1. Gravitation force on each due to other three particles provides the necessary centripetal force.

\[
\therefore \frac{2GM^2}{(\sqrt{2}R)^2} \cos 45^\circ + \frac{GM^2}{(2R)^2} = \frac{Mv^2}{R}
\]

Simplifying it, we get,

\[
v = \sqrt{\frac{GM}{R} \left( \frac{2\sqrt{2} + 1}{4} \right)}
\]

2. \[
\frac{kQ}{r^2} = \frac{k(2Q)}{(r + a)^2} \Rightarrow r = \frac{a}{\sqrt{2} - 1}
\]
distance from origin

\[
= \frac{a}{\sqrt{2} - 1} - a = 2\sqrt{2} \text{ (in negative direction)}
\]
4. In this question \( R = 3\Omega \), \( mn = 24 \), \( r = 0.5\Omega \) and
\[
R = \frac{mr}{n}.
\]
on putting the values we get \( n = 2 \) and \( m = 12 \).

5. According to question resistance of wire ADC is twice that of wire ABC. Hence current flows through ADC is half that of ABC i.e. \( i_2 = \frac{1}{2}i_1 \).

Also \( i_1 + i_2 + i = i \Rightarrow i_1 = \frac{2i}{3} \) and \( i_2 = \frac{i}{3} \)

Magnetic field at centre O due to wire AB and BC (part 1 and 2)
\[
B_1 = \frac{\mu_0}{4\pi} \frac{2i_1 \sin 45^\circ}{a/2} \otimes
\]

and magnetic field at centre O due to wires AD and DC (i.e. part 3 and 4)
\[
B_3 = B_4 = \frac{\mu_0}{4\pi} \frac{2\sqrt{2}i_2}{a} \otimes
\]

Also \( i_1 = 2i_2 \). So \((B_1 = B_2) > (B_3 = B_4)\)

Hence net magnetic field at centre O
\[
B_{net} = (B_1 + B_2) - (B_3 + B_4)
\]

\[
= 2 \times \frac{\mu_0}{4\pi} \frac{2\sqrt{2} \times (\frac{2}{3})}{a} \frac{\mu_0}{4\pi} \frac{2\sqrt{2} (\frac{1}{3})}{3a} \otimes
\]

\[
= \frac{\mu_0}{4\pi} \frac{4\sqrt{2}i}{3a} (2-1) \otimes = \frac{\sqrt{2}\mu_0i}{3\pi a} \otimes
\]

6. \( T = \frac{2\pi R}{v} \)
\[
\frac{GMm}{R^n} = \frac{mv^2}{R}
\]
or \( v = \sqrt[\frac{n}{n-1}]{\frac{GM}{R}} \)

\[
\therefore T = \frac{2\pi R}{\sqrt{GM/R}} = \frac{2\pi}{\sqrt{GM}} \times R^{(n+1)/2}
\]

\[
\therefore T \propto R^{(n+1)/2}
\]

7. \( E_x = -\frac{\partial V}{\partial x} = 5 \)
\( E_y = -\frac{\partial V}{\partial y} = -3 \)
\( E_z = -\frac{\partial V}{\partial z} = -\sqrt{15} \)
\( E = \sqrt{E_x^2 + E_y^2 + E_z^2} = 7 \)

8. \( V_A = V_B = 60V \)
\( V_1 = \frac{C_2}{C_1 + C_2} V_{AB} \)
\( V_2 = \frac{12}{16} \times 60 = 45V \)
so \( V_D = V_A - V_1 = 15V \)
(1) and loop (2)

9. Suppose current through different paths of the circuit is as follows. After applying KVL for loop

\[
\begin{align*}
1 & \quad 5 & \quad 2 \\
8V & \quad 6V & \quad 12V
\end{align*}
\]
We get \(28i_1 = -6 - 8 \Rightarrow i_1 = -\frac{1}{2}\,\text{A}\)
and \(54i_2 = -6 - 12 \Rightarrow i_2 = -\frac{1}{3}\,\text{A}\)

Hence \(i_3 = i_1 + i_2 = -\frac{5}{6}\,\text{A}\)

10. By using \(r = \frac{mv\sin\theta}{qB}\)

\[
r = \frac{1.67 \times 10^{-27} \times 2 \times 10^6 \times \sin 30^\circ}{1.6 \times 10^{-19} \times 0.104} = 0.1\text{m}
\]

and it’s time period

\[
T = \frac{2\pi m}{qB} = \frac{2 \times \pi \times 1.67 \times 10^{-27}}{1.6 \times 10^{-19} \times 0.104} = 2 \pi \times 10^{-7} \text{sec}.
\]

