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## Disclaimer

[^1]- There will be three papers of Multiple Choice Questions (MCQs) in 'Mathematics', 'Physics and Chemistry' and 'Biology' of 100 marks each. Duration of each paper will be 90 minutes.
- Questions will be based on the syllabus prescribed by Maharashtra State Board of Secondary and Higher Secondary Education with approximately $20 \%$ weightage given to Std. XI and $80 \%$ weightage will be given to Std. XII curriculum.
- Difficulty level of questions will be at par with JEE (Main) for Mathematics, Physics, Chemistry and at par with NEET for Biology.
- There will be no negative marking.
- Questions will be mainly application based.
- Details of the papers are as given below:

| Paper | Subject(s) | No. of <br> MCQs based on |  | Mark(s) <br> Per Question | Total <br> Marks | Duration in <br> Minutes |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | (10per I | Mathematics | 10 | 40 | 2 |
| 100 | 90 |  |  |  |  |  |
| Paper II | Physics | 10 | 40 | 1 | 100 | 90 |
|  | Chemistry | 10 | 40 | 1 | 100 | 90 |
| Paper III | Biology | 20 | 80 | 1 | 100 |  |

- Chapters / units from Std. XI curriculum:

| Sr.no | Subject | Chapters/Units of Std. XI |
| :---: | :---: | :--- |
| 1 | Physics | Motion in a Plane, Laws of Motion, Gravitation, Thermal Properties of <br> Matter, Sound, Optics, Electrostatics, Semiconductors |
| 2 | Chemistry | Some Basic Concepts of Chemistry, Structure of Atom, Chemical <br> Bonding, Redox Reactions, Elements of Group 1 and Group 2, States of <br> Matter (Gaseous and Liquid States), Adsorption and Colloids (Surface <br> Chemistry), Hydrocarbons, Basic Principles of Organic Chemistry |
| 3 | Mathematics | Trigonometry II, Straight Line, Circle, Measures of Dispersion, <br> Probability, Complex Numbers, Permutations and Combinations, <br> Functions, Limits, Continuity |
| 4 | Biology | Biomolecules, Respiration and Energy Transfer, Human Nutrition, <br> Excretion and Osmoregulation |

- Language of Question Paper:

The medium for examination shall be English / Marathi / Urdu for Physics, Chemistry and Biology. Mathematics paper shall be in English only.

- Duration of Examination:

The duration of the examination for PCB is 180 minutes and PCM is 180 minutes.

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Motion in a Plane

## 01

1. While plotting graph, independent variable (i.e., time) is plotted along $\qquad$ .
(A) $x$-axis
(B) $y$-axis
(C) $\quad \mathrm{z}$-axis
(D) negative z -axis
2. An electron travelling with a speed of $8 \times 10^{3} \mathrm{~m} / \mathrm{s}$ passes through an electric field with an acceleration of $10^{12} \mathrm{~m} / \mathrm{s}^{2}$. How long will it take for electron triple its speed?
(A) $1.6 \times 10^{-8} \mathrm{~s}$
(B) $0.6 \times 10^{-10} \mathrm{~s}$
(C) $5 \times 10^{-9} \mathrm{~s}$
(D) $16 \times 10^{-10} \mathrm{~s}$
3. A ball is dropped vertically from a height d above the ground. It hits the ground and bounces up vertically to a height $\mathrm{d} / 2$. Neglecting subsequent motion and air resistance, its velocity v varies with the height h above the ground as
(A)

(B)

(C)

(D)

