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Product Name : Physics Topic-wise & Chapter-wise DPP (Daily Practice Problem) Sheets for NEET/AIIMS/JIPMER

Product Description : The book “Physics Topic-wise and Chapter-wise Daily Practice Problem (DPP) Sheets for NEET 3rd Edition” is precise, apt and tuned to all the requirements of a NEET aspirant.

The DPP Sheets contains:

1. Well Crafted collection of questions. The book is divided into 2 parts - Topic-wise DPP followed by Chapter-wise DPP Sheets.

2. Part A Sheets divides the complete NEET Physics syllabus into 60 most important Topics. Each chapter has been broken into 2 or more topics.

3. Part B provides 27 Chapter-wise DPPs based on the NCERT.

4. Time Limit, Maximum Marks, Cut-off, Qualifying Score for each DPP Sheet is provided.

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6. Collection of 3000+ MCQ’s .

7. Covers all important Concepts of each Topic

8. As per latest pattern and syllabus of NEET exam.

10. No matter where you PREPARE from – a coaching or NCERT books or any other textbook/ Guide Daily Practice Problem Sheets provides you the right ASSESSMENT on each topic.
1. A projectile is given an initial velocity of \( \vec{v} = (2i + m/s, where \( \vec{i} \) is along the ground and \( \vec{j} \) is along the vertical. If \( g = 10 \text{ m/s}^2 \), the equation of its trajectory is:
   (a) \( y = x - 5x^2 \)
   (b) \( y = 2x - 5x^2 \)
   (c) \( 4y = 2x - 5x^2 \)
   (d) \( 4y = 2x - 25x^2 \)

2. An aircraft moving with a speed of 250 m/s is at a height of 6000 m, just overhead of an anti aircraft-gun. If the muzzle velocity is 500 m/s, the firing angle \( \theta \) should be:
   (a) 30°
   (b) 45°
   (c) 60°
   (d) 75°

3. Two racing cars of masses \( m_1 \) and \( m_2 \) are moving in circles of radii \( r_1 \) and \( r_2 \) respectively. Their speeds are such that each makes a complete circle in the same duration of time \( t \). The ratio of the angular speed of the first to the second car is:
   (a) \( m_1 : m_2 \)
   (b) \( r_1 : r_2 \)
   (c) \( 1 : 1 \)
   (d) \( m_1 r_1 : m_2 r_2 \)

4. A boy playing on the roof of a 10 m high building throws a ball with a speed of 10 m/s at an angle of 30° with the horizontal. How far from the throwing point will the ball be at the height of 10 m from the ground?
   \[ g = 10 \text{ m/s}^2, \sin 30° = \frac{1}{2}, \cos 30° = \frac{\sqrt{3}}{2} \]
   (a) 5.20 m
   (b) 4.33 m
   (c) 2.60 m
   (d) 8.66 m

5. A bomber plane moves horizontally with a speed of 500 m/s and a bomb released from it, strikes the ground in 10 sec. Angle at which it strikes the ground will be (\( g = 10 \text{ m/s}^2 \))
   (a) \( \tan^{-1} \left( \frac{1}{5} \right) \)
   (b) \( \tan \left( \frac{1}{5} \right) \)
   (c) \( \tan^{-1} (1) \)
   (d) \( \tan^{-1} (5) \)

6. Two particles start simultaneously from the same point and move along two straight lines, one with uniform velocity \( \vec{v} \) and other with a uniform acceleration \( \vec{a} \). If \( \alpha \) is the angle between the lines of motion of two particles then the least value of relative velocity will be at time given by
   (a) \( \frac{\vec{v} \sin \alpha}{\vec{a}} \)
   (b) \( \frac{\vec{v} \cos \alpha}{\vec{a}} \)
   (c) \( \frac{\vec{v} \tan \alpha}{\vec{a}} \)
   (d) \( \frac{\vec{v} \cot \alpha}{\vec{a}} \)

7. Initial velocity with which a body is projected is 10 m/sec and angle of projection is 60°. Find the range \( R \)
   (a) \( \frac{\sqrt{15} \text{ m}}{2} \)
   (b) \( \frac{\sqrt{40} \text{ m}}{3} \)
   (c) \( \frac{5 \sqrt{5} \text{ m}}{3} \)
   (d) \( \frac{2 \sqrt{20} \text{ m}}{3} \)
8. The position vectors of points A, B, C and D are
   \( A = 3 \hat{i} + 4 \hat{j} + 5 \hat{k}, B = 4 \hat{i} + 5 \hat{j} + 6 \hat{k}, C = 7 \hat{i} + 9 \hat{j} + 3 \hat{k} \)
   and \( D = 4 \hat{i} + 6 \hat{j} \) then the displacement vectors \( \overrightarrow{AB} \) and \( \overrightarrow{CD} \) are
   (a) perpendicular  (b) parallel  (c) antiparallel  (d) inclined at an angle of 60°
9. A person swims in a river aiming to reach exactly on the opposite point on the bank of a river. His speed of swimming is 0.5 m/s at an angle of 120° with the direction of flow of water. The speed of water is
   (a) 1.0 m/s  (b) 0.5 m/s  (c) 0.25 m/s  (d) 0.43 m/s
10. A projectile thrown with velocity \( \mathbf{v} \) making angle \( \theta \) with vertical gains maximum height \( H \) in the time for which the projectile remains in air, the time period is
   (a) \( \sqrt{\frac{H \cos \theta}{g}} \)  (b) \( \sqrt{\frac{2H \cos \theta}{g}} \)
   (c) \( \sqrt{\frac{4H \cos \theta}{g}} \)  (d) \( \sqrt{\frac{8H \cos \theta}{g}} \)
11. A ball is thrown from a point with a speed \( \mathbf{v}_0 \) at an elevation angle of 0°. From the same point and at the same instant, a person starts running with a constant speed \( \frac{v_0}{2} \) to catch the ball. Will the person be able to catch the ball? If yes, what should be the angle of projection \( \theta \) ?
   (a) No, 0°  (b) Yes, 30°  (c) Yes, 60°  (d) Yes, 45°
12. If vectors \( \mathbf{A} = \cos \omega t \hat{i} + \sin \omega t \hat{j} \) and \( \mathbf{B} = \cos \frac{\omega t}{2} \hat{i} + \sin \frac{\omega t}{2} \hat{j} \) are functions of time, then the value of \( t \) at which they are orthogonal to each other is:
   (a) \( \frac{\pi}{2\omega} \)  (b) \( \frac{\pi}{\omega} \)  (c) \( t = 0 \)  (d) \( t = \frac{\pi}{4\omega} \)
13. A bus is moving on a straight road towards north with a uniform speed of 50 km/hour turns through 90°. If the speed remains unchanged after turning, the increase in the velocity of bus in the turning process is
   (a) 70.7 km/hour along south-west direction
   (b) 70.7 km/hour along north-west direction.
   (c) 50 km/hour along west
   (d) zero
14. The velocity of projection of oblique projectile is \((6\hat{i} + 8\hat{j}) \text{ m/s}^{-1}\). The horizontal range of the projectile is
   (a) 4.9 m  (b) 9.6 m  (c) 19.6 m  (d) 14 m
15. A point \( P \) moves in counter-clockwise direction on a circular path as shown in the figure. The movement of \( P \) is such that it sweeps out a length \( s = r^2 + 5 \), where \( s \) is in metres and \( t \) is in seconds. The radius of the path is 20 m. The acceleration of \( P \) when \( t = 2 \) s is nearly
   (a) 13 m/s²  (b) 12 m/s²  (c) 7.2 m/s²  (d) 14 m/s²
16. The resultant of two vectors \( \mathbf{A} \) and \( \mathbf{B} \) is perpendicular to the vector \( \mathbf{A} \) and its magnitude is equal to half the magnitude of vector \( \mathbf{B} \). The angle between \( \mathbf{A} \) and \( \mathbf{B} \) is
   (a) 120°  (b) 150°  (c) 135°  (d) 180°
17. A man running along a straight road with uniform velocity \( \mathbf{u} = u \hat{i} \) feels that the rain is falling vertically down along \( -\hat{j} \). If he doubles his speed, he finds that the rain is coming at an angle \( \theta \) with the vertical. The velocity of the rain with respect to the ground is
   (a) \( u \hat{i} - u \hat{j} \)  (b) \( u \hat{i} - \frac{u}{\tan \theta} \hat{j} \)
   (c) \( 2u \hat{i} + u \cot \theta \hat{j} \)  (d) \( u \hat{i} + u \sin \theta \hat{j} \)
18. Two projectiles \( A \) and \( B \) thrown with speeds in the ratio 1 : \( \sqrt{2} \) acquired the same heights. If \( A \) is thrown at an angle of 45° with the horizontal, the angle of projection of \( B \) will be
   (a) 0°  (b) 60°  (c) 30°  (d) 45°
19. A projectile can have the same range \( 'R' \) for two angles of projection. If \( 'T_1' \) and \( 'T_2' \) be time of flights in the two cases, then the product of the two time of flights is directly proportional to
   (a) \( R \)  (b) \( \frac{1}{R} \)  (c) \( \frac{1}{R^2} \)  (d) \( R^2 \)
20. A man standing on the roof of a house of height \( h \) throws one particle vertically downwards and another particle horizontally with the same velocity \( u \). The ratio of their velocities when they reach the earth's surface will be
   (a) \( \sqrt{2gh + u^2} : u \)  (b) 1 : 2
   (c) 1 : 1  (d) \( \sqrt{2gh + u^2} : \sqrt{2gh} \)
21. If a unit vector is represented by \( 0.5 \hat{i} + 0.8 \hat{j} + c \hat{k} \), the value of \( c \) is
   (a) 1  (b) \( \sqrt{0.11} \)  (c) \( \sqrt{0.01} \)  (d) 0.39
22. An aeroplane is flying at a constant horizontal velocity of 600 km/hr at an elevation of 6 km towards a point directly above the target on the earth's surface. At an appropriate time, the pilot releases a ball so that it strikes the target at the earth. The ball will appear to be falling
   (a) on a parabolic path as seen by pilot in the plane
   (b) vertically along a straight path as seen by an observer on the ground near the target
   (c) on a parabolic path as seen by an observer on the ground near the target
   (d) on a zig-zag path as seen by pilot in the plane
23. A particle is projected with a velocity $v$ such that its range on the horizontal plane is twice the greatest height attained by it. The range of the projectile is (where $g$ is acceleration due to gravity)

(a) $\frac{4v^2}{5g}$  
(b) $\frac{4g}{5v^2}$  
(c) $\frac{v^2}{g}$  
(d) $\frac{4v^2}{\sqrt[4]{5g}}$

24. Two stones are projected from the same point with same speed making angles $(45^\circ + \theta)$ and $(45^\circ - \theta)$ with the horizontal respectively. If $\theta \leq 45^\circ$, then the horizontal ranges of the two stones are in the ratio of

(a) $1:1$  
(b) $1:2$  
(c) $1:3$  
(d) $1:4$

25. Three forces acting on a body are shown in the figure. To have the resultant force only along the y-direction, the magnitude of the minimum additional force needed is:

(a) $0.5 \, \text{N}$  
(b) $1.5 \, \text{N}$  
(c) $\sqrt{3} \, \text{N}$  
(d) $\sqrt{5} \, \text{N}$

26. A particle moves in x-y plane under the action of force $\vec{F}$ and $\vec{p}$ at a given time $t$. $p_x = 2\cos \theta, p_y = 2\sin \theta$. Then the angle $\theta$ between $\vec{F}$ and $\vec{p}$ at a given time $t$ is :

(a) $\theta = 30^\circ$  
(b) $\theta = 180^\circ$  
(c) $\theta = 0^\circ$  
(d) $\theta = 90^\circ$

27. A person sitting in the rear end of the compartment throws a ball towards the front end. The ball follows a parabolic path. The train is moving with velocity of 20 m/s. A person standing outside on the ground also observes the ball. How will the maximum heights ($y_m$) attained and the ranges ($R$) seen by the thrower and the outside observer compare with each other?

(a) Same $y_m$ different $R$  
(b) Same $y_m$ and $R$  
(c) Different $y_m$ same $R$  
(d) Different $y_m$ and $R$

28. A car moves on a circular road. It describes equal angles about the centre in equal intervals of time. Which of the following statement about the velocity of the car is true ?

(a) Magnitude of velocity is not constant  
(b) Both magnitude and direction of velocity change  
(c) Velocity is directed towards the centre of the circle  
(d) Magnitude of velocity is constant but direction changes

29. Three particles A, B and C are thrown from the top of a tower with the same speed. A is thrown up, B is thrown down and C is horizontally. They hit the ground with speeds $v_A$, $v_B$ and $v_C$ respectively then,

(a) $v_A = v_B = v_C$  
(b) $v_A = v_B > v_C$  
(c) $v_B > v_C > v_A$  
(d) $v_A > v_B = v_C$

30. A particle is moving such that its position coordinate $(x, y)$ are

(2m, 3m) at time $t = 0$  
(6m, 7m) at time $t = 2 \, \text{s}$ and  
(13m, 14m) at time $t = 5 \, \text{s}$.

Average velocity vector $\left( \vec{v}_{av} \right)$ from time $t = 0$ to $t = 5 \, \text{s}$ is :

(a) $\frac{1}{5} (13\hat{i} + 14\hat{j})$  
(b) $\frac{7}{3} (\hat{i} + \hat{j})$  
(c) $2(\hat{i} + \hat{j})$  
(d) $\frac{11}{5} (\hat{i} + \hat{j})$

31. A particle moves so that its position vector is given by $\vec{r} = \cos \omega t \hat{x} + \sin \omega t \hat{y}$. Where $\omega$ is a constant. Which of the following is true ?