11. \(\omega = \frac{2\pi}{24 \times 3600}\)

g’ = g – R\,\omega^2\) or \(0 = g – R\,\omega^2\)

or \(\omega’ = \sqrt{\frac{g}{R_e}}\)

\(\omega’ = 17\omega\)

13. We know \(Q = CV\)

Hence \((Q_1)_{\text{max}} = 6\,\text{mC}\) while \((Q_2)_{\text{max}} = 12\,\text{mC}\)

However in series charge is same so maximum charge on \(C_2\) will also be 6mC (and not 12mC) and hence potential difference across \(C_2\) will be

\(V_2 = \frac{6\,\text{mC}}{3\mu\text{F}} = 2\,\text{kV}\) and as in series

\(V = V_1 + V_2\)

So \(V_{\text{max}} = 6\,\text{kV} + 2\,\text{kV} = 8\,\text{kV}\)

14. By using \(H = \frac{V^2 t}{R}\) where

\(R = \rho \frac{l}{A} \Rightarrow H = \frac{V^2 t A}{\rho l}\)

\(t \propto l\)

Which gives

\[
\frac{t_2}{t_1} = \frac{l_2}{l_1} \Rightarrow \frac{t_2}{15} = \frac{2}{3} \frac{l_1}{l_1} \Rightarrow t_2 = 10\,\text{min}
\]

15. Force on portion ab of wire \(F_1 = Bi \ell \sin 90^\circ = Bi \ell\)

Force on portion bc of wire

\(F_2 = Bi \left(\sqrt{2}\right) \sin 45^\circ = Bi \ell\)

So \(\frac{F_1}{F_2} = 1\).

16. \(F = \frac{Gm(M - m)}{r^2} = \frac{G}{r^2} \left(\frac{mM - m^2}{m^2}\right)\)

For \(F\) to be maximum \(\frac{dF}{dm} = 0\) (as \(M\) and \(r\) are constants).

\[
\frac{d}{dm} \left[ \frac{G}{r^2} \left(\frac{mM - m^2}{m^2}\right) \right] = 0
\]

i.e., \(M - 2m = 0\)

or \(\frac{m}{M} = \frac{1}{2}\)

17. \(E = \frac{2k\lambda}{R} = \frac{2}{4\pi\varepsilon_0} \frac{(Q/\pi R)}{R}\)

18. At steady state terminal potential difference between battery

\(V = IR = \frac{ER}{r + R} = \frac{2.5 \times 2}{0.5 + 2} = 2\,\text{V}\)

Charge on capacitor \(Q = CV = 4 \times 2\mu\text{C}\).

19. For a conductor of non-uniform cross-section

\(v_d \propto \frac{1}{\text{Area of cross-section}}\)

20. Magnetic field at any point lying on the current carrying straight conductor is zero.

Here \(H_1 = \text{Magnetic field at M due to current in PQ}\).

\(H_2 = \text{Magnetic field at M due to QR}\)

+ magnetic field at M due to \(QS\)

+ magnetic field at M due to \(PQ\)

\[
= 0 + H_1 + H_1 = \frac{3}{2} H_1 \Rightarrow \frac{H_1}{H_2} = \frac{2}{3}
\]
21. Here, angular momentum is conserved, i.e., \(L = I\omega = \text{constant}\). At A, the moment of inertia \(I\) is least, so angular speed and therefore the linear speed of planet at A is maximum.

23. \(C_1 = KC\) \hspace{1cm} \(C_2 = C\)

\[
V_1 = 0 \hspace{1cm} V_2 = V_0
\]

\[
V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}
\]

\[
V = \frac{V_0}{K+1} \Rightarrow (K+1)V = V_0
\]

\[
KV = V_0 - V
\]

\[
K = \frac{V_0 - V}{V}
\]

24. Series resistance \(R_s = R_1 + R_2\) and parallel resistance \(R_p = \frac{R_1R_2}{R_1 + R_2}\)

\[
\Rightarrow \frac{R_s}{R_p} = \frac{(R_1 + R_2)^2}{R_1R_2} = n
\]

\[
\Rightarrow \frac{R_1 + R_2}{\sqrt{R_1R_2}} = \sqrt{n}
\]

\[
\Rightarrow \frac{\sqrt{R_1^2} + \sqrt{R_2^2}}{\sqrt{R_1R_2}} = \sqrt{n}
\]

\[
\Rightarrow \sqrt{\frac{R_1}{R_2}} + \sqrt{\frac{R_2}{R_1}} = \sqrt{n}
\]

25. \[\frac{1}{2}mv^2 = qV \Rightarrow v = \sqrt{\frac{2qV}{m}}\]. Also \(F = qvB\)

\[
F = qB\sqrt{\frac{2qV}{m}} \text{ hence } F \propto \sqrt{V} \text{ which gives}
\]

\[
F' = \sqrt{5F}
\]

26. \[T = 2\pi \left[\frac{(R_e + h)^3}{GM_e}\right]^{1/2}\]

When the earth shrinks to half its radius, the radius of the orbit of satellite still remains the same, i.e., \((R_e + h)\). Hence, time period will remain the same.

