{1}{bx^2}\right)^r$$

$13 - 3r = -5$

$\Rightarrow$ $r = 6$

Coeff $= {}^{13}C_6 \dfrac{a^7}{b^6}$

Now,

$${}^{13}C_2 \dfrac{a^{11}}{b^2} = {}^{13}C_6 \dfrac{a^7}{b^6}$$

$$a^4 b^4 = \dfrac{{}^{13}C_6}{{}^{13}C_2} = 22$$

22. Two dice are rolled and sum of numbers of two dice is N then probability that $2^N < N!$ is $\dfrac{m}{n}$, where m and n are co-prime, then $11m - 3n$ is

Answer (85)

Sol. $\because$ $2^N < N!$ is true when $N \geq 24$

   $\therefore$ When $N = 1$ (not possible)

   $N = 2$, $(1, 1)$

   $N = 3$ $(1, 2)$ $(2, 1)$

   $\therefore$ required probability $= \dfrac{36 - 3}{36} = \dfrac{33}{36}$

   $= \dfrac{11}{12}$

   $\therefore$ $m = 11$, $n = 12$

   $\therefore$ $11m - 3n = 121 - 36$

   $= 85$

23. If the number of ways in which a mixed double badminton can be played such that no couples played into a same game is 840. Then find the number of players

Answer (16)

Sol. Let total number of couples be n

then according to given condition

$${}^nC_2 \cdot {}^{n-2}C_2 \times 2 = 840$$
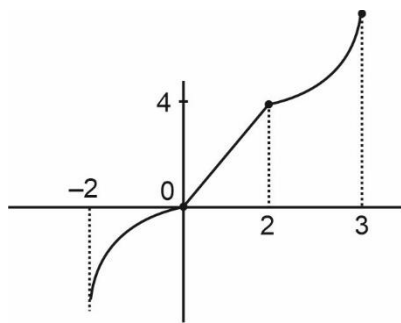
$$\Rightarrow \quad n = 8$$

$$\therefore \quad \text{Total players} = 8 \times 2 = 16$$

24. Find number of points of non-differentiability for $f(x)$

$$f(x) = \begin{cases} x|x| & -2 < x \le 0 \\ |x-3| + |x+1| - 2|x-2| & 0 < x \le 2 \\ |x|(x^2 - x) & 2 < x \le 3 \end{cases}$$

Answer (2)

Sol. $f(x) = \begin{cases} -x^2 ; & -2 < x \le 0 \\ 2x ; & 0 < x \le 2 \\ x^3 - x^2 ; & 2 < x \le 3 \end{cases}$

Points of non-differentiability = 0, 2

25. Let f be a differentiable function

$$x^2 f(x) - x = 4\int_0^x tf(t)\,dt$$

If $f(1) = \dfrac{2}{3}$ then $18f(3)$ is

Answer (160)

Sol. $x^2 f(x) - x = 4\int_0^x tf(t)\,dt$

$$2xf(x) + x^2 f'(x) - 1 = 4xf(x)$$

$$x^2 \frac{dy}{dx} - 2xy = 1$$

$$\frac{dy}{dx} - \frac{2y}{x} = \frac{1}{x^2}$$

$$\text{I.F.} = e^{\int \frac{-2}{x}dx} = e^{-2\ln x} = \frac{1}{x^2}$$

$$\frac{y}{x^2} = \int \frac{1}{x^4}dx$$

$$\frac{y}{x^2} = \frac{-1}{3x^3} + c$$

Now, $y(1) = \dfrac{2}{3}$

$$\frac{2}{3} = -\frac{1}{3} + c$$

$$\Rightarrow \quad c = 1$$

$$\therefore \quad y = -\frac{1}{3x} + x^2$$

$$18f(3) = 18\left[-\frac{1}{9} + 9\right]$$

$$= -2 + 162$$

$$= 160$$

26. The mean of the data

0 – 10	10 – 20	20 – 30	30 – 40	40 – 50
5	2	5	x	6

is 26, then variance of the data is

Answer (815)

Sol. $\bar{x} = \dfrac{25 + 30 + 125 + 35x + 270}{18 + x} = 26$

$$\Rightarrow \quad \boxed{x = 2}$$

Variance $= \dfrac{5 \cdot 21^2 + 2 \cdot 11^2 + 5 \cdot 1^2 + 2 \cdot 9^2 + 6 \cdot 19^2}{20}$

$$= 239$$

27.

28.

29.

30.

❑ ❑ ❑