(a) Velocity and acceleration both are perpendicular to $\vec{r}$  
(b) Velocity and acceleration both are parallel to $\vec{r}$  
(c) Velocity is perpendicular to $\vec{r}$ and acceleration is directed towards the origin  
(d) Velocity is parallel to $\vec{r}$ and acceleration is directed away from the origin

32. Two boys are standing at the ends $A$ and $B$ of a ground where $AB = a$. The boy at $B$ starts running in a direction perpendicular to $AB$ with velocity $v_B$. The boy at $A$ starts running simultaneously with velocity $v$ and catches the other boy in a time $t$, where $t$ is

(a) $\frac{a}{\sqrt{v^2 + v_B^2}}$  
(b) $\frac{a}{v + v_B}$  
(c) $\frac{a}{v - v_B}$  
(d) $\frac{a^2}{(v^2 - v_B^2)}$

33. A projectile is fired at an angle of $45^\circ$ with the horizontal. Elevation angle of the projectile at its highest point as seen from the point of projection is

(a) $60^\circ$  
(b) $\tan^{-1} \left( \frac{1}{2} \right)$  
(c) $\tan^{-1} \left( \frac{\sqrt{3}}{2} \right)$  
(d) $45^\circ$

34. The position vector of a particle $\vec{R}$ as a function of time is given by $\vec{R} = 4 \sin(2\pi t) \hat{i} + 4 \cos(2\pi t) \hat{j}$. Where $R$ is in meter, $t$ in seconds and $\hat{i}$ and $\hat{j}$ denote unit vectors along x-and y-directions, respectively. Which one of the following statements is wrong for the motion of particle?

(a) Magnitude of acceleration vector is $\frac{v^2}{R}$, where $v$ is the velocity of particle  
(b) Magnitude of the velocity of particle is 8 meter/second  
(c) Path of the particle is a circle of radius 4 meter.  
(d) Acceleration vector is along $-\vec{R}$

35. The vectors $\vec{A}$ and $\vec{B}$ are such that $|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$

The angle between the two vectors is

(a) $60^\circ$  
(b) $75^\circ$  
(c) $45^\circ$  
(d) $90^\circ$
36. The velocity of projection of oblique projectile is 
\( (6i + 8j) \) m/s. The horizontal range of the projectile is 
(a) 4.9 m (b) 9.6 m (c) 19.6 m (d) 14 m

37. An artillery piece which consistently shoots its shells with the same muzzle speed has a maximum range R. To hit a target which is \( \frac{R}{2} \) from the gun and on the same level, the elevation angle of the gun should be 
(a) 15° (b) 45° (c) 30° (d) 60°

38. A car runs at a constant speed on a circular track of radius 100 m, taking 62.8 seconds in every circular loop. The average velocity and average speed for each circular loop respectively, is 
(a) 0, 10 m/s (b) 10 m/s, 10 m/s (c) 10 m/s, 0 (d) 0, 0

39. A vector of magnitude \( b \) is rotated through angle \( \theta \). What is the change in magnitude of the vector? 
(a) \( 2b \sin \frac{\theta}{2} \) (b) \( 2b \cos \frac{\theta}{2} \) (c) \( 2b \sin \theta \) (d) \( 2b \cos \theta \)

40. A stone projected with a velocity \( u \) at an angle \( \theta \) with the horizontal reaches maximum height \( H_1 \). When it is projected with velocity \( u \) at an angle \( \left( \frac{\pi}{2} - \theta \right) \) with the horizontal, it reaches maximum height \( H_2 \). The relation between the horizontal range \( R \) of the projectile, heights \( H_1 \) and \( H_2 \) is 
(a) \( R = 4\sqrt{H_1H_2} \) (b) \( R = 4(H_1 - H_2) \) (c) \( R = 4(H_1 + H_2) \) (d) \( R = \frac{H_1^2}{H_2} \)

41. The vector sum of two forces is perpendicular to their vector differences. In that case, the forces 
(a) cannot be predicted (b) are equal to each other (c) are equal to each other in magnitude (d) are not equal to each other in magnitude

42. A particle crossing the origin of co-ordinates at time \( t = 0 \), moves in the xy-plane with a constant acceleration \( a \) in the y-direction. If its equation of motion is \( y = bx^2 \) (\( b \) is a constant), its velocity component in the x-direction is 
(a) \( \frac{2b}{a} \) (b) \( \frac{a}{2b} \) (c) \( \frac{a}{b} \) (d) \( \frac{b}{a} \)

43. A vector \( \vec{A} \) is rotated by a small angle \( \Delta \theta \) radian (\( \Delta \theta \ll 1 \)) to get a new vector \( \vec{B} \). In that case \( \|B - A\| \) is: 
(a) \( \|A\|\Delta \theta \) (b) \( \|B\|\Delta \theta - \|A\| \) (c) \( \|A\|\left(1 - \frac{\Delta \theta^2}{2}\right) \) (d) 0

44. If a body moving in circular path maintains constant speed of 10 ms\(^{-1}\), then which of the following correctly describes relation between acceleration and radius? 
(a) \( \frac{a}{r} \) (b) \( \frac{a}{r} \) (c) \( \frac{a}{r} \) (d) \( \frac{a}{r} \)

45. The position of a projectile launched from the origin at \( t = 0 \) is given by \( \vec{r} = (40i + 50j) \) m at \( t = 2s \). If the projectile was launched at an angle \( \theta \) from the horizontal, then \( \theta \) is \( \text{take } g = 10 \text{ ms}^{-2} \)
(a) \( \tan^{-1} \frac{2}{3} \) (b) \( \tan^{-1} \frac{3}{2} \) (c) \( \tan^{-1} \frac{7}{4} \) (d) \( \tan^{-1} \frac{4}{5} \)
1. A change of 8.0 mA in the emitter current bring a change of 7.9 mA in the collector current. The values of parameters $\alpha$ and $\beta$ are respectively
   (a) 0.99, 90 (b) 0.96, 79 (c) 0.97, 99 (d) 0.99, 79

2. A pure semiconductor has equal electron and hole concentration of $10^{16}$ m$^{-3}$. Doping by indium increases number of hole concentration $n_h$ to $5 \times 10^{22}$ m$^{-3}$. Then, the value of number of electron concentration $n_e$ in the doped semiconductor is
   (a) $10^6$/m$^3$ (b) $10^{22}$/m$^3$ (c) $2 \times 10^6$/m$^3$ (d) $2 \times 10^9$/m$^3$

3. For LED’s to emit light in visible region of electromagnetic light, it should have energy band gap in the range of:
   (a) 0.1 eV to 0.4 eV (b) 0.5 eV to 0.8 eV (c) 0.9 eV to 1.6 eV (d) 1.7 eV to 3.0 eV

4. A common emitter amplifier has a voltage gain of 50, an input impedance of 100Ω and an output impedance of 200Ω. The power gain of the amplifier is
   (a) 1000 (b) 1250 (c) 100 (d) 500

5. Which logic gate with inputs A and B performs the same operation as that performed by the following circuit?

   - (a) NAND gate
   - (b) OR gate
   - (c) NOR gate
   - (d) AND gate

6. In an unbiased p-n junction, holes diffuse from the p-region to n-region because of
   (a) the potential difference across the p-n junction
   (b) the attraction of free electrons of n-region
   (c) the higher hole concentration in p-region than that in n-region
   (d) the higher concentration of electrons in the n-region than that in the p-region

7. A silicon diode has a threshold voltage of 0.7 V. If an input voltage given by $2 \sin(\pi t)$ is supplied to a half wave rectifier circuit using this diode, the rectified output has a peak value of
   (a) 2V (b) 1.4V (c) 1.3V (d) 0.7V

**Space for Rough Work**
8. The current gain for a transistor working as common-base amplifier is 0.96. If the emitter current is 7.2 mA, then the base current is
(a) 0.29 mA (b) 0.35 mA (c) 0.39 mA (d) 0.43 mA

9. In a npn transistor $10^{10}$ electrons enter the emitter in $10^{-6}$ s. 4% of the electrons are lost in the base. The current transfer ratio will be
(a) 0.98 (b) 0.97 (c) 0.96 (d) 0.94

10. Assuming that the silicon diode having resistance of $20 \Omega$, the current through the diode is (knee voltage 0.7 V)
(a) 0 mA (b) 10 mA (c) 6.5 mA (d) 13.5 mA

11. Transfer characteristics [output voltage ($V_o$) vs input voltage ($V_i$)] for a base biased transistor in CE configuration is as shown in the figure. For using transistor as a switch, it is used
(a) in region III (b) both in region (I) and (III) (c) in region II (d) in region (I)

12. A half-wave rectifier is being used to rectify an alternating voltage of frequency 50 Hz. The number of pulses of rectified current obtained in one second is
(a) 50 (b) 25 (c) 100 (d) 2000

13. A diode having potential difference 0.5 V across its junction which does not depend on current, is connected in series with resistance of $20 \Omega$ across source. If 0.1 A current passes through resistance then what is the voltage of the source?
(a) 1.5V (b) 2.0V (c) 2.5V (d) 5V

14. In common emitter amplifier, the current gain is 62. The collector resistance and input resistance are 5 k$\Omega$ and 500$\Omega$ respectively. If the input voltage is 0.01V, the output voltage is
(a) 0.62V (b) 6.2V (c) 62V (d) 620V

15. On doping germanium with donor atoms of density $10^{17}$ cm$^{-3}$ its conductivity in mho/cm will be
[Given : $\mu_e = 3800$ cm$^2$/Vs and $n_e = 2.5 \times 10^{13}$ cm$^{-3}$]
(a) 30.4 (b) 60.8 (c) 91.2 (d) 121.6

16. The voltage gain of an amplifier with 9% negative feedback is 10. The voltage gain without feedback will be
(a) 90 (b) 10 (c) 125 (d) 100

17. A system of four gates is set up as shown. The ‘truth table’ corresponding to this system is:

18. The intrinsic conductivity of germanium at $27^\circ$ is 2.13 mho m$^{-1}$ and mobilities of electrons and holes are 0.38 and 0.18 m$^2$V$^{-1}$s$^{-1}$ respectively. The density of charge carriers is
(a) $2.37 \times 10^{19}$ m$^{-3}$ (b) $3.28 \times 10^{19}$ m$^{-3}$ (c) $7.83 \times 10^{19}$ m$^{-3}$ (d) $8.47 \times 10^{19}$ m$^{-3}$

19. The logic circuit shown below has the input waveforms ‘A’ and ‘B’ as shown. Pick out the correct output waveform

20. Pure Si at 500K has equal number of electron ($n_e$) and hole ($n_h$) concentrations of $1.5 \times 10^{16}$ m$^{-3}$. Doping by indium increases $n_h$ to $4.5 \times 10^{22}$ m$^{-3}$. The doped semiconductor is of
(a) n-type with electron concentration $n_e = 5 \times 10^{12}$ m$^{-3}$ (b) p-type with electron concentration $n_e = 5 \times 10^{10}$ m$^{-3}$
(c) n-type with electron concentration $n_e = 5 \times 10^{22}$ m$^{-3}$ (d) p-type having electron concentration $n_e = 5 \times 10^{9}$ m$^{-3}$

21. Which of the following statements is incorrect?
(a) The resistance of intrinsic semiconductors decrease with increase of temperature
(b) Doping pure Si with trivalent impurities give p-type semiconductors
(c) The majority carriers in n-type semiconductors are holes
(d) A p-n junction can act as a semiconductor diode

**Response Grid**

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Space for Rough Work
22. The relation between number of free electrons (n) in a semiconductor and temperature (T) is given by
   (a) \( n \propto T \)  (b) \( n \propto T^2 \)  (c) \( n \propto \sqrt{T} \)  (d) \( n \propto T^{3/2} \)

23. If a PN junction diode of depletion layer width \( W \) and barrier height \( V_0 \) is forward biased, then
   (a) \( W \) increases, \( V_0 \) decreases
   (b) \( W \) decreases, \( V_0 \) increases
   (c) both \( W \) and \( V_0 \) increase
   (d) both \( W \) and \( V_0 \) decrease

24. The circuit has two oppositely connected ideal diodes in parallel. The current flowing in the circuit is

25. For a transistor amplifier in common emitter configuration
    for load impedance of 1 k\( \Omega \) \( (h_{fe} = 50 \) and \( h_{re} = 25) \) the current gain is
    (a) \( -24.8 \)  (b) \( -15.7 \)  (c) \( -5.2 \)  (d) \( -48.78 \)

26. A PN junction has a thickness of the order of
    (a) 1 cm  (b) 1 mm  (c) 10\(^{-6}\) m  (d) 10\(^{-12}\) cm

27. A working transistor with its three legs marked \( P \), \( Q \) and \( R \) is tested using a multimeter. No conduction is found between \( P \) and \( Q \). By connecting the common (negative) terminal of the multimeter to \( R \) and the other (positive) terminal to \( P \) or \( Q \), some resistance is seen on the multimeter. Which of the following is true for the transistor?
   (a) It is an npn transistor with \( R \) as base
   (b) It is a pnp transistor with \( R \) as base
   (c) It is a pnp transistor with \( R \) as emitter
   (d) It is an npn transistor with \( R \) as collector

28. If in a p-n junction, a square input signal of 10 V is applied as shown, then the output across \( R_L \) will be

29. When \( n \)-type semiconductor is heated
   (a) number of electrons increases while that of holes decreases
   (b) number of holes increases while that of electrons decreases
   (c) number of electrons and holes remain same
   (d) number of electrons and holes increases equally

30. The ratio of electron and hole currents in a semiconductor is 7/4 and the ratio of drift velocities of electrons and holes is 5/4, then the ratio of concentrations of electrons and holes will be
    (a) 7/5  (b) 5/7  (c) 25/49  (d) 49/25

31. C and Si both have same lattice structure, having 4 bonding electrons in each. However, C is insulator whereas Si is intrinsic semiconductor. This is because:
   (a) In case of C the valence band is not completely filled at absolute zero temperature.
   (b) In case of C the conduction band is partly filled even at absolute zero temperature.
   (c) The four bonding electrons in the case of C lie in the second orbit, whereas in the case of Si they lie in the third.
   (d) The four bonding electrons in the case of C lie in the third orbit, whereas for Si they lie in the fourth orbit.