27. \[
\frac{kq^2}{a} + \frac{kqQ}{a} + \frac{kqQ}{a\sqrt{2}} = 0
\]

\[
Q = -\frac{\sqrt{2}}{\sqrt{2} + 1}
\]

28. Plane conducting surfaces facing each other must have equal and opposite charge densities. Here as the plate areas are equal, \(Q_2 = -Q_3\).

The charge on a capacitor means the charge on the inner surface of the positive plate (here it is \(Q_2\)).

Potential difference between the plates

\[
= \frac{\text{charge}}{\text{capacitance}} = \frac{Q_2}{C} = \frac{2Q_2}{2C}
\]

\[
= \frac{Q_2 - (-Q_3)}{2C} = \frac{Q_2 - Q_3}{2C}
\]

29. The given part of a closed circuit can be redrawn as follows. It should be remember that product of current and resistance can be treated as an imaginary cell having emf = \(iR\).

\[
\Rightarrow \frac{4}{A} - \frac{9V}{B} + \frac{2}{V}
\]

\[
\Rightarrow \text{Hence } V_A - V_B = +9 \text{ V}
\]

30. \[T = 2\pi \sqrt{\frac{1}{MB}} \Rightarrow \frac{T}{T'} = \sqrt{\frac{B'}{B}} = \sqrt{\frac{B}{B_h}}
\]

\[
\Rightarrow \frac{T}{T'} = \sqrt{\frac{1}{\cos \phi}} = \sqrt{\frac{1}{\cos 60^\circ}} = \sqrt{2} \Rightarrow T' = \frac{T}{\sqrt{2}}
\]

32. \[4 \left(\frac{k(q)(q)}{a}\right) + 2 \frac{k(q)(q)}{a\sqrt{2}}\]

33. Initially capacitance \(C_0 = \frac{\varepsilon_0A}{d}\) \ ...(i)

Finally capacitance \(C = \frac{\varepsilon_0A}{d - \frac{d}{4} + \frac{d/4}{\varepsilon_r}}\) \ ...(ii)

By dividing equation (ii) by equation (i)

\[
\frac{C}{C_0} = \frac{4\varepsilon_r}{3\varepsilon_r + 1}
\]
34. Potential gradient \( V = iR \)
\[ \frac{V}{L} = \frac{i\rho L}{A} = \frac{i\rho}{A} \]
\[ = \frac{0.2 \times 40 \times 10^{-8}}{8 \times 10^{-8}} = 10^{-2} \text{ V/m} \]

35. Current sensitivity \( S_i = \frac{0}{i} = \frac{\text{NBA}}{i} \)
\[ \Rightarrow \frac{0}{i} = \frac{100 \times 5 \times 10^{-4}}{10^{-8}} = 5 \text{ rad/μA} \cdot \]

37. \( W = -pE[\cos 180^\circ - \cos 30^\circ] \)
\[ = pE[1 + \sqrt{3}/2] \]

38. To solve such type of problem following guidelines should be follows :
Guideline 1 : mark the number (1, 2, 3,......) on the plates

```
A
\|--|--|--|
|   |   |   |
| 1 | 2 | 3 |
|   |   |   |
| 4 |
```

Guideline 2 : Rearrange the diagram as shown below

```
A
\|--|--|--|
|   |   |   |
| 1 | 2 | 3 |
|   |   |   |
| 4 |
```

Guideline 3 : Since middle capacitor having plates 2, 3 is short circuited so it should be eliminated from the circuit

```
A
\|--|--|--|
|   |   |   |
| 1 | 2 | 3 |
|   |   |   |
| 4 |
```

Hence equivalent capacitance between A and B,
\[ C_{AB} = \frac{2 \varepsilon_0 A}{d} \]