4. The angular velocity of a wheel is $60 \mathrm{rad} / \mathrm{s}$. If the radius of the wheel is 0.3 m , then linear velocity of the wheel is
(A) $18 \mathrm{~m} / \mathrm{s}$
(B) $15 \mathrm{~m} / \mathrm{s}$
(C) $35 \mathrm{~m} / \mathrm{s}$
(D) $28 \mathrm{~m} / \mathrm{s}$
5. A particle is moving on a circular path with constant speed, then its acceleration will be
(A) zero.
(B) external radial acceleration.
(C) internal radial acceleration.
(D) constant acceleration.
6. If a car travelling at $72 \mathrm{~km} / \mathrm{h}$ overtakes another car travelling at $40 \mathrm{~km} / \mathrm{h}$, the relative velocity of first car with respect to another car is
(A) $-18 \mathrm{~km} / \mathrm{h}$
(B) $32 \mathrm{~km} / \mathrm{h}$
(C) $98 \mathrm{~km} / \mathrm{h}$
(D) $112 \mathrm{~km} / \mathrm{h}$
7. The angle of projection for a projectile thrown perpendicular to horizontal is
(A) $90^{\circ}$
(B) $60^{\circ}$
(C) $45^{\circ}$
(D) $0^{\circ}$
8. A particle shows distance-time curve as shown in the figure. The slope of the particle is maximum at
(A) P
(B) S
(C) R
(D) Q