32. Which one of the following represents forward bias diode?
   (a) \( -4V \)  (b) \( -2V \)  (c) \( 3V \)  (d) \( 0V \)

33. An oscillator is nothing but an amplifier with
    (a) positive feedback  (b) negative feedback
    (c) large gain  (d) no feedback

34. The current gain of a transistor in the common emitter mode is 10. The input impedance is 20 k\( \Omega \) and load of resistance is 100 k\( \Omega \). The power gain is
    (a) 300  (b) 500  (c) 200  (d) 100

35. The input signal given to a CE amplifier having a voltage gain of 150 is \( V_i = 2 \cos \left( 15t + \frac{\pi}{3} \right) \). The corresponding output signal will be:
    (a) \( 75 \cos \left( 15t + \frac{2\pi}{3} \right) \)  (b) \( 2 \cos \left( 15t + \frac{5\pi}{6} \right) \)
    (c) \( 300 \cos \left( 15t + \frac{4\pi}{3} \right) \)  (d) \( 300 \cos \left( 15t + \frac{\pi}{3} \right) \)

36. To use a transistor as an amplifier
    (a) the emitter base junction is forward biased and the base collector junction is reverse biased
    (b) no bias voltage is required
    (c) both junctions are forward biased
    (d) both junctions are reverse biased.
37. A piece of copper and another of germanium are cooled from room temperature to 77K. The resistance of
   (a) copper increases and germanium decreases
   (b) each of them decreases
   (c) each of them increases
   (d) copper decreases and germanium increases

38. A d.c. battery of V volt is connected to a series combination of a resistor R and an ideal diode D as shown in the figure below. The potential difference across R will be

![Diagram of a series combination of a resistor and an ideal diode]

(a) 2V when diode is forward biased
(b) Zero when diode is forward biased
(c) 5V when diode is reverse biased
(d) 6V when diode is forward biased

39. The current gain for a transistor working as common-base amplifier is 0.96. If the emitter current is 7.2 mA, then the base current is
   (a) 0.29 mA (b) 0.35 mA (c) 0.39 mA (d) 0.43 mA

40. In the circuit given below, A and B represent two inputs and C represents the output.

![Diagram of a logic circuit]

The circuit represents
   (a) NOR gate (b) AND gate
   (c) NAND gate (d) OR gate

41. The I-V characteristic of a P-N junction diode is shown below. The approximate dynamic resistance of the p-n junction when a forward bias voltage of 2 volt is applied is

![I-V characteristic graph]

(a) 1W (b) 0.25W (c) 0.5W (d) 5W

42. The circuit diagram shows a logic combination with the states of outputs X, Y and Z given for inputs P, Q, R and S all at state 1. When inputs P and R change to state 0 with inputs Q and S still at 1, the states of outputs X, Y and Z change to

![Logic circuit diagram]

(a) 1, 0, 0 (b) 1, 1, 1 (c) 0, 1, 0 (d) 0, 0, 1

43. The following configuration of gate is equivalent to

![Logic gate configuration]

(a) NAND gate (b) XOR gate
(c) OR gate (d) NOR gate

44. A p-n photodiode is made of a material with a band gap of 2.0 eV. The minimum frequency of the radiation that can be absorbed by the material is nearly
   (a) $10 \times 10^{14}$ Hz (b) $5 \times 10^{14}$ Hz
   (c) $1 \times 10^{14}$ Hz (d) $20 \times 10^{14}$ Hz

45. The average value of output direct current in a full wave rectifier is
   (a) $I_0/\pi$ (b) $I_0/2$ (c) $\pi I_0/2$ (d) $2I_0/\pi$
1. (b) \( \ddot{u} = \dot{2} \dot{j} = u_i \dot{i} + u_j \dot{j} \Rightarrow u \cos \theta = 1, \ u \sin \theta = 2 \)

\[ y = x \tan \theta - \frac{1}{2} \frac{g x^2}{u_x} \]

\[
\therefore \ y = 2x - \frac{1}{2} \frac{g x^2}{x} = 2x - 5x^2
\]

2. (c) \( 500 \cos \theta = 250 \Rightarrow \cos \theta = \frac{1}{2} \)

or \( \theta = 60^\circ \).

3. (c) As time periods are equal therefore ratio of angular speeds will be 1 : 1. \( \left( \omega = \frac{2\pi}{T} \right) \).

4. (d) \[
\begin{align*}
\text{Range} \ R &= u^2 \sin 20^\circ / g \\
&= \frac{(10)^2 \sin(2 \times 30^\circ)}{10} \approx 5\sqrt{3} \approx 8.66 \text{ m}
\end{align*}
\]

From the figure it is clear that range is required

\[
R = \frac{u^2 \sin 20^\circ}{g} = \frac{(10)^2 \sin(2 \times 30^\circ)}{10} = 5\sqrt{3} = 8.66 \text{ m}
\]

5. (a) Horizontal component of velocity \( v_x = 500 \) m/s and vertical component of velocity while striking the ground.

\[
u_v = 0 + 10 \times 10 = 100 \text{ m/s}
\]

\[
\therefore \ \text{Angle with which it strikes the ground}
\]

\[ \theta = \tan^{-1} \left( \frac{u_v}{u_x} \right) = \tan^{-1} \left( \frac{100}{500} \right) = \tan^{-1} \left( \frac{1}{5} \right) \]

6. (b) \[
\begin{align*}
\text{The velocity of first particle, } v_1 &= v \\
\text{The velocity of second particle, } v_2 &= at
\end{align*}
\]

Relative velocity, \( \ddot{v_2} = v_1 - \ddot{v_2} \)

or \( v_1^2 = v^2 + (at)^2 - 2v(at \cos \alpha) \)

For least value of relative velocity, \( \frac{dv_2}{dt} = 0 \)

or \( \frac{d}{dt} \left[ v^2 + a^2 t^2 - 2v at \cos \alpha \right] = 0 \)

or \( 0 + a^2 \times 2t - 2v \cos \alpha = 0 \)

or \( t = \frac{v \cos \alpha}{a} \)

7. (d) \[
\begin{align*}
\text{Distance} \ R &= 10 \cos 30^\circ t - \frac{1}{2} g \sin 30^\circ t^2 \\
&= \frac{10\sqrt{3}}{2} \left( \frac{2}{\sqrt{3}} \right) - \frac{1}{2} \left( 10 \right) \left( \frac{1}{2} \right) \left( \frac{4}{3} \right) = 10 - \frac{10}{3} = \frac{20}{3} \text{ m}
\end{align*}
\]

8. (b) \[
\begin{align*}
\overrightarrow{AB} &= (4 \dot{i} + 5 \dot{j} + 6 \dot{k}) - (3 \dot{i} + 4 \dot{j} + 5 \dot{k}) = \dot{i} + \dot{j} + \dot{k} \\
\overrightarrow{CD} &= (4 \dot{i} + 6 \dot{j}) - (7 \dot{i} + 9 \dot{j} + 3 \dot{k}) = 3 \dot{i} - 3 \dot{j} + 3 \dot{k}
\end{align*}
\]

\( \overrightarrow{AB} \) and \( \overrightarrow{CD} \) are parallel, because its cross-product is 0.

9. (c) Here \( v = 0.5 \) m/sec. \( u = ? \)

so \[ \sin \theta = \frac{u}{v} \Rightarrow \frac{u}{v} = \frac{1}{2} \text{ or } u = 0.25 \text{ ms}^{-1} \]

10. (d) Max. height = \( H = \frac{v^2 \sin^2 (90 - \theta)}{2g} \) \( 
\]

Time of flight, \( T = \frac{2v \sin (90 - \theta)}{g} \) 

From (i), \( \frac{v \cos \theta}{g} = \frac{2H}{g} \) 

From (ii), \( T = 2 \sqrt{\frac{2H}{g}} = \sqrt{\frac{8H}{g}} \)
11. (c) Yes, the person can catch the ball when horizontal velocity is equal to the horizontal component of ball’s velocity, the motion of ball will be only in vertical direction with respect to person for that,

\[ \frac{v_x}{2} = v_o \cos \theta \text{ or } \theta = 60^\circ \]

12. (b) Two vectors

\[ \vec{A} = \cos \omega \hat{i} + \sin \omega \hat{j} \]
\[ \vec{B} = \cos \left( \frac{\omega}{2} \right) \hat{i} + \sin \left( \frac{\omega}{2} \right) \hat{j} \]

For two vectors \( \vec{A} \) and \( \vec{B} \) to be orthogonal \( \vec{A} \cdot \vec{B} = 0 \)

\[ \vec{A} \cdot \vec{B} = 0 = \cos \left( \frac{\omega}{2} \right) \cos \omega + \sin \left( \frac{\omega}{2} \right) \sin \omega \]

\[ \cos \left( \frac{\omega}{2} \right) = \cos \omega \]

So, \( \frac{\omega}{2} = \frac{\pi}{2} \text{ or } \omega = \pi \)

\[ \therefore t = \frac{\pi}{\omega} \]

13. (a) \( \vec{v_1} = 50 \text{ km h}^{-1} \) due North;
\[ \vec{v_2} = 50 \text{ km h}^{-1} \) due West. Angle between \( \vec{v_1} \) and \( \vec{v_2} = 90^\circ \)
\[ \vec{v_2} = 50 \text{ km h}^{-1} \) due South

\[ \therefore \text{Change in velocity} \]
\[ |\vec{v_2} - \vec{v_1}| = |\vec{v_2} + (-\vec{v_1})| \]
\[ = \sqrt{v_x^2 + v_y^2} = \sqrt{50^2 + 50^2} = 70.7 \text{ km/h} \]

The direction of this change in velocity is in South-West.

14. (b) \( \vec{v} = 6\hat{i} + 8\hat{j} \)

[Diagram]

Comparing with \( \vec{v} = v_x \hat{i} + v_y \hat{j} \), we get
\[ v_x = 6 \text{ m/s} \text{ and } v_y = 8 \text{ m/s} \]

Also, \( v^2 = v_x^2 + v_y^2 = 36 + 64 = 100 \)
\[ \therefore v = 10 \text{ m/s} \]

\[ \sin \theta = \frac{8}{10} \text{ and } \cos \theta = \frac{6}{10} \]
\[ R = \frac{v^2 \sin 2\theta}{g} = \frac{2v^2 \sin \theta \cos \theta}{g} \]
\[ R = 2 \times 10 \times 10 \times \frac{8}{10} \times \frac{6}{10} \times \frac{1}{10} = 9.6 \text{ m} \]

15. (d) \( s = t^3 + 5 \)

\[ \Rightarrow \text{velocity}, v = \frac{ds}{dt} = 3t^2 \]

Tangential acceleration \( a_t = \frac{dv}{dt} = 6t \)
Radial acceleration \( a_c = \frac{v^2}{R} = \frac{9t^4}{R} \)

At \( t = 2 \), \( a_t = 6 \times 2 = 12 \text{ m/s}^2 \)
\[ a_c = \frac{9 \times 16}{20} = 7.2 \text{ m/s}^2 \]
\[ \therefore \text{Resultant acceleration} \]
\[ \sqrt{a_t^2 + a_c^2} = \sqrt{(12)^2 + (7.2)^2} = \sqrt{144 + 51.84} = \sqrt{195.84} = 14 \text{ m/s}^2 \]

16. (b) \[ \frac{B}{2} = \sqrt{A^2 + B^2 + 2AB \cos \theta} ...... (i) \]

\[ \therefore \tan 90^\circ = \frac{B \sin \theta}{A + B \cos \theta} \Rightarrow A + B \cos \theta = 0 \]

\[ \therefore \cos \theta = -\frac{A}{B} \]

Hence, from (i) \[ \frac{B^2}{A} = A^2 + B^2 - 2A^2 \Rightarrow A = \frac{\sqrt{3}B}{2} \]
\[ \Rightarrow \cos \theta = -\frac{A}{B} = -\frac{\sqrt{3}}{2} \therefore \theta = 150^\circ \]

17. (b) Suppose velocity of rain \( \vec{v_r} = v_x \hat{i} - v_y \hat{j} \)

and the velocity of the man \( \vec{v_m} = u \hat{i} \)

\[ \vec{v_Rm} = \vec{v_R} - \vec{v_m} = (v_x - u) \hat{i} - v_y \hat{j} \]

According to given condition that rain appears to fall vertically, so \( (v_x - u) \) must be zero.
\[ \therefore v_x - u = 0 \text{ or } v_x = u \]

When he doubles his speed, \( \vec{v_Rm} = 2u \hat{i} \)

Now \[ \vec{v_Rm} = \vec{v_x} - \vec{v_y} \]
\[ = (v_x \hat{i} - v_y \hat{j}) - (2u \hat{i}) \]
\[ = (v_x - 2u) \hat{i} - v_y \hat{j} \]

The \( \vec{v_Rm} \) makes an angle \( \theta \) with the vertical

\[ \tan \theta = \frac{x \text{ component of } \vec{v_Rm}}{y \text{ component of } \vec{v_Rm}} \]
\[ = \frac{(v_x - 2u)}{-v_y} \]
\[ = \frac{u - 2u}{-v_y} \]
which gives
\[ v_y = \frac{u}{\tan \theta} \]

Thus the velocity of rain
\[ \vec{v}_R = v_x \hat{i} - v_y \hat{j} = u \hat{i} - \frac{u}{\tan \theta} \hat{j}. \]

18. (c) For projectile A

Maximum height, \( H_A = \frac{u_A^2 \sin^2 45^\circ}{2g} \)

For projectile B

Maximum height, \( H_B = \frac{u_B^2 \sin^2 \theta}{2g} \)

As we know, \( H_A = H_B \)

\[ \frac{\sin^2 \theta}{\sin^2 45^\circ} = \frac{u_A^2}{u_B^2} \]

\[ \sin^2 \theta = \left( \frac{1}{\sqrt{2}} \right)^2 \left( \frac{1}{\sqrt{2}} \right)^2 = \frac{1}{4} \]

\[ \sin \theta = \frac{1}{2} \Rightarrow \theta = \sin^{-1} \left( \frac{1}{2} \right) = 30^\circ \]

19. (a) The angle for which the ranges are same is complementary.

Let one angle be \( \theta \), then other is \( 90^\circ - \theta \)

\[ T_1 = \frac{2u \sin \theta}{g}, \quad T_2 = \frac{2u \cos \theta}{g} \]

\[ T_1T_2 = \frac{4u^2 \sin \theta \cos \theta}{g} = 2R \quad (\because R = \frac{u^2 \sin^2 \theta}{g}) \]

Hence it is proportional to \( R \).

20. (c) When particle thrown in vertically downward direction with velocity \( u \) then final velocity at the ground level

\[ \sqrt{v^2 = u^2 + 2gh} \Rightarrow v = \sqrt{u^2 + 2gh} \]

Another particle is thrown horizontally with same velocity then velocity of particle at the surface of earth.

\[ v_y = \sqrt{2gh} \]

Horizontal component of velocity \( v_x = u \)

\[ \therefore \text{Resultant velocity, } v = \sqrt{u^2 + 2gh} \]

For both the particles, final velocities when they reach the earth’s surface are equal.