39. \( A_1 = A_2 = A \)
\[ l_1 = x_1 \]
\[ l_2 = x_2 \]
\[ \rho_1 \quad \rho_2 \]

```
x_1
\|--|--|--|
|   |   |   |
| x_2 |
```

\[ R_s = R_1 + R_2 \quad (\because R = \frac{\rho x}{A}) \]
\[ \rho_s \left( \frac{x_1 + x_2}{A} \right) = \rho_1 \frac{x_1}{A} + \rho_2 \frac{x_2}{A} \]
\[ \rho_s = \frac{\rho_1 x_1 + \rho_2 x_2}{x_1 + x_2} \]

40. Direction of magnetic field \( (B_1, B_2, B_3 \text{ and } B_4) \)
at origin due to wires 1, 2, 3 and 4 are shown in the following figure.

```
B_1 = B_2 = B_3 = B_4 = \frac{\mu_0}{4\pi} \cdot \frac{2i}{x} = B \quad \text{So net magnetic field at origin O}
```
\[ B_{net} = \sqrt{(B_1 + B_3)^2 + (B_2 + B_4)^2} \]
\[ = \sqrt{(2B)^2 + (2B)^2} = 2\sqrt{2}B \]

41. Orbital velocity is independent of mass

43. As we know, for conductors resistance \( \propto \) Temperature.

From figure \( R_1 \propto T_1 \Rightarrow \tan \theta \propto T_1 \)
\[ \Rightarrow \tan \theta = kT_1 \quad \text{(i)} \]
(k = constant)

and \( R_2 \propto T_2 \Rightarrow \tan (90^\circ - \theta) \propto T_2 \)
\[ \Rightarrow \cot \theta = kT_2 \quad \text{(ii)} \]

From equation (i) and (ii)
\[ k(T_2 - T_1) = (\cot \theta - \tan \theta) \]
\[ K(T_2 - T_1) = \frac{(\cos \theta - \sin \theta)}{\sin \theta \cos \theta} = \frac{(\cos^2 \theta - \sin^2 \theta)}{\sin \theta \cos \theta} \]
\[ = \frac{\cos 2\theta}{\sin \theta \cos \theta} = 2\cot 2\theta \]
\[ \Rightarrow (T_2 - T_1) \propto \cot 2\theta \]
45. Since plane of the coil is parallel to magnetic field.
   So $\theta = 90^\circ$
   Hence $\tau = NBiA \sin 90^\circ = NBiA$
   $= 50 \times 0.25 \times 2 \times (12 \times 10^{-2} \times 10 \times 10^{-2}) = 0.3$

46. 3-Ethyl-4,4-dimethyl heptane

47. 

48. 

49. oxidative C-C bond cleavage

50. Nucleophilic substitution reaction at aromatic ring $\propto$ EWG at ring

51. 5-methyl cyclopent-2-en-1-ol

52. 

53. 

54. Formyl halids are unstable compound thus
   $\text{O} \quad \text{H-C-H}$ can not be synthesised by rosen mund reduction
   $\text{O} \quad \text{H}_2\text{Pd BaSO}_4 \quad \text{O} \quad \text{R-C-Cl}$
   $\text{H}_2\text{Pd BaSO}_4$ quinolene $\text{R-C-H} + \text{HCl}$

55. Rate of nucleophilic substitution $\propto$ Nucleophilicity (SN$^2$)

56. 

57. The non limiting SN$^1$ reaction (common SN$^1$) takes place as -

58. 

59. Rate of nucleophile substitution $\propto$ stability of carbocation.

60. 

61. 'S' configuration
62. Bulky base is taken thus Hoffmann eliminations

63. \[
\begin{align*}
\text{Br} & \quad \text{Br} \\
\text{CH}_3\text{–CH}_2 & \quad \text{Br}
\end{align*}
\]
\[
\xrightarrow{\text{AIC\,KOH}} \quad \text{CH}_3=\text{CH}
\]
Benzoic acid not phenylacetic acid

65. \[
\begin{align*}
\text{H} & \quad \text{H} \\
\text{H} & \quad \text{H} \\
\text{H} & \quad \text{C=N} \\
\end{align*}
\]
\[
\begin{align*}
\text{H} & \quad \text{H} \\
\text{H} & \quad \text{H} \\
\text{H} & \quad \text{C=N} \\
\end{align*}
\]
\[13\,\sigma\, & \,5\,\pi\]

66. A & B both are \(\text{CH}_3\text{–CH}_2\text{–C–CH}_3\)

Thus identical compound.