9. A shell is fired at an angle of $60^{\circ}$ to the horizontal with velocity $115.4 \mathrm{~m} / \mathrm{s}$. The time of flight is
(A) 6.5 s
(B) 12.8 s
(C) 16.5 s
(D) 20.4 s
10. A boat is moving with velocity of $2 \hat{i}+5 \hat{j}$ in river and water is moving with a velocity of $-2 \hat{i}-5 \hat{j}$ with respect to ground. Relative velocity of boat with respect to water is
(A) $-4 \hat{i}-10 \hat{j}$
(B) $4 \hat{i}+10 \hat{j}$
(C) $8 \hat{\mathrm{i}}$
(D) $6 \hat{i}$
11. Which of the following is NOT an example of a projectile?
(A) Aeroplane in flight.
(B) A bullet fired from the gun.
(C) A hammer thrown by an athlete.
(D) A stone thrown from the top of the building.
12. If the equation of a projectile is $y=x-\frac{\mathrm{gx}^{2}}{2}$, then the angle of projection is
(A) $80^{\circ}$
(B) $60^{\circ}$
(C) $45^{\circ}$
(D) $30^{\circ}$
13. An athlete completes one round of a circular track of radius R in 50 s . What will be his displacement at the end of 2 min 30 s ?
(A) zero
(B) 2 R
(C) $2 \pi R$
(D) $7 \pi R$
14. A shell is fired from canon with a velocity of $300 \mathrm{~m} / \mathrm{s}$ at an angle of $45^{\circ}$ with the horizontal. The horizontal range attained by it is ( $\mathrm{g}=10 \mathrm{~ms}^{-2}$ )
(A) $2 \times 10^{2} \mathrm{~m}$
(B) $9 \times 10^{3} \mathrm{~m}$
(C) $4 \times 10^{4} \mathrm{~m}$
(D) $8 \times 10^{3} \mathrm{~m}$
15. A cricketer can throw a ball to a maximum horizontal distance of 120 m . How much high above the ground can the cricketer throw the same ball?
(A) 100 m
(B) 75 m
(C) 30 m
(D) 25 m
16. A person travels along a straight road due east for the first half distance with speed $v_{1}$ and the second half distance with speed $v_{2}$, the average speed of the person is
(A) $\frac{v_{1}+v_{2}}{2}$
(B) $\frac{\mathrm{v}_{1}}{2}+\frac{\mathrm{v}_{2}}{2}$
(C) $\frac{v_{1}+v_{2}}{2 v_{1} v_{2}}$
(D) $\frac{2 \mathrm{v}_{1} \mathrm{v}_{2}}{\mathrm{v}_{1}+\mathrm{v}_{2}}$
17. The height $y$ and the distance $x$ along the horizontal, for a body projected in the vertical plane are given by $y=4 t-10 t^{2}$ and $x=6 t$, the initial velocity at $t=0$ of the body is
(A) $12 \sqrt{3} \mathrm{~m} / \mathrm{s}$
(B) $2 \sqrt{13} \mathrm{~m} / \mathrm{s}$
(C) $3 \sqrt{5} \mathrm{~m} / \mathrm{s}$
(D) $2 \sqrt{19} \mathrm{~m} / \mathrm{s}$
18. The speed of a boat is $10 \mathrm{~km} / \mathrm{hr}$ in still water. It crosses a river of width 2 km along the shortest possible path in 20 minutes. The velocity of the river water is nearly
(A) $1 \mathrm{~km} / \mathrm{hr}$
(B) $3 \mathrm{~km} / \mathrm{hr}$
(C) $4 \mathrm{~km} / \mathrm{hr}$
(D) $5 \mathrm{~km} / \mathrm{hr}$
19. A particle covers 50 m distance when projected with an initial speed. On the same surface it will cover a distance, when projected with four times the initial speed
(A) 100 m
(B) 150 m
(C) 800 m
(D) 250 m
20. A ball is kicked at an angle of $30^{\circ}$ with the vertical. If the horizontal component of its velocity is $24.6 \mathrm{~m} \mathrm{~s}^{-1}$. The maximum height is
(A) 135.8 m
(B) 92.6 m
(C) 39.2 m
(D) 60 m
21. If a tension in a string is 4.2 N . A load at the lower end of a string is 0.2 kg , the length of string is 8 m then find its angular velocity
( $\mathrm{g}=10 \mathrm{~m} / \mathrm{s}^{2}$ )
(A) $0.12 \mathrm{rad} / \mathrm{s}$
(B) $3.42 \mathrm{rad} / \mathrm{s}$
(C) $1.62 \mathrm{rad} / \mathrm{s}$
(D) $1.43 \mathrm{rad} / \mathrm{s}$
22. A proton of mass $1.6 \times 10^{-27} \mathrm{~kg}$ goes round in a circular orbit of radius 0.10 m under a centripetal force of $6 \times 10^{-13} \mathrm{~N}$. The frequency of revolution of the proton is about
(A) $0.1 \times 10^{8}$ cycles per s
(B) $4 \times 10^{8}$ cycles per s
(C) $8 \times 10^{8}$ cycles per s
(D) $12 \times 10^{8}$ cycles per s
23. An object moving with a speed of $12.25 \mathrm{~m} / \mathrm{s}$, is decelerated at a rate given by $\frac{\mathrm{dv}}{\mathrm{dt}}=-2.5 \sqrt{\mathrm{v}}$ where v is the instantaneous speed. The time taken by the object, to come to rest, would be
(A) 1.2 s
(B) 2.8 s
(C) 4.3 s
(D) 8.4 s
24. A small coin is kept at the rim of a horizontal circular disc which is set into rotation about vertical axis passing through its centre. If radius of the disc is 8 cm and $\mu_{\mathrm{s}}=0.4$, then the angular speed at which the coin will just slip is
(A) $5 \mathrm{rad} / \mathrm{s}$
(B) $7 \mathrm{rad} / \mathrm{s}$
(C) $10 \mathrm{rad} / \mathrm{s}$
(D) $4.9 \mathrm{rad} / \mathrm{s}$
25. A particle first accelerates from rest and then retards to rest during the time interval of 12 s . If the retardation is 2 times the acceleration, then the time for which it accelerated is
(A) 2 s
(B) 3 s
(C) 4 s
(D) 8 s
26. A large number of bullets are fired in all directions with a speed of $150 \mathrm{~m} / \mathrm{s}$. What is the maximum area on the ground on which these bullets will $\operatorname{spread}\left(\right.$ Take $\left.g=10 \mathrm{~m} / \mathrm{s}^{2}\right)$
(A) $3 \times 10^{7} \mathrm{~m}^{2}$
(B) $1.6 \times 10^{7} \mathrm{~m}^{2}$
(C) $1.2 \times 10^{7} \mathrm{~m}^{2}$
(D) $8 \times 10^{7} \mathrm{~m}^{2}$
27. The angle between velocity and acceleration of a particle describing uniform circular motion is
(A) $180^{\circ}$
(B) $90^{\circ}$
(C) $45^{\circ}$
(D) $60^{\circ}$
28. The velocity of a projectile at the initial point A is $(3 \hat{\mathrm{i}}+4 \hat{\mathrm{j}}) \mathrm{m} / \mathrm{s}$. Its velocity (in $\mathrm{m} / \mathrm{s}$ ) at point $B$ is
(A) $-3 \hat{\mathrm{i}}-4 \hat{\mathrm{j}}$
(B) $-3 \hat{\mathrm{i}}+4 \mathrm{j}$
(C) $3 \hat{\mathrm{i}}-4 \hat{\mathrm{j}}$
(D) $3 \hat{i}+4 j$