21. (b) \( \hat{r} = 0.5 \hat{i} + 0.8 \hat{j} + \hat{k} \)

\[ |\hat{r}| = 1 = \sqrt{(0.5)^2 + (0.8)^2 + c^2} \]

\[ (0.5)^2 + (0.8)^2 + c^2 = 1 \]

\[ c^2 = 0.11 \Rightarrow c = \sqrt{0.11} \]

22. (c) The pilot will see the ball falling in straight line because the reference frame is moving with the same horizontal velocity but the observer at rest will see the ball falling in parabolic path.

23. (a) \( R = 2H \) (given)

We know, \( R = 4H \cot \theta \Rightarrow \cot \theta = \frac{1}{2} \)

From triangle we can say that

\[ \sin \theta = \frac{2}{\sqrt{5}}, \cos \theta = \frac{1}{\sqrt{5}} \]

\[ \therefore \text{Range of projectile } R = \frac{2v^2 \sin \theta \cos \theta}{g} \]

\[ = \frac{2v^2}{g} \times \frac{2}{\sqrt{5}} \times \frac{1}{\sqrt{5}} = \frac{4v^2}{5g} \]

24. (a) Note that the given angles of projection add up to \( 90^\circ \).

For complementary angles of projection \((45^\circ + \alpha)\) and \((45^\circ - \alpha)\) with same initial velocity \( u \), range \( R \) is same.

\[ \theta_1 + \theta_2 = (45^\circ + \alpha) + (45^\circ - \alpha) = 90^\circ \]

So, the ratio of horizontal ranges is 1:1.

25. (a) The components of 1 N and 2 N forces along \( x \) axis = \( 1 \cos 60^\circ + 2 \sin 30^\circ \)

\[ = 1 \times \frac{1}{2} + 2 \times \frac{1}{2} + 1 = 1.5 \text{ N} \]
The component of 4 N force along \(-x\)-axis
\[= 4 \sin 30^\circ = 4 \times \frac{1}{2} = 2 \text{ N}.\]
Therefore, if a force of 0.5N is applied along \(+x\)-axis, the resultant force along \(x\)-axis will become zero and the resultant force will be obtained only along \(y\)-axis.

26. (d) \(F_x = \frac{dp_x}{dt} = -2 \sin \theta.\)

Similarly, \(F_y = \frac{dp_y}{dx} = 2 \cos \theta.\)

Angle \(\theta\) between two vectors
\[\cos \theta = \frac{F_x p_x + F_y p_y}{|F||p|} = \frac{(-2 \sin \theta)(2 \cos \theta) + (2 \cos \theta)(2 \sin \theta)}{|F||p|} = \frac{-2 \cos \theta}{|F||p|} \Rightarrow \cos \theta = 0 \Rightarrow \theta = 90^\circ.

27. (a) The motion of the train will affect only the horizontal component of the velocity of the ball. Since, vertical component is same for both observers, the \(y_m\) will be same, but \(R\) will be different.

28. (d) As body covers equal angle in equal time intervals. Its angular velocity and hence magnitude of linear velocity is constant.

29. (a) For A: It goes up with velocity \(u\) will it reaches its maximum height (i.e. velocity becomes zero) and comes back to \(O\) and attains velocity \(u\).

Using \(v^2 = u^2 + 2as\) \(\Rightarrow v_A = \sqrt{u^2 + 2gh}\)

For B, going down with velocity \(u\)
\[\Rightarrow v_B = \sqrt{u^2 + 2gh}\]

For C, horizontal velocity remains same, i.e. \(u\). Vertical velocity = \(\sqrt{v^2 + 2gh} = \sqrt{2gh}\)

The resultant \(v_C = \sqrt{v_x^2 + v_y^2} = \sqrt{u^2 + 2gh} \cdot \Rightarrow v_A = v_B = v_C\)

30. (d) \(\bar{v}_{av} = \frac{\Delta \bar{r}}{\Delta t} (\text{displacement})\)
\[= \frac{(13-2)i + (14-3)j}{5-0} = \frac{11}{5}(i + j)\]

31. (c) Position vector
\[\bar{r} = \cos wt \hat{x} + \sin wt \hat{y}\]
\[\therefore \text{Velocity, } \bar{v} = -\cos wt \hat{x} + \cos wt \hat{y}\]

and acceleration,
\[\bar{a} = -\omega^2 \cos wt \hat{x} + \omega \sin wt \hat{y} = -\omega^2 \bar{r}\]

\(\bar{r} \cdot \bar{v} = 0\) hence \(\bar{r} \perp \bar{v}\) and \(\bar{a}\) is directed towards the origin.

32. (d) Velocity of A relative to B is given by
\[
\bar{v}_{AB} = \bar{v}_A - \bar{v}_B = v - v_1 \ldots (1)
\]

By taking \(x\)-components of equation (1), we get
\[0 = v \sin \theta - v_1 \Rightarrow \sin \theta = \frac{v_1}{v} \ldots (2)
\]

By taking \(Y\)-components of equation (1), we get
\[v_y = v \cos \theta \ldots (3)
\]

Time taken by boy at A to catch the boy at B is given by
\[
t = \frac{a}{v \cos \theta} = \frac{a}{v \sqrt{1 - \sin^2 \theta}} = \frac{a}{v \sqrt{1 - \left(\frac{v_1}{v}\right)^2}} \ldots (1)
\]

From equation (1)
\[= \frac{a}{v \sqrt{\frac{v^2 - v_1^2}{v^2}}} = \frac{a}{\sqrt{v^2 - v_1^2}} \ldots (1)
\]

33. (b) \(H = \frac{u^2 \sin^2 45^\circ}{2g} = \frac{u^2}{4g}\)
34. (b) Here, \( x = 4 \sin(2 \pi t) \) \( \ldots (i) \)
\( y = 4 \cos(2 \pi t) \) \( \ldots (ii) \)
Squaring and adding equation \((i)\) and \((ii)\)
\( x^2 + y^2 = 4^2 \)
\( \Rightarrow R = 4 \)

Motion of the particle is circular motion, acceleration vector is along \(-\mathbf{R}\) and its magnitude \(= \frac{v^2}{R} \)

Velocity of particle, \( v = \omega R = (2 \pi)(4) = 8 \pi \)

35. (d) \( |\mathbf{A} + \mathbf{B}|^2 = |\mathbf{A} - \mathbf{B}|^2 \)
\( |\mathbf{A} + \mathbf{B}|^2 = |\mathbf{A}|^2 + |\mathbf{B}|^2 + 2 \mathbf{A} \cdot \mathbf{B} = A^2 + B^2 + 2AB \cos \theta \)
\( |\mathbf{A} - \mathbf{B}|^2 = |\mathbf{A}|^2 + |\mathbf{B}|^2 - 2 \mathbf{A} \cdot \mathbf{B} \)
\( = A^2 + B^2 - 2AB \cos \theta \)
So, \( A^2 + B^2 + 2AB \cos \theta \)
\( = A^2 + B^2 - 2AB \cos \theta \)
\( 4AB \cos \theta = 0 \Rightarrow \cos \theta = 0 \)
\( \therefore \theta = 90^\circ \)
So, angle between \( \mathbf{A} \) & \( \mathbf{B} \) is \( 90^\circ \).

36. (b) \( \vec{v} = 6\hat{i} + 8\hat{j} \)

Comparing with \( \vec{v} = v_x \hat{i} + v_y \hat{j} \), we get
\( v_x = 6 \) m/s \( \text{and} \ v_y = 8 \) m/s \( \text{per} \)
Also, \( v^2 = v_x^2 + v_y^2 = 36 + 64 = 100 \)
or \( v = 10 \text{ m/s} \)
\( \sin \theta = \frac{8}{10} \) \( \text{and} \ \cos \theta = \frac{6}{10} \)

37. (a) Range of a projectile is maximum when it is projected at an angle of \( 45^\circ \) and is given by
\[ R_{\text{max}} = \frac{u^2 \sin 2\theta}{g} \]
Two \( \ldots (i) \)
\[ R = \frac{u^2 \sin 2\theta}{g} = \frac{2v^2 \sin \theta \cos \theta}{g} \]
\[ R = 2 \times 10 \times 10 \times \frac{8}{10} \times \frac{6}{10} \times \frac{1}{10} = 9.6 \text{ m} \]

38. (a) Distance covered in one circular loop = \( 2\pi r \)
\( = 2 \times 3.14 \times 100 = 628 \text{ m} \)
Speed = \( \frac{628}{62.8} = 10 \) m/sec
Displacement in one circular loop = 0

39. (a) \( \overrightarrow{PQ} + \overrightarrow{QR} = \overrightarrow{PR} \)
\( \therefore \overrightarrow{QR} = \overrightarrow{b} - \overrightarrow{b'} \)
Now \( |\overrightarrow{b} - \overrightarrow{b'}|^2 = (\overrightarrow{b} - \overrightarrow{b})(\overrightarrow{b} - \overrightarrow{b}) \)
\( = b^2 - 2bb' \cos \theta + b'^2 \)
\( = 2b^2(1 - \cos \theta) \) \( \because b' = b \)
\( \overrightarrow{b} - \overrightarrow{b'} = \sqrt{2b}\sqrt{1 - \cos \theta} \)
\( = \sqrt{2b} \left( \sqrt{2} \sin \frac{\theta}{2} \right) = 2b \sin \frac{\theta}{2} \)

40. (a) \( H_1 = \frac{u^2 \sin^2 \theta}{2g} \)
and \( H_2 = \frac{u^2 \sin^2 (90^\circ - \theta)}{2g} \)
\( \therefore R = \sqrt{H_1 H_2} \)

41. (c) \( \vec{P} = \text{vector sum} = \overrightarrow{A} + \overrightarrow{B} \)
\( \vec{Q} = \text{vector differences} = \overrightarrow{A} - \overrightarrow{B} \)
Since $\vec{p}$ and $\vec{Q}$ are perpendicular
\[ \implies \vec{p} \cdot \vec{Q} = 0 \]
\[ \Rightarrow (\vec{A} + \vec{B}) \cdot (\vec{A} - \vec{B}) = 0 \Rightarrow A^2 = B^2 \Rightarrow |A| = |B| \]

42. (b) Differentiating w.r.t to $t$ an both sides, we get
\[ \frac{dy}{dt} = b2x \frac{dx}{dt} \]
\[ v_y = 2bxv_x \]
Again differentiating w.r.t to $t$ on both sides we get
\[ \frac{dv_y}{dt} = 2bv_x \frac{dx}{dt} + 2bx \frac{dv_x}{dt} = 2b^2 \]
\[ \frac{dv_x}{dt} = 0, \text{ because the particle has constant acceleration along y-direction} \]
Now, \[ \frac{dv_y}{dt} = a = 2bv_x^2; \]
\[ v_y^2 = \frac{a}{2b} \]
\[ v_x = \sqrt{\frac{a}{2b}} \]

43. (a) Arc length = radius $\times$ angle
So, \[ |\vec{B} - \vec{A}| \sim |\vec{A}| \Delta \theta \]

44. (c) Speed, $V = \text{constant (from question)}$
Centripetal acceleration,
\[ a = \frac{v^2}{r} \]
\[ ra = \text{constant} \]
Hence graph (c) correctly describes relation between acceleration and radius.

45. (c) From question,
Horizontal velocity (initial),
\[ u_x = \frac{40}{2} = 20 \text{m/s} \]
Vertical velocity (initial), \[ 50 = u_y t + \frac{1}{2} gt^2 \]
\[ \Rightarrow u_y t + \frac{1}{2} (-10) \times 4 \]
or, \[ 50 = 2u_y - 20 \]
or, \[ u_y = \frac{70}{2} = 35 \text{m/s} \]
\[ \Rightarrow \tan \theta = \frac{u_y}{u_x} = \frac{35}{20} = \frac{7}{4} \]
\[ \Rightarrow \text{Angle } \theta = \tan^{-1} \frac{7}{4} \]
1. (d) $\Delta I_E = 8.0 \text{mA}$  
$\Delta I_C = 7.9 \text{mA}$  
$\alpha = \frac{\Delta I_C}{\Delta I_E} = \frac{7.9}{8.0} = 0.9875 = 0.99$  
Also, $\beta = \frac{\alpha}{1 - \alpha} = \frac{0.9875}{0.0125} = 79$

2. (d) Here, $n_i = 10^{16} \text{m}^{-3}$, $n_h = 5 \times 10^{22} \text{m}^{-3}$  
As $n_n n_h = n_i^2$  
$\therefore n_e = \frac{n_i^2}{n_h} = \frac{(10^{16} \text{m}^{-3})^2}{5 \times 10^{22} \text{m}^{-3}} = 2 \times 10^9 \text{m}^{-3}$

3. (d) Energy band gap range is given by, 
$E_g = \frac{\hbar c}{\lambda}$  
For visible region $\lambda = (4 \times 10^{-7} \sim 7 \times 10^{-7}) \text{m}$  
$E_g = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{7 \times 10^{-7}} = 19.8 \times 10^{-26}$  
$= 2.8 \times 10^{-19}$  
$E_g = 1.75 \text{eV}$

4. (b) Voltage gain $= \beta \times \text{Impedance gain}$  
$50 = \beta \times \frac{200}{100} = 2 \beta \Rightarrow \beta = 25$  
and power gain $= \beta^2 \times \frac{200}{100} = 1250$.

5. (b) When either of $A$ or $B$ is 1 i.e. closed then lamp will glow.  
In this case, Truth table

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This represents OR gate.

6. (c) In p-region of p-n junction holes concentration $>$ electrons concentration and in n-region electrons concentration $>$ holes concentration.

7. (c) Peak value of rectified output voltage  
$= \text{peak value of input voltage} - \text{barrier voltage}$  
$= 2 - 0.7 = 1.3 \text{V}$.