68. The alcohol which unable to form methyl ketonic group (\(\text{CH}_3\text{–C–}\)) does not give lodo form test

\[
\begin{align*}
\text{CH}_3\text{–CH}_2\text{–CH}_2\text{–OH} & \quad \text{CH}_3\text{–CH}_2\text{–C–H}
\end{align*}
\]

69. Hoffmann bromamide reaction does not given by 2\(^\circ\) amide or 3\(^\circ\) amide

\[
\begin{align*}
\text{Ph–C–NH–CH}_3 & \quad 2\text{\textdegree}\text{ amide}
\end{align*}
\]

70. Gauche form of ethylene glycol is more stable -due to intramolecular H-bonding

71. –CH\(_3\) group due to +I & hyperunjugative effect behave as ortho paradirector for ESR at benzene ring

74. \[
\begin{align*}
\text{N}_2^+ & \quad \text{OH} \\
\xrightarrow{\Delta} & \quad \text{FeCl}_3
\end{align*}
\]
Voilet colour solution.

75. \[
\begin{align*}
\delta^\delta & \quad \text{MgCl} \\
\xrightarrow{\delta} & \quad \text{H–OH}
\end{align*}
\]
\[
\begin{align*}
\delta & \quad \text{Mg\,Cl(OH)}
\end{align*}
\]

76. Dichloro carbene have incomplete octate thus behave as electrophile

77. Rate of EAR \(\propto\) stability of carbocation intermediate

78. In cross cannizzarro reaction more reactive aldehyde change into salt of carboxylic acid & less reactive aldehyde change into alcohol

79. Hinsberg reagent is \(\xrightarrow{\text{HCl, H}}\) [2] [3]

80. \[
\begin{align*}
\text{O} & \quad \text{O} \\
\xrightarrow{\text{HCl, H}} & \quad \text{O}
\end{align*}
\]

81. Strongest -I group in given example, this compound is most acidic
82. \[ \text{CH}_2=\text{C}-\text{C}=\text{CH}=\text{CH}_2 \xrightarrow{\text{Br}^+} \text{CH}_2=\text{C}-\text{CH}=\text{CH}_2 \]

\[ \text{CH}_2=\text{C}-\text{CH}=\text{CH}-\text{CH}_2 \]

\[ \text{CH}_2=\text{C}-\text{CH}=\text{CH}_2 \xrightarrow{\text{Br}^+ \text{Br}^- \text{Br}^-} \text{CH}_2=\text{C}-\text{CH}=\text{CH}_2 \]

more stable product (major)

83. Ketone does not reduce Fehling solution

84. \[ \text{CH}_3=\text{CH}_2\text{N}≡\text{C} \xrightarrow{\text{H}_2\text{O}^\circ \text{Hydrolysis}} \text{CH}_3=\text{CH}_2\text{NH}_2 + \text{H}–\text{C}–\text{OH} \]

85. \[ \text{CH}_3=\text{CH}_2\text{N}≡\text{C} \xrightarrow{\text{NaOH}/\text{Br}_2 \text{Hoffmann bromide reaction}} \text{NH}_2 \]

86. \[ \text{CH}_2=\text{C} \text{ does not exhibit hyperconjugation thus least stable in given options} \]

\[ \text{HOH} \propto \frac{1}{\text{Stability of alkene}} \]

87. S$_\text{N}$1 reaction rate \( \propto \) stability of carbocation \( \propto \) leaving ability of group

88. \[ \text{CH}_3–\text{C}≡\text{N} + \text{H}_2\text{O} \xrightarrow{\text{H}^\circ} \text{CH}_3–\text{C}=\text{OH} + \text{NH}_3 \]

\[ \xrightarrow{\text{soda lime}} \text{CH}_4+\text{CO}_2 \]

89. \[ \text{Zn/NH}_\text{Cl} \text{ Neutral medium} \]

90. \[ \text{HNO}_3+\text{H}_2\text{SO}_4 \xrightarrow{\Delta} \text{NH}_2–\text{C}–\text{CH}_3 \]

\[ \xrightarrow{\text{HNO}_3+\text{H}_2\text{SO}_4 \Delta} \text{NH}_2–\text{C}–\text{CH}_3 \]

\[ \xrightarrow{\text{Zn/NH}_\text{Cl} \text{ Neutral medium}} \text{NH–OH} \]

\[ \xrightarrow{\text{Pyridine}} \text{NH–C}–\text{CH}_3 \]

\[ \xrightarrow{\text{HNO}_3+\text{H}_2\text{SO}_4 \Delta} \text{NH–C}–\text{CH}_3 \]

\[ \xrightarrow{\text{H}_2\text{O} \Delta} \text{NH–C}–\text{CH}_3 \]