29. A particle is moving with constant acceleration and $v_{1}, v_{2}$ and $v_{3}$ are the average velocities of the particle in three successive intervals $t_{1}, t_{2}$ and $t_{3}$. Which of the following relations will be correct?
(A) $\frac{v_{1}-v_{3}}{v_{2}-v_{3}}=\frac{t_{1}-t_{2}}{t_{2}+t_{3}}$
(B) $\frac{v_{1}-v_{2}}{v_{2}-v_{3}}=\frac{t_{1}-t_{2}}{t_{1}-t_{3}}$
(C) $\frac{v_{1}-v_{2}}{v_{2}-v_{3}}=\frac{t_{1}-t_{2}}{t_{2}-t_{3}}$
(D) $\frac{v_{1}-v_{2}}{v_{2}-v_{3}}=\frac{t_{1}+t_{2}}{t_{2}+t_{3}}$
30. The horizontal distance x and the vertical height $y$ of a projectile at a time $t$ are given by $x=a t$ and $\mathrm{y}=\mathrm{bt}^{2}+\mathrm{ct}$ where $\mathrm{a}, \mathrm{b}$ and c are constants. The magnitude of the velocity of the projectile 1 second after it is fired is
(A) $\left[\mathrm{a}^{2}+(2 \mathrm{~b}+\mathrm{c})^{2}\right]^{1 / 2}$
(B) $\left[2 \mathrm{a}^{2}+(\mathrm{b}+\mathrm{c})^{2}\right]^{1 / 2}$
(C) $\left[2 a^{2}+(2 b+c)^{2}\right]^{1 / 2}$
(D) $\left[\mathrm{a}^{2}+(\mathrm{b}+2 \mathrm{c})^{2}\right]^{1 / 2}$
31. A ball is rolled off the edge of a horizontal table at a speed of $6 \mathrm{~m} /$ second. It hits the ground after 0.3 second. Which statement given below is true?
(A) It hits the ground at a horizontal distance 2.6 m from the edge of the table.
(B) The speed with which it hits the ground is $4.0 \mathrm{~m} /$ second.
(C) Height of the table is 0.45 m .
(D) It hits the ground at an angle of $60^{\circ}$ to the horizontal.
32. When a body is projected vertically up from the ground, its velocity is reduced to $\left(\frac{1}{4}\right)^{\text {th }}$ of its initial value at height $y$ above the ground. The maximum height reached by the body is
(A) $\frac{3}{4 y}$
(B) $\frac{8 y}{15}$
(C) $\frac{9 y}{16}$
(D) $9 y$
33. The length of the string of a conical pendulum is 20 m and it has a bob of mass 30 g . The angle that the string makes with the vertical is $30^{\circ}$. If the bob covers one revolution in 3 s , then the corresponding centripetal force acting on the bob will be
(A) 10 N
(B) $\quad 1.3 \mathrm{~N}$
(C) $\quad 1.5 \mathrm{~N}$
(D) 5 N
34. The maximum height attained by projectile is increased by $20 \%$ by changing the angle of projection, without changing the speed of projection. The percentage increase in the time of flight will be
(A) $20 \%$
(B) $15 \%$
(C) $10 \%$
(D) $5 \%$
35. A river is flowing from west to east at a speed of $5 \mathrm{~m} / \mathrm{min}$. In what direction should a man on the south bank of the river, capable of swimming at $15 \mathrm{~m} / \mathrm{min}$ in still water, swim to cross the river in the shortest time?
(A) East - North
(B) West - North
(C) South - West
(D) North - West
36. A projectile can have the same range R for two angles of projection. If $t_{1}$ and $t_{2}$ are the times of flight in the two cases, then the product of the two time of flight is proportional
(A) $\mathrm{R}^{2}$
(B) $\frac{1}{\mathrm{R}^{2}}$
(C) $\frac{1}{\mathrm{R}}$
(D) R
37. A body thrown with an initial speed of $80 \mathrm{ft} / \mathrm{s}$ reaches the ground after $\left(\mathrm{g}=32 \mathrm{ft} / \mathrm{s}^{2}\right)$
(A) 3 s
(B) 5 s
(C) 12 s
(D) 8 s
38. A particle is moving with velocity $8 \mathrm{~m} / \mathrm{s}$ towards east and its velocity changes to $8 \mathrm{~m} / \mathrm{s}$ north in 20 s . Find the acceleration.
(A) $\sqrt{2} \mathrm{~N}-\mathrm{W}$
(B) $\frac{1}{\sqrt{2}} \mathrm{~N}-\mathrm{W}$
(C) $\frac{1}{\sqrt{2}} \mathrm{~N}-\mathrm{E}$
(D) $\frac{2 \sqrt{2}}{5} \mathrm{~N}-\mathrm{E}$
39. A ball is dropped from a highly raised platform at $t=0$ starting from rest. After 9 second another ball is thrown downwards from the same platform with a speed v. The two balls meet at $t=20 \mathrm{~s}$. What is the value of v ?
(Take $\mathrm{g}=10 \mathrm{~m} / \mathrm{s}^{2}$ )
(A) $126.8 \mathrm{~m} / \mathrm{s}$
(B) $132.5 \mathrm{~m} / \mathrm{s}$
(C) $129.6 \mathrm{~m} / \mathrm{s}$
(D) $140 \mathrm{~m} / \mathrm{s}$
40. A particle starts from rest, accelerates at $3 \mathrm{~m} \mathrm{~s}^{-2}$ for 20 s and then goes for constant speed for 30 s and then decelerates at $4 \mathrm{~m} \mathrm{~s}^{-2}$ till it stops. The distance travelled is
(A) 2850 m
(B) 2200 m
(C) 2750 m
(D) 2500 m