8. (a) Current gain $(\alpha) = 0.96$  
$I_e = 7.2 \text{mA}$  
$I_c = \frac{I_e}{\alpha} = \frac{7.2}{0.96} = 7.5 \text{mA}$  
$I_c = 0.96 \times 7.2 \text{mA} = 6.91 \text{mA}$  
$I_e = I_c + I_b$  
$\Rightarrow I_b = I_e - I_c = 7.2 - 6.91 = 0.29 \text{mA}$

9. (c) No. of electrons reaching the collector, 
$n_C = \frac{96}{100} \times 10^{10} = 0.96 \times 10^{10}$  
Emitter current, $I_E = \frac{n_E \times e}{t}$  
Collector current, $I_C = \frac{n_C \times e}{t}$  
$\therefore$ Current transfer ratio, 
$\alpha = \frac{I_C}{I_E} = \frac{n_C}{n_E} = \frac{0.96 \times 10^{10}}{10^{10}} = 0.96$

10. (c) Here diode is forward biased with voltage $= 2 - 0 = 2 \text{V}$.  
$V_B = V_{knee} + IR = 2 + 0.7 = 2.7 \text{V}$  
$2 = 0.7 + 1 \times 200$  
(\therefore \text{Total resistance} = 180 + 20 = 200 \Omega)  
$I = \frac{1.3}{200} = 6.5 \text{mA}$

11. (b) I $\rightarrow$ ON  
II $\rightarrow$ OFF  
In IIIrd state it is used as a amplifier it is active region.

12. (b) In half wave rectifier only half of the wave is rectified.

13. (c) $V' = V + IR = 0.5 + 0.1 \times 20 = 2.5 \text{V}$

14. (b) $\frac{V_o}{V_i} = \frac{R_o}{R_i} \times \beta = \frac{5 \times 10^3 \times 62}{500} = 10 \times 62 = 620$  
$V_o = 620 \times V_i = 620 \times 0.01 = 6.2 \text{V}$  
$\therefore V_o = 6.2 \text{V}$

15. (b) Conductivity $\sigma = n_i e \mu_e = 10^{17} \times (1.6 \times 10^{-19}) \times 3800$  
$= 60.8 \text{mho/cm}$
16. (d) Negative feedback is applied to reduce the output voltage of an amplifier. If there is no negative feedback, the value of output voltage could be very high. In the options given, the maximum value of voltage gain is 100. Hence it is the correct option.

17. (a) In the given system all four gate is NOR gate

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18. (a) Conductivity, \( \sigma = \frac{1}{\rho} = e(n_e \mu_e + n_h \mu_h) \)

\[ 2.13 \times 1.6 \times 10^{-10} (0.38 + 0.18) n_i \]

(Since in intrinsic semi-conductor, \( n_e = n_h = n_i \))

\[ \therefore \text{density of charge carriers, } n_i = 2.13 \times 1.6 \times 10^{-19} \times 0.56 \]

19. (d) Here \( Y = \overline{(A + B)} = \overline{A} \overline{B} = A \cdot B \). Thus, it is an AND gate for which truth table is

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20. (d) \( n_i^2 = n_e n_h \)

\[ (1.5 \times 10^{16})^2 = n_e (4.5 \times 10^{22}) \]

\[ \Rightarrow n_e = 0.5 \times 10^{10} \]

or \( n_e = 5 \times 10^9 \)

Given \( n_h = 4.5 \times 10^{22} \)

\[ \Rightarrow n_h >> n_e \]

\[ \therefore \text{Semiconductor is } p\text{-type and} \]

\[ n_e = 5 \times 10^9 \text{m}^{-3} \]

21. (c) In \( n\)-type semiconductors, electrons are the majority charge carriers.

22. (d) For semiconductor, \( n = AT^{3/2} e^{-\frac{E_g}{2kT}} \);

so \( n \propto T^{3/2} \)

23. (d) When PN junction diode is forward biased both depletion layer width \( W \) and barrier height \( V_0 \) decrease and current due to molarity carrier increases.

24. (b) \( D_2 \) is forward biased whereas \( D_1 \) is reversed biased. So effective resistance of the circuit

\[ R = 4 + 2 = 6 \Omega \]

\[ \therefore i = \frac{12}{6} = 2 \text{ A} \]

25. (d) In common emitter configuration current gain

\[ A_i = \frac{-hfe}{1 + hfe R_L} = \frac{-50}{1 + 25 \times 10^{-6} \times 1 \times 10^{-3}} = -48.78 \]

26. (c) (b) It is a \( p-n-p \) transistor with \( R \) as base.

27. (c) Here P-N junction diode rectifies half of the ac wave i.e., acts as half wave rectifier. During +ve half cycle Diode \( \to \) forward biased output across will be

\[ 5V \]

During -ve half cycle Diode \( \to \) reverse biased output will not obtained.

29. (d) Due to heating, when a free electron is produced then simultaneously a hole is also produced.

30. (b) \( I = nA \times e \) or \( I = n \times v_d \)

\[ \therefore \frac{l_e}{l_h} = \frac{n_e v_e}{n_h v_h} \text{ or } \frac{n_e}{l_h} \times \frac{l_e}{v_e} = \frac{7}{4} \times \frac{4}{5} = \frac{7}{5} \]

31. (c) Electronic configuration of \( ^6\text{C} \)

\( ^6\text{C} = 1s^2, 2s^2 2p^2 \)

The electronic configuration of \( ^{14}\text{Si} \)

\( ^{14}\text{Si} = 1s^2, 2s^2 2p^6, 3s^2 3p^2 \)

As they are away from Nucleus, so effect of nucleus is low for Si even for Sn and Pb are almost metallic.

32. (d) In forward bias, \( V_1 > V_2 \) i.e., in figure (d) \( p\)-type semiconductor is at higher potential w.r.t. \( n\)-type semiconductor.

33. (a) A positive feedback from output to input in an amplifier provides oscillations of constant amplitude.

34. (b) The power gain in case of CE amplifier, \( \text{Power gain} = \beta^2 \times \frac{R_o}{R_i} \)

\[ = (10)^2 \times 5 = 500. \]

35. (c) Given: Voltage gain \( A_V = 150 \)

\[ V_i = 2\cos \left( 15t + \frac{\pi}{3} \right) ; V_0 = ? \]

For CE transistor phase difference between input and output signal is \( \pi = 180^0 \)

Using formula, \( A_V = \frac{V_0}{V_i} \)

\[ \Rightarrow V_0 = A_V \times V_i \]

\[ = 150 \times 2\cos \left( 15t + \frac{\pi}{3} \right) \]
36. (a) To use a transistor as an amplifier the emitter base junction is forward biased while the collector base junction is reverse biased.

37. (d) Copper is a conductor, so its resistance decreases on decreasing temperature as thermal agitation decreases; whereas germanium is semiconductor therefore on decreasing temperature resistance increases.

38. (b) In forward biasing, the diode conducts. For ideal junction diode, the forward resistance is zero; therefore, entire applied voltage occurs across external resistance \( R \) i.e., there occurs no potential drop, so potential across \( R \) is \( V \) in forward biased.

39. (a) Current gain (\( \alpha \)) = 0.96

\[
I_e = 7.2 \text{ mA}
\]

\[
\frac{I_c}{I_e} = \alpha = 0.96
\]

\[
I_c = 0.96 \times 7.2 \text{ mA} = 6.91 \text{ mA}
\]

\[
I_e = I_c + I_b
\]

\[
\Rightarrow I_b = I_e - I_c = 7.2 - 6.91 = 0.29 \text{ mA}
\]

40. (d)

The truth table for the above logic gate is:

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This truth table follows the boolean algebra \( C = A + B \) which is for OR gate.

41. (b) \[ R = \frac{\Delta V}{\Delta I} = \frac{2.1 - 2}{(800 - 400) \times 10^{-3}} = \frac{1}{4} = 0.25 \Omega \]

42. (c)

43. (b)

\[ Y_1 = A + B, \quad Y_2 = \overline{A \cdot B} \]

\[ Y = (A + B) \cdot \overline{A \cdot B} = A \cdot \overline{A} + A \cdot B + B \cdot A + B \cdot \overline{B} \]

\[ = 0 + A \cdot B + B \cdot \overline{A} + 0 = A \cdot B + B \cdot \overline{A} \] (XOR gate)

44. (b) \[ E_g = 2.0 \text{ eV} = 2 \times 1.6 \times 10^{-19} \text{ J} \]

\[ E_g = h \nu \]

\[ \Rightarrow \nu = \frac{E_g}{h} = \frac{2 \times 1.6 \times 10^{-19} \text{ J}}{6.62 \times 10^{-34} \text{ Js}} \]

\[ = 0.4833 \times 10^{15} \text{ s}^{-1} = 4.833 \times 10^{14} \text{ Hz} \]

\[ = 5 \times 10^{14} \text{ Hz} \]

45. (d) The average value of output direct current in a full wave rectifier = (average value of current over a cycle)

\[ = (2I_0/\pi) = \frac{2I_0}{\pi} \]
DIRECTIONS (Q.1-Q.20) : There are 20 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which ONLY ONE choice is correct.

Q.1 A boy standing on a weighing machine observes his weight as 200 N. When he suddenly jumps upwards, his friend notices that the reading increased to 400 N. The acceleration by which the boy jumped will be-
(a) $9.8 \text{ m/s}^2$  
(b) $29.4 \text{ m/s}^2$  
(c) $4.9 \text{ m/s}^2$  
(d) $14.7 \text{ m/s}^2$

Q.2 A force of $(6 \hat{i} + 8 \hat{j}) \text{ N}$ acted on a body of mass 10 kg. The displacement after 10 sec, if it starts from rest, will be -
(a) 50 m along $\tan^{-1} 4/3$ with x axis  
(b) 70 m along $\tan^{-1} 3/4$ with x axis  
(c) 10 m along $\tan^{-1} 4/3$ with x axis  
(d) None

Q.3 A boat of mass 1000 kg is moving with a velocity of 5 m/s. A person of mass 60 kg jumps into the boat. The velocity of the boat with the person will be -
(a) 4.71 m/s  
(b) 4.71 cm/s  
(c) 47.1 m/s  
(d) 47.1 cm/s

Q.4 A disc of mass 10 gm is kept horizontally in air by firing bullets of mass 5 g each at the rate of 10/s. If the bullets rebound with same speed. The velocity with which the bullets are fired is -
(a) 49 cm/s  
(b) 98 cm/s  
(c) 147 cm/s  
(d) 196 cm/s

Q.5 A fire man has to carry an injured person of mass 40 kg from the top of a building with the help of the rope which can withstand a load of 100 kg. The acceleration of the fireman if his mass is 80 kg, will be-
(a) 8.17 m/s$^2$  
(b) 9.8 m/s$^2$  
(c) 1.63 m/s$^2$  
(d) 17.97 m/s$^2$
Q.6 A body of mass 0.02 kg falls from a height of 5 metre into a pile of sand. The body penetrates the sand a distance of 5 cm before stopping. What force has the sand exerted on the body?
(a) 1.96 N (b) −19.6 N (c) −0.196 N (d) 0.0196 N

Q.7 The magnitude of the force (in newton) acting on a body varies with time t (in microsecond) as shown in fig. AB, BC, and CD are straight line segments. The magnitude of the total impulse of the force on the body from t = 4 μs to t = 16 μs is
(a) 5 × 10^−4 N.s (b) 5 × 10^−3 N.s (c) 5 × 10^−5 N.s (d) 5 × 10^−2 N.s

Q.8 The total mass of an elevator with a 80 kg man in it is 1000 kg. This elevator moving upward with a speed of 8 m/sec, is brought to rest over a distance of 16m. The tension T in the cables supporting the elevator and the force exerted on the man by the elevator floor will respectively be-
(a) 7800 N, 624 N (b) 624 N, 7800 N (c) 78 N, 624 N (d) 624 N, 78 N

Q.9 In the arrangement shown in fig. the ends P and Q of an unstretchable string move downwards with a uniform speed U. Pulleys A and B are fixed. Mass M moves upwards with a speed of
(a) 2U cos 0 (b) U cos 0 (c) 2U cos 0 (d) U cos 0

Q.10 An engine of mass 5 × 10^4 kg pulls a coach of mass 4 × 10^4 kg. Suppose that there is a resistance of 1 N per 100 kg acting on both coach and engine, and that the driving force of engine is 4500 N. The acceleration of the engine and tension in the coupling will respectively be-
(a) 0.04 m/s², 2000 N (b) 0.4 m/s², 200 N (c) 0.4 m/s², 20 N (d) 4 m/s², 200 N

Q.11 A body whose mass 6 kg is acted upon by two forces (8\hat{i} + 10\hat{j}) N and (4\hat{i} + 8\hat{j}) N. The acceleration produced will be (in m/s²) –
(a) (3\hat{i} + 2\hat{j}) (b) 12\hat{i} + 18\hat{j} (c) \frac{1}{3}(\hat{i} + \hat{j}) (d) 2\hat{i} + 3\hat{j}

Q.12 A car of 1000 kg moving with a velocity of 18 km/hr is stopped by the brake force of 1000 N. The distance covered by it before coming to rest is -
(a) 1 m (b) 162 m (c) 12.5 m (d) 144 m

Q.13 A block of metal weighing 2 kg is resting on a frictionless plane. It is struck by a jet releasing water at a rate of 1 kg/s and at a speed of 5 m/s. The initial acceleration of the block will be –
(a) 2.5 m/s² (b) 5 m/s² (c) 0.4 m/s² (d) 0

Q.14 A man fires the bullets of mass \( m \) each with the velocity \( v \) with the help of machine gun, if he fires \( n \) bullets every sec, the reaction force per second on the man will be -
(a) \( \frac{m}{v} n \) (b) \( m n v \) (c) \( \frac{mv}{n} \) (d) \( vn \)

Q.15 A body of mass 15 kg moving with a velocity of 10 m/s is to be stopped by a resistive force in 15 sec, the force will be -
(a) 10 N (b) 5 N (c) 100 N (d) 50 N

Q.16 A cricket ball of mass 250 gm moving with a velocity of 24 m/s is hit by a bat so that it acquires a velocity of 28 m/s in the opposite direction. The force acting on the ball, if the contact time is 1/100 of a second, will be -
(a) 1300 N in the final direction of ball (b) 13 N in the initial direction of ball (c) 130 N in the final direction of ball (d) 1.3 N in the initial direction of ball
Q.17 A force of 2 N is applied on a particle for 2 sec, the change in momentum will be -
(a) 2 Ns  (b) 4 Ns  (c) 6 Ns  (d) 3 Ns

Q.18 A body of mass 2 kg is moving along x-direction with a velocity of 2 m/sec. If a force of 4 N is applied on it along y-direction for 1 sec, the final velocity of particle will be -
(a) $2\sqrt{2}$ m/s  (b) $\sqrt{2}$ m/s
(c) $1/\sqrt{2}$ m/s  (d) $1/2\sqrt{2}$ m/s

Q.19 A cricket ball of mass 150 g is moving with a velocity of 12 m/sec and is hit by a bat so that the ball is turned back with a velocity of 20 m/sec, the force on the ball acts for 0.01 sec, then the average force exerted by the bat on the ball will be
(a) 48 N  (b) 40 N  (c) 480 N  (d) 400 N

Q.20 A body of mass 20 kg moving with a velocity of 3 m/s, rebounds on a wall with same velocity. The impulse on the body is -
(a) 60 Ns  (b) 120 Ns  (c) 30 Ns  (d) 180 Ns

DIRECTIONS (Q.21-Q.23) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :
(a) 1, 2 and 3 are correct  (b) 1 and 2 are correct
(c) 2 and 4 are correct  (d) 1 and 3 are correct

Q.21 A mass of 60 kg is on the floor of a lift moving down. The lift moves at first with an acceleration of $3 \text{ m/sec}^2$, then with constant velocity and finally with a retardation of $3 \text{ m/sec}^2$. Choose the correct options related to possible reactions exerted by the lift on the body in each part of the motion –
(1) 408 N  (2) 588 N  (3) 768 N  (4) 508 N

Q.22 A mass of 10 kg is hung to a spring balance in lift. If the lift is moving with an acceleration g/3 in upward & downward directions, choose the correct options related to the reading of the spring balance.
(1) 13.3 kg  (2) 6.67 kg  (3) 32.6 kg  (4) 0

Q.23 Choose the correct options
(1) A reference frame in which Newton’s first law is valid is called an inertial reference frame.
(2) Frame moving at constant velocity relative to a known inertial frame is also an inertial frame.
(3) Ideally, no inertial frame exists in the universe for practical purpose, a frame of reference may be considered as inertial if its acceleration is negligible with respect to the acceleration of the object to be observed.
(4) To measure the acceleration of a falling apple, earth cannot be considered as an inertial frame.

DIRECTIONS (Q.24-Q.26) : Read the passage given below and answer the questions that follows:

Pseudo force is an imaginary force which is recognised only by a non-inertial observer to explain the physical situation according to newton’s laws. Magnitude of pseudo force $F_p$ is equal to the product of the mass $m$ of the object and the acceleration $a$ of the frame of reference. The direction of the force is opposite to the direction of acceleration, $F_p = -ma$

Q.24 A spring weighing machine inside a stationary lift reads 50 kg when a man stand on it. What would happen to the scale reading if the lift is moving upward with (i) constant velocity (ii) constant acceleration ?
(a) 50 kg wt, $\left(50 + \frac{50a}{g}\right)$ kg wt
(b) 50 kg wt, $\left(50 + \frac{50a}{g}\right)$ kg wt
(c) 50 kg wt, $\left(\frac{50a}{g}\right)$ kg wt
(d) 50 kg wt, $\left(\frac{50a}{g}\right)$ kg wt

Q.25 A 25 kg lift is supported by a cable. The acceleration of the lift when the tension in the cable is 175 N, will be -
(a) $2.8 \text{ m/s}^2$  (b) $16.8 \text{ m/s}^2$
(c) $-9.8 \text{ m/s}^2$  (d) $14 \text{ m/s}^2$

RESPONSE GRID
17. a b c d  18. a b c d  19. a b c d  20. a b c d  21. a b c d
22. a b c d  23. a b c d  24. a b c d  25. a b c d
Q.26 A body is suspended by a string from the ceiling of an elevator. It is observed that the tension in the string is doubled when the elevator is accelerated. The acceleration will be -
(a) 4.9 m/s²  
(b) 9.8 m/s²  
(c) 19.6 m/s²  
(d) 2.45 m/s²

DIRECTIONS (Q. 27-Q.29) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(c) Statement-1 is False, Statement-2 is True.
(d) Statement-1 is True, Statement-2 is False.

Q.27 Statement-1 : A cloth covers a table. Some dishes are kept on it. The cloth can be pulled out without dislodging the dishes from the table.
Statement-2 : To every action there is an equal and opposite reaction.

Q.28 Statement-1 : If the net external force on the body is zero then its acceleration is zero.
Statement-2 : Acceleration does not depend on force.

Q.29 Statement-1 : The slope of momentum versus time graph give us the acceleration.
Statement-2 : Force is given by the rate of change of momentum.

RESPONSE GRID 26. a b c d 27. a b c d 28. a b c d 29. a b c d

DAILY PRACTICE PROBLEM SHEET 9 - PHYSICS

<table>
<thead>
<tr>
<th>Total Questions</th>
<th>29</th>
<th>Total Marks</th>
<th>116</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attempted</td>
<td></td>
<td>Correct</td>
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</tr>
<tr>
<td>Incorrect</td>
<td></td>
<td>Net Score</td>
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<tr>
<td>Cut-off Score</td>
<td>30</td>
<td>Qualifying Score</td>
<td>44</td>
</tr>
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</table>

Success Gap = Net Score – Qualifying Score

Net Score = (Correct x 4) – (Incorrect x 1)

Space for Rough Work
DPP - Daily Practice Problems

Name: ___________________________ Date: ___________________________

Start Time: ______________________ End Time: ______________________

PHYSICS

Max. Marks: 108 Time: 60 min.

GENERAL INSTRUCTIONS

• The Daily Practice Problem Sheet contains 27 MCQ’s. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
• You have to evaluate your Response Grids yourself with the help of solution booklet.
• Each correct answer will get you 4 marks and 1 mark shall be deducted for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
• The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
• After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.19) : There are 19 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which ONLY ONE choice is correct.

Q.1 The magnitude of magnetic field at a point having perpendicular distance 50 mm from a long straight conducting wire carrying a current of 3A is
(a) 0.12 G (b) 1.2 G (c) 12 G (d) 0.012 G

Q.2 A circular arc of wire of radius of curvature r subtends an angle of \( \pi/4 \) radian at its centre. If i current is flowing in it then the magnetic induction at its centre is -
(a) \( \frac{\mu_0 i}{8r} \) (b) \( \frac{\mu_0 i}{4r} \) (c) \( \frac{\mu_0 i}{16r} \) (d) 0

Q.3 A current \( i \) is flowing in a conductor PQRST shaped as shown in the figure. The radius of curved part QRS is \( r \) and length of straight portions PQ and ST is very large. The magnetic field at the centre O of the curved part is -

(a) \( \frac{\mu_0 i}{4\pi r} \left[ \frac{3\pi}{2} + 1 \right] \hat{k} \) (b) \( \frac{\mu_0 i}{4\pi r} \left[ \frac{3\pi}{2} - 1 \right] \hat{k} \)
(c) \( \frac{\mu_0 i}{4\pi r} \left[ \frac{3\pi}{2} + 1 \right] (-\hat{k}) \) (d) \( \frac{\mu_0 i}{4\pi r} \left[ \frac{3\pi}{2} - 1 \right] (-\hat{k}) \)

RESPONSE GRID

1. a b c d  2. a b c d  3. a b c d

Space for Rough Work
Q.4 Consider the loop PQRSP, carrying clockwise current \( i \), shown in the figure. The magnitude of magnetic field at the centre O of the curved portion is

(a) \( \frac{\mu_0 i}{2\pi r} [\pi - \phi + \tan \phi] \)

(b) \( \frac{\mu_0 i}{2\pi r} \)

(c) 0

(d) \( \frac{\mu_0 i}{2\pi r} [\pi - \phi + \tan \phi] \)

Q.5 A circular coil of 0.2 m diameter has 100 turns and carries a current of 0.1 ampere. The intensity of magnetic field at the centre of the coil is -

(a) \( 6.28 \times 10^{-4} \) tesla

(b) \( 62.8 \times 10^{-4} \) tesla

(c) \( 6.28 \times 10^{-5} \) tesla

(d) \( 62.8 \times 10^{-5} \) tesla

Q.6 For the arrangement of two current carrying identical coils shown in the figure, the magnetic field at the center O is (N and a represent number of turns and radius of each coil)-

(a) \( \frac{\mu_0 NI}{2a} \)

(b) \( \frac{\mu_0 NI}{2\sqrt{2}a} \)

(c) \( \frac{\mu_0 NI}{2} \)

(d) \( \frac{\mu_0 NI}{2a} \)

Q.7 A current is flowing through a conducting hollow pipe whose area of cross-section is shown in the fig. The value of magnetic induction will be zero at:

(a) Point P, Q and R

(b) Point R but not at P and Q

(c) Point Q but not at P and R

(d) Point P but not at Q and R

Q.8 Dimensional formula of \( \mu_0 \) is-

(a) MLT\(^{-2}\)A\(^{-2}\)

(b) MLT\(^{-2}\)A\(^{2}\)

(c) MLT\(^{-2}\)A\(^{2}\)

(d) MLT\(^{2}\)A\(^{2}\)

Q.9 A current of 1.0 ampere is flowing in the sides of an equilateral triangle of side \( 4.5 \times 10^{-2} \) m. Find the magnetic field at the centroid of the triangle.

(Permeability constant \( \mu_0 = 4\pi \times 10^{-7} \) V-s/A-m).

(a) \( 4.0 \times 10^{-3} \) Weber/m\(^2\)

(b) \( 6.0 \times 10^{-3} \) Weber/m\(^2\)

(c) \( 2.0 \times 10^{-3} \) Weber/m\(^2\)

(d) \( 7.0 \times 10^{-12} \) Weber/m\(^2\)

Q.10 An air-solenoid has 500 turns of wire in its 40 cm length. If the current in the wire be 1.0 ampere then the magnetic field on the axis inside the solenoid is -

(a) 15.7 gauss

(b) 1.57 gauss

(c) 0.157 gauss

(d) 0.0157 gauss

Q.11 A solenoid of length 0.2m has 500 turns on it. If \( 8.71 \times 10^{-6} \) Weber/m\(^2\) be the magnetic field at an end of the solenoid, then the current flowing in the solenoid is –

(a) \( \frac{0.174}{\pi} \) A

(b) \( \frac{0.0174}{\pi} \) A

(c) \( \frac{17.4}{\pi} \) A

(d) \( \frac{174}{\pi} \) A

Q.12 A circular current carrying coil has a radius R. The distance from the centre of the coil on the axis where the magnetic induction will be \( \frac{1}{8} \)th to its value at the centre of the coil, is

(a) \( \frac{R}{3} \)

(b) \( R\sqrt{3} \)

(c) \( 2\sqrt{3}R \)

(d) \( \frac{2}{\sqrt{3}}R \)

Q.13 The average radius of an air cored made toroid is 0.1 m and it has 500 turns. If it carries 0.5 ampere current, then the magnetic field inside it is :

(a) \( 5 \times 10^{-4} \) tesla

(b) \( 5 \times 10^{-3} \) tesla

(c) \( 5 \times 10^{-2} \) tesla

(d) \( 2 \times 10^{-3} \) tesla

Q.14 The straight long conductors AOB and COD are perpendicular to each other and carry current \( i_1 \) and \( i_2 \). The magnitude of the magnetic induction at point P at a distance a from the point O in a direction perpendicular to the plane ACBD is

(a) \( \frac{\mu_0}{2\pi a} (i_1 + i_2) \)

(b) \( \frac{\mu_0}{2\pi a} (i_1 - i_2) \)

(c) \( \frac{\mu_0}{2\pi a} (i_1^2 + i_2^2)^{1/2} \)

(d) \( \frac{\mu_0}{2\pi a} (i_1^2 + i_2^2) \)

RESPONSE GRID

4. a b c d 5. a b c d 6. a b c d 7. a b c d 8. a b c d

9. a b c d 10. a b c d 11. a b c d 12. a b c d 13. a b c d

14. a b c d

Space for Rough Work
Q.15 A conducting circular loop of radius $r$ carries a constant current $i$. It is placed in a uniform magnetic field $\vec{B}$, such that $\vec{B}$ is perpendicular to the plane of the loop. The magnetic force acting on the loop is
(a) $ir\vec{B}$  (b) $2\pi ri\vec{B}$  (c) zero  (d) $\pi ri\vec{B}$

Q.16 The radius of a circular loop is $r$ and a current $i$ is flowing in it. The equivalent magnetic moment will be
(a) $ir$  (b) $2\pi ir$  (c) $i\pi r^2$  (d) $\frac{1}{r^2}$

Q.17 A current of 30 A is flowing in a vertical straight wire. If the horizontal component of earth's magnetic field is $2 \times 10^{-5}$ tesla then the distance of null point from wire is -
(a) 0.9 m  (b) 0.3 mm  (c) 0.3 cm  (d) 0.3 m

Q.18 A charged particle is released from rest in a region of steady uniform electric and magnetic fields which are parallel to each other. The particle will move in a
(a) Straight line  (b) Circle  (c) Helix  (d) Cycloid

Q.19 A 6.28m long wire is turned into a coil of diameter 0.2m and a current of 1 amp is passed in it. The magnetic induction at its centre will be -
(a) $6.28 \times 10^{-5}$ T  (b) 0 T  (c) 6.28 T  (d) $6.28 \times 10^{-3}$ T

DIRECTIONS (Q.20-Q.21) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :
(a) 1, 2 and 3 are correct  (b) 1 and 2 are correct
(c) 2 and 4 are correct  (d) 1 and 3 are correct

Q.20 Two long straight parallel wires carry currents $I_1$ and $I_2$, respectively, in the same direction (as shown). The distance between the wires is $R$. The magnetic field at the centre of the two wires will be-
(1) $\frac{\mu_0 (I_1 - I_2)}{\pi R}$ into the plane of paper (If $I_1 > I_2$)
(2) $\frac{\mu_0 (I_1 - I_2)}{\pi R}$ out of the plane of paper (if $I_2 > I_1$)
(3) $\frac{\mu_0 (I_2 - I_1)}{\pi R^2}$ out of the plane of paper (if $I_2 > I_1$)
(4) $\frac{\mu_0 (I_1 - I_2)}{\pi R^2}$ into the plane of paper (if $I_1 > I_2$)

Q.21 A wire of length L carrying current $I$ is bent into a circle of one turn. The field at the center of the coil is $B_1$. A similar wire of length L carrying current $I$ is bent into a square of one turn. The field at its center is $B_2$. Then
(1) $B_1 > B_2$  (2) $B_1 = B_2$  (3) $\frac{B_1}{B_2} = 2$  (4) $B_1 < B_2$

DIRECTIONS (Q.22-Q.24) : Read the passage given below and answer the questions that follows :

A conducting wire is bent into a loop as shown in the figure. The segment AOB is parabolic given by the equation $y^2 = 2x$ while segment BA is a straight line parallel to the $y$-axis.

The magnetic field in the region is $\vec{B} = -8 \hat{k}$ and the current in the wire is 2A.

Q.22 The torque on the loop will be
(a) $16\sqrt{2}$ Nm  (b) 16 Nm
(c) $18\sqrt{2}$ Nm  (d) Zero

Q.23 The field created by the current in the loop at point C will be
(a) $-\frac{\mu_0 I_2^2}{4\pi}$  (b) $-\frac{\mu_0 I_2^2}{2\pi}$
(c) $-\frac{\mu_0 \sqrt{2}}{\pi} \hat{k}$  (d) None of these

RESPONSE GRID

15. a b c d  16. a b c d  17. a b c d  18. a b c d  19. a b c d
20. a b c d  21. a b c d  22. a b c d  23. a b c d

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Space for Rough Work
Q.24 Magnetic field at point D due to segment AO of the loop is directed parallel to

(a) \( \hat{k} \)  (b) \( -\hat{k} \)  (c) \( \hat{i} \)  (d) \( \hat{j} \)

DIRECTIONS (Q. 25-Q.27): Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(c) Statement-1 is False, Statement-2 is True.
(d) Statement-1 is True, Statement-2 is False.

Q.25 Statement-1: Cyclotron does not accelerate electron.
Statement-2: Mass of the electron is very small.

Q.26 Statement-1: The ion cannot move with a speed beyond a certain limit in a cyclotron.
Statement-2: As velocity increases time taken by ion increases.

Q.27 Statement-1: If an electron, while coming vertically from outerspace, enter the earth's magnetic field, it is deflected towards west.
Statement-2: Electron has negative charge.
(1) (a) Force causing the acceleration = 400 – 200 = 200N
mass of the boy = 200/9.8
hence acceleration = F/m = \(\frac{200}{200} \times 9.8 = 9.8 \text{ m/s}^2\)

(2) (a) Acceleration = \(\frac{F}{m}\) in the direction of force and displacement
\[\vec{S} = \vec{u} + \frac{1}{2} \vec{a}t^2 = 0 + \frac{1}{2} \left( \frac{6i + 8j}{10} \right) \times 100 = 30i + 40j\]
So the displacement is 50 m along \(\arctan \frac{4}{3}\) with x-axis

(3) (a) From the law of conservation of momentum
\[1000 \times 5 + 0 = (1000 + 60) v\]
\[\Rightarrow v = \frac{1000 \times 5}{1060} = 4.71 \text{ m/s}\]

(4) (b) Weight of disc = \(\frac{10}{1000}\) kg.
Let speed of the bullet = v
So rate of change of momentum of the bullets
\[v = \text{applied force on the disc}\]
Now \[\frac{2 \times 10 \times 5}{1000} \times v = \frac{10 \times g}{1000}\]
\[\Rightarrow v = \frac{9.8 \text{ m/s}^2}{98 \text{ cm/s}^2}\]

(5) (c) Total mass = 80 + 40 = 120 kg
The rope cannot withstand this load so the fireman should slide down the rope with some acceleration.
\(\therefore\) The maximum tension = 100 \times 9.8 N
\[m (g – a) = \text{tension}\]
120(9.8 – a) = 100 \times 9.8 \Rightarrow a = 1.63 m/s^2

(6) (b) Suppose the velocity of the body at the instant it reaches the pile of sand be v. Then
\[v^2 = 0 + 2(9.8) \times (5 \text{ metre}) = 98(\therefore v^2 = u^2 + 2as)\]
\[a = -\frac{98}{2 \times (0.05)} = -980 \text{ m/sec}^2\]
Now, retarding force
\[F = \text{mass} \times \text{acceleration} = 0.02 \times (-980 \text{ m/sec}^2) = -19.6 \text{ N}\]

(7) (b) Impulse = F \cdot t = \text{Area under F-t curve from 4 \mu s to 16 \mu s} = \text{Area under BCDFB}
\[= \text{Area of trapezium BCEF + area of \triangle ACDE}\]
\[= \frac{1}{2} (200+800)(2 \times 10^{-6}) + \frac{1}{2} \times 10 \times 10^{-6} \times 800\]
\[= 10 \times 10^{-4} + 40 \times 10^{-4} \text{ N-s} = 50 \times 10^{-4}\]
\[= 5.0 \times 10^{-3} \text{ N-s}\]

(8) (a) The elevator having an initial upward speed of 8 m/sec is brought to rest within a distance of 16 m
Hence, \[0 = (8)^2 + 2a (16) \therefore v^2 = u^2 + 2as,\]
\[a = -\frac{8 \times 8}{2 \times 16} = -2 \text{ m/sec}^2\]
Resultant upward force on elevator = T – mg. According to Newton's law.
\[T – mg = ma\]
or \[T = mg + ma = m (g + a) = 1000 (9.8 -2) = 7800 \text{ N}\]
(b) Let P be the upward force exerted on the man by the elevator floor. If m' be the mass of the man, then, weight of the man acting downward = m'g.
Upward force on the man = P – m'g
According to Newton's law, \[P - m'g = m' a\]
or \[P = m' (a + g) = (-2 + 9.8) = 624 \text{ N}\]

(9) (d) As P and Q move down, the length \(\ell\) decreases at the rate of \(U \text{ m/s}\)

(10) (a) The engine, coach, coupling and resistance are shown in figure.

Driving force = 4500 N

Opposing force (Resistance) = \[\frac{(5 + 4)10^4}{100} = 900 \text{ N}\]
Resultant force = 4500 – 900 = 3600 N
Mass of engine and coach = 9 \times 10^4 kg
According to Newton's law, \[F = ma\]
or \[a = (3600) / (9 \times 10^4) = 0.04 \text{ m/sec}^2\]
So acceleration of the train = 0.04 m/sec^2
Now considering the equilibrium of the coach only, we have

\[ T - R = 4 \times 10^4 \times 0.04 \quad (\because F = ma) \]

or \( T - \frac{4 \times 10^4}{100} = 4 \times 10^4 \times 0.04 \),

\[ T = 4 \times 10^4 \times 0.04 + 4 \times 10^2 = 1600 + 400 = 2000 \text{ N} \]

(11) (d) Given that \( F_1 = (8\hat{i} + 10\hat{j}) \) and \( F_2 = (4\hat{i} + 8\hat{j}) \)

Then the total force \( \vec{F} = 12\hat{i} + 18\hat{j} \)

So acceleration \( \vec{a} = \frac{\vec{F}}{m} = \frac{12\hat{i} + 18\hat{j}}{6} = 2\hat{i} + 3\hat{j} \text{ m/sec}^2 \)

Net acceleration \( \vec{a} \cdot \vec{a} = \sqrt{2^2 + 3^2} = \sqrt{4 + 9} = \sqrt{13} \text{ m/sec}^2 \)

(12) (c) From the relation \( F = ma \) 

\[ \Rightarrow a = \frac{F}{m} = \frac{1000}{1000} = 1 \text{ m/sec}^2 \]

As the force is brake force, acceleration is \(-1 \text{ m/sec}^2\) using relation \( v^2 = u^2 + 2as \), we obtain

\[ 2as = u^2 \Rightarrow s = \frac{u^2}{2a} = \frac{\left(18 \times \frac{5}{18}\right)^2}{2} = 12.5 \text{ m} \]

(13) (a) The water jet striking the block at the rate of 1 kg/s at a speed of 5 m/s will exert a force on the block

\[ F = v \frac{dm}{dt} = 5 \times 1 = 5 \text{ N} \]

And under the action of this force of 5 N, the block of mass 2 kg will move with an acceleration given by,

\[ F = ma \Rightarrow a = \frac{F}{m} = \frac{5}{2} = 2.5 \text{ m/sec}^2 \]

(14) (a) Relative speed of the ball \( = (v + u) \)

Speed after rebouncing \( = -(v + u) \)

So, \( F = \frac{m \Delta v}{\Delta t} = \frac{m[v(v + u) - \{(v + u)]}{t} = \frac{2m(v + u)}{t} \)

(15) (b) \( F = \frac{dp}{dt} \Rightarrow F \, dt = dp = p_2 - p_1 \)

\[ \Rightarrow F \times 1 = m(v_2 - v_1) \]

\[ \Rightarrow F = mnv \]

(Total mass of the bullets fired in 1 sec = mn)

(16) (a) The initial momentum \( = 15 \times 10 = 150 \text{ kgm/sec} \) and

Force \( = \frac{\text{change in momentum}}{\text{time}} = \frac{0 - 150}{15} = -10 \text{ N} \)

A constant force of 10 N must be acting in opposite direction to the motion of the body.

(17) (a) The change in momentum in the final direction is equal to the impulse = \( \frac{250}{1000} \times 28 - \left(\frac{250}{1000} \times 24\right) = 13 \text{ Ns} \)

and force \( = \frac{\text{impulse}}{\text{time}} = \frac{13}{1/100} = 1300 \text{ N} \)

in the direction of the ball.

(18) (b) We know \( \vec{F} = \frac{dp}{dt} \Rightarrow F \, dt = dp \)

\[ \Rightarrow 2 \times 2 = dp \Rightarrow 4 = dp \]

Therefore change in momentum = 4 Ns

(19) (a) We know \( \vec{F} = \frac{dp}{dt} \)

\[ \Rightarrow F \, dt = dp = p_2 - p_1 = m(v_2 - v_1) \]

\[ \Rightarrow 4 \times 1 = 2 \times \vec{v}_2 = 2(\vec{i}) \]

\[ \Rightarrow 2 \vec{v}_2 - 4 \hat{j} = 2\vec{v}_2 - 2(2\hat{i}) = 4\hat{j} + 4\hat{i} \]

\[ \Rightarrow \vec{v}_2 = 2\hat{i} + 2\hat{j} \]

\[ \Rightarrow \vec{v}_2 = 2\sqrt{5} \text{ m/s} \]

(20) (c) Initial momentum of the ball

\[ = \frac{150}{1000} \times 12 = 1.8 \text{ kg.m/sec} \]

Final momentum of the ball = \( -\frac{150}{1000} \times 20 = -3.0 \text{ kg m/sec} \)

Change in momentum = 4.8 kg m/sec

Average force exerted = Impulse/ time = \( \frac{4.8}{0.1} = 480 \text{ N} \)

(21) (b) Initial momentum of the body = \( mu = 20 \times 3 = 60 \text{ m/gm/ sec} \)

and final momentum of the body = \( -mu = -20 \times 3 = -60 \text{ m/gm/ sec} \)

The change in momentum of body in initial direction = \(-60 - 60 = -120\)

The change in momentum imparted to the body in opposite direction = \(120\)

\[ \Rightarrow \text{The impulse imparted to the body = 120 Ns} \]

(22) (a) (1) Since the lift is moving down with an acceleration of 3 m/sec^2, then the inertial force \( F = ma \), acts upwards on the body

\[ F = ma = 20 \times 3 = 60 \text{ N} \]

\[ R \text{ mg} \]

Now, \( R + F = mg \)

or \( R = mg - F = mg - ma = m(g - a) = 60(9.8 - 3) = 408 \text{ N} \)

(2) When the lift is moving down with constant velocity \( a = 0 \) and hence, \( R = mg = 60 \times 9.8 = 588 \text{ N} \)

(3) The lift is now moving down with a retardation of
The retardation is 3 m/sec² in the downward direction is equivalent to an acceleration of 3 m/sec² upwards.

Hence the direction of fictitious force is downwards.

Now, \( R = mg + ma = m (g + a) = 60 \times 12.8 = 768 \text{ N} \)

(23) (b) When the lift is moving up \( m (g + a) = \text{force} \)

The scale reading = \( \frac{m(g + a)}{g} = \frac{10}{g} \left( g + \frac{g}{3} \right) \) = 13.3 kg

When lift is moving down the scale reading

\( \frac{m(g - a)}{g} = \frac{10}{g} \left( g - \frac{g}{3} \right) = 6.67 \text{ kg} \)

(24) (a)

(1) A reference frame in which Newton’s first law is valid is called an inertial reference frame.
(2) Frame moving at constant velocity relative to a known inertial frame is also an inertial frame.
(3) Ideally, no inertial frame exists in the universe for practical purpose, a frame of reference may be considered as inertial if its acceleration is negligible with respect to the acceleration of the object to be observed.
(4) To measure the acceleration of a falling apple, earth can be considered as an inertial frame.

(25) (a)

(i) In the case of constant velocity of lift, there is no reaction, therefore the apparent weight = actual weight. Hence the reading of machine is 50 kg wt.
(ii) In this case the acceleration is upward the reaction \( R = ma \) acts downward, therefore apparent weight is more than actual weight.

\[ \text{i.e. } W' = W + R = m (g + a) \]

Hence, scale show a reading of

\[ m (g + a) \text{ Newton} = \left( 50 + \frac{50g}{a} \right) \text{ kg wt} \]

(26) (a) Tension = \( m (g + a) \), when lift moving up, putting the values, we get

\[ 175 = 25(9.8 + a) \implies a = 2.8 \text{ m/s}^2 \]

[\text{negative sign shows that lift is moving downward}]

(27) (b) Apparent tension, \( T = 2T_0 \)

So, \( T = 2T_0 = T_0 \left( 1 + \frac{a_0}{g} \right) \)

or \( 2 = 1 + \frac{a_0}{g} \implies a_0 = g = 9.8 \text{ m/s}^2 \)

(28) (b) Cloth can be pulled out without dislodging the dishes from the table because of inertia. Therefore, statement- 1 is true.
This is Newton’s third law and hence true. But statement 2 is not a correct explanation of statement 1.