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1. When a car moves towards east 40 m then towards south 40 m , later on towards west 40 m , finally towards north 40 m , the displacement of the car in magnitude is
(A) 200 m
(B) 100 m
(C) 50 m
(D) zero
2. An aircraft is moving with a velocity of $280 \mathrm{~ms}^{-1}$. If all the forces acting on it are balanced, then
(A) it will fall down instantaneously.
(B) it will lose its velocity gradually.
(C) it still moves with the same velocity.
(D) It will be just floating at the same point in space.
3. A train covers the first half of the distance between two stations at the speed of $60 \mathrm{~km} \mathrm{~h}^{-1}$ and the other half at $80 \mathrm{~km} \mathrm{~h}^{-1}$. Its average speed is
(A) $68.57 \mathrm{~km} \mathrm{~h}^{-1}$
(B) $42.6 \mathrm{~km} \mathrm{~h}^{-1}$
(C) $152 \mathrm{~km} \mathrm{~h}^{-1}$
(D) $52.8 \mathrm{~km} \mathrm{~h}^{-1}$
4. The diameters of two planets are in the ratio $5: 2$ and their mean densities in the ratio $3: 2$. The acceleration due to gravity on the planets will be in the ratio
(A) $15: 4$
(B) $12: 13$
(C) $22: 13$
(D) $10: 6$
5. If the distance between two masses is tripled, gravitational attraction between them
(A) is tripled.
(B) becomes nine times.
(C) is reduced to three times.
(D) is reduced to nine times.
6. The value of gravitational acceleration at a height equal to twice the radius of earth, is
(A) $50 \%$ of value at earth's surface.
(B) $25 \%$ of value at earth's surface.
(C) $11 \%$ of value at earth's surface.
(D) same as value at earth's surface.
7. A body projected vertically upwards with a velocity of $u$ returns to the starting point in 10 second. If $g=9.8 \mathrm{~m} \mathrm{~s}^{-2}$, the value of ' $u$ ' is
(A) $60 \mathrm{~m} / \mathrm{s}$
(B) $30.4 \mathrm{~m} / \mathrm{s}$
(C) $49 \mathrm{~m} / \mathrm{s}$
(D) $15 \mathrm{~m} / \mathrm{s}$
8. The CORRECT statement about Newton's second law of motion is
(A) It provides the measure of inertia.
(B) It measures the action reaction force