(29) (d) According to Newton’s second law

\[ \text{Acceleration} = \frac{\text{Force}}{\text{Mass}} \]

i.e. if net external force on the body is zero then acceleration will be zero.

(30) (c) \( F = \frac{dp}{dt} = \text{Slope of momentum-time graph} \)

i.e. Rate of change of momentum = Slope of momentum-time graph = force.
DAILY PRACTICE PROBLEMS

1. (a) We know magnetic field due to a long straight current carrying wire

\[ B = \frac{\mu_0 i}{2\pi r} = \frac{4\pi \times 10^{-7} \times 3}{2\pi \times 50 \times 10^{-3}} \]

(Note that \( \mu_0 = 4\pi \times 10^{-7} \) in SI system)

\[ = 1.20 \times 10^{-5} \text{ Tesla} = 0.12 \text{ G}. \]

[As 1 Gauss = 10^{-4} Tesla]

2. (c) The magnetic induction produced due to a current carrying arc at its centre of curvature is

\[ B = \frac{\mu_0 i a}{4\pi r} \]

(subtending angle \( \alpha \) at the centre of curvature)

\[ \Rightarrow B = \frac{\mu_0 i \alpha}{4\pi r} = \frac{\mu_0 i}{16r} \]

3. (a)

\[ \vec{B}_O = \vec{B}_{QRS} + \vec{B}_{ST}. \]

\[ \vec{B}_{PSQ} = \text{zero, } \vec{B}_{QRS} = \frac{3}{4} \times \frac{\mu_0 i}{2r}, \vec{B}_{ST} = \frac{\mu_0 i}{4r} \]

\[ \Rightarrow \vec{B}_O = \frac{\mu_0 i}{4\pi} \hat{k} + \frac{3}{4} \frac{\mu_0 i}{2r} \hat{k} = \frac{\mu_0 i}{4\pi} \left[ \frac{3\pi}{2} + 1 \right] \hat{k} \]

4. (a)

\[ \vec{B}_O = \vec{B}_{PSR} + \vec{B}_{PQR} \]

\[ \vec{B}_{PSR} = \frac{\mu_0 i}{4\pi} \left[ \frac{2\pi - 2\phi}{r} \right] = \frac{\mu_0 i}{2\pi r} \left[ \pi - \phi \right] (-\hat{k}) \]

\[ \vec{B}_{PQR} = \frac{\mu_0 i}{4\pi} \frac{2\sin \phi}{\sqrt{1 - \sin^2 \phi}} (-\hat{k}) = \frac{\mu_0 i}{2\pi r} \frac{2\sin \phi}{\cos \phi} = \frac{\mu_0 i}{2\pi r} \tan \phi (\hat{k}) \]

From eqs. (a), (b) and (c)

\[ \vec{B} = \frac{\mu_0 i}{2\pi r} \left[ \pi - \phi \right] (\hat{k}) + \frac{\mu_0 i}{2\pi r} \tan \phi (\hat{k}) \]

\[ = \frac{\mu_0 i}{2\pi r} (\pi - \phi + \tan \phi) (\hat{k}) \]

5. (a) The rotating rod is a current-loop whose radius \( a = 0.6 \text{ m}. \)

The magnetic field due to this current-loop at a point on its axis at a distance \( x \) from its centre is given by

\[ B = \frac{\mu_0 i a^2}{2(a^2 + x^2)^{3/2}} \]

Let \( T \) be the period of rotation of the rod. Then

\[ i = \frac{q}{T} = \frac{1 \text{ coulomb} \times 10^4 \pi / \text{ sec}}{2\pi} = 5 \times 10^3 \text{ amp}. \]

Now, \( a = 0.6 \text{ m, } x = 0.8 \text{ m and } \mu_0 = 4\pi \times 10^{-7} \text{ V} / \text{s} / \text{A} - \text{m}. \)

Substituting these values in eq. (i) we get

\[ B = \frac{(4\pi \times 10^{-7} \text{ V} / \text{s} / \text{A} - \text{m})(5 \times 10^3 \text{ A})(0.6\text{ m})^2}{2(0.36 + 0.64)^{3/2} \text{ m}^3} \]

\[ = 0.36\pi \times 10^{-3} = 1.13 \times 10^{-3} \text{ tesla} \]

In the second case the current remains the same because the rotating charge and the angular frequency are the same. However, the radius of the loop becomes half \( (a = 0.3 \text{ m}) \) and the distance \( x \) is now 0.4 m.

\[ \Rightarrow B = \frac{\mu_0 i a^2}{2(a^2 + x^2)^{3/2}} \]

\[ = \frac{(4\pi \times 10^{-7} \text{ V} / \text{s} / \text{A} - \text{m})(5 \times 10^3 \text{ A})(0.3\text{ m})^2}{2(0.09 + 0.16)^{3/2} \text{ m}^3} \]

\[ = 0.72 \times 10^{-3} \pi = 2.26 \times 10^{-3} \text{ tesla}. \]

6. (a) The magnetic field at the centre of a current carrying coil having \( n \) turns is given by

\[ B = \frac{\mu_0 ni}{2r} \text{ N/A.m} \]

where \( i \) is the current in the coil and \( r \) is the radius of the coil.

Here \( i = 0.1 \text{ A, } n = 1000 \text{ and } r = 0.1 \text{ m}. \)

\[ \Rightarrow B = \frac{(4\pi \times 10^{-7}) \times 1000 \times 0.1}{2 \times 0.1} = 6.28 \times 10^{-4} \text{ N/A.m} \]

7. (a) The two coils are perpendicular to each other. Coil 1 produces field along X axis and coil 2 produces field along Y axis. Thus the resultant field will be-

\[ B = \sqrt{B_1^2 + B_2^2} \text{ making an angle} \]

\[ \theta = \tan^{-1} \left( \frac{B_2}{B_1} \right) \text{ with } x \text{ axis} \]

As \( B_1 = B_2 = \frac{\mu_0 NI}{2a} \)

\[ \Rightarrow B = \sqrt{2} \left( \frac{\mu_0 NI}{2a} \right) = \frac{\mu_0 NI}{\sqrt{2}a} \text{ and } \theta = 45^\circ. \]
(8) (d) Applying ampere's law at P, Q and R respectively, we find that there is no current enclosed by the circle of P. So magnetic induction at P is zero while that at Q and R is non-zero.

(9) (a) For a current carrying coil

\[ B = \frac{\mu_0 i}{2R} \text{ at centre and force on a current carrying conductor is} \]

\[ F = i \ell B \Rightarrow F = \frac{\mu_0 i^2 \ell}{2R} \]

\[ \Rightarrow [\text{MLT}^{-2}] = [\frac{\mu_0 [A^2][L]}{[L]}] \]

\[ \Rightarrow [\mu_0] = [\text{MLT}^{-2} A^{-2}] \]

(10) (c) By Biot Savart Law,

\[ \delta B = \frac{\mu_0 i \delta \ell \sin \theta}{4\pi \ell^2} \]

When \( \theta = 90^\circ \), then \( \sin 90^\circ = 1 \) = maximum

\[ \therefore \delta B = \frac{\mu_0 i \delta \ell}{4\pi \ell^2} = \text{maximum} \]

(11) (a) The magnitude of the magnetic field at the centroid O of the triangle due to a side PQ (say) is

\[ B = \frac{3\mu_0 i}{4\pi r} (\sin \phi_1 + \sin \phi_2) \]

Where \( r \) is the perpendicular distance of PQ from O, and \( \phi_1, \phi_2 \) the angles as shown. The field is perpendicular to the plane of paper and is directed into plane of paper. Since the magnetic field due to each of the three sides is the same in magnitude and direction, the magnitude of the resultant field at O is

\[ B = \frac{3\mu_0 i}{4\pi r} \]

Here \( i = 1 \) ampere, \( \phi_1 = \phi_2 = 60^\circ \)

and \( r = \frac{l}{2} \cot 60^\circ = \frac{l}{2} \times \frac{1}{\sqrt{3}} \)

and \( l \) is the side of the triangle (= 4.5 \times 10^{-2} meter).

\[ \therefore B = \frac{3 \times 10^{-7} \times 1.0}{\left(\frac{l}{2} \times \frac{4.5 \times 10^{-2}}{\sqrt{3}}\right)} \left(\frac{\sqrt{3}}{2} + \frac{\sqrt{3}}{2}\right) \]

\[ = \frac{3 \times 10^{-7} \times 2 \times 3}{4.5 \times 10^{-2}} = 4.0 \times 10^{-5} \text{ weber/m}^2. \]

(12) (a) The magnetic field inside (near centre) a current carrying solenoid having \( n \) turns per unit length is given by

\[ B = \frac{\mu_0 n i}{2\pi r} \text{ newton/(ampere-meter)}, \]

where \( i \) (ampere) is the current in the solenoid and \( \mu_0 = 4\pi \times 10^{-7} \text{ newton/ampere}^2 \).

Here \( n = \frac{500}{0.40} = 1250 \text{ per meter} \), \( i = 1.0 \) amp.

\[ \therefore B = (4 \times 3.14 \times 10^{-7}) \times 1250 \times 1.0 \]

\[ = 15.7 \times 10^{-4} \text{ newton/(ampere-meter)} = 15.7 \text{ gauss}. \]

(13) (b) We know, \( B_{\text{end}} = \frac{\mu_0 ni}{2} \)

Here \( n = \frac{500}{0.2} = 2500/\text{metre} \),

\[ i = \frac{2B_{\text{end}}}{\mu_0 n} = \frac{2 	imes 8.71 \times 10^{-6}}{4\pi \times 10^{-7} \times 2500} \]

\[ = \frac{17.42 \times 10^{-3}}{\pi} = 0.01742 \text{ amp} \]

(14) (b) centre

\[ B = \frac{3}{2} \left(\frac{x}{R}\right)^2 \]

\[ \text{also } B_{\text{axis}} = \frac{1}{2} B_{\text{centre}} \]

\[ \Rightarrow \frac{x}{R} = \frac{3}{2} \left(\frac{1}{2 R}\right)^2 \]

\[ \Rightarrow x = \frac{3}{2} R \]

(15) (a) \( B_0 = \frac{\mu_0 N i}{2\pi R} \)

\[ = \frac{4\pi \times 10^{-7} \times 500 \times 0.5}{2\pi \times 0.1} = 5 \times 10^{-4} \text{ tesla} \]

(16) (c) At P : \( B_{\text{net}} = \sqrt{B_1^2 + B_2^2} \)

\[ = \sqrt{\left(\frac{\mu_0 2i_1}{4\pi a}\right)^2 + \left(\frac{\mu_0 2i_2}{4\pi a}\right)^2} \]

\[ = \frac{\mu_0}{2\pi a} \left(\frac{l_1^2 + l_2^2}{2}\right)^{1/2} \]
Current distribution in the network is as shown. Now, consider the pair of wires AB and GH. As current in these wires produce equal but opposite magnetic fields at centre O of the cube, resultant field due to the pair is zero.

We can see five such more pairs namely:
(i) AE, CG
(ii) AD, FI
(iii) BC, EH
(iv) EF, DC
(v) BF, OH
Magnetic field due to each of these pairs is zero. Therefore, resultant magnetic field at centre O is zero.

Magnetic field inside a solid cylinder of current is

\[ B_{\text{inside}} = \frac{\mu_0 i r}{2\pi R^2} \]

\[ \Rightarrow B_0 = \frac{\mu_0 i R}{2\pi R^2} \quad \text{(as per given information)} \]

Magnetic field outside a solid cylinder of current is

\[ B_{\text{outside}} = \frac{\mu_0 i}{2\pi r} \]

\[ \Rightarrow B_{\text{outside}} \quad \text{at a distance} \quad 2R = \frac{\mu_0 (4B_0 \pi R)}{2\pi (2R)} = B_0 \]

As per sense of transversal,

\[ i_{\text{crossing}} = I_1 - I_2 - I_3 \]

By Ampere's law, \( \oint B \cdot d\vec{c} = \mu_0 i_{\text{crossing}} \)

\[ \Rightarrow \oint B \cdot d\vec{c} = \mu_0 (I_2 - I_1 - I_3) \]

\[ \ell = (2\pi r) \quad \text{ nor } \quad n = \frac{\ell}{2\pi r} \]

\[ B = \frac{\mu_0 n i}{2r} = \frac{\mu_0 i}{4\pi r^2} \]

\[ \text{or} \quad B = \frac{4\pi \times 10^{-7} \times 6.28 \times 1}{2 \times 2 \times 2 \times (0.10)^2} = 6.28 \times 10^{-5} \text{ Tesla.} \]

The arrangement is shown in fig.

The magnetic field at a point P in between the two wires is

\[ \vec{B} = \vec{B}_1 + \vec{B}_2. \]

The field \( \vec{B}_1 \) (due to current \( I_1 \)) points down while \( \vec{B}_2 \) (due to current \( I_2 \)) points upwards. Thus field at point P is-

\[ B = \frac{\mu_0 [I_1 - I_2]}{2\pi (R-x)} \quad \text{in to the plane of paper.} \]

At \( x = R/2 \),

\[ B = \frac{\mu_0 (I_1 - I_2)}{\pi R} \quad \text{into the plane of paper, (if} \ I_1 > I_2) \]

\[ \text{or} \quad B = \frac{\mu_0 (I_2 - I_1)}{\pi R} \quad \text{out of the plane of paper (if} \ I_2 > I_1) \]

For circular coil \( B_1 = \frac{\mu_0 I}{2r} \)

Circumference of the coil = \( 2\pi r = L \).

\[ B_1 = \frac{\pi \mu_0 I}{L} = 3.14 \mu_0 I/L \]

Circumference of the coil = \( 2\pi r = L \).

\[ B_1 = \frac{\pi \mu_0 I}{L} = 3.60 \mu_0 I/L \]

Thus \( B_1 < B_2 \).

Since \( \vec{M} \parallel \vec{B} \), Torque = \( \vec{M} \times \vec{B} \) is zero.

The field must be in + \( \hat{k} \) direction.

The statements are independently correct.

\[ \vec{r} = \vec{m} \times \vec{B} \Rightarrow \vec{r} = 0 \quad \text{for} \ \theta = 0^o, 180^o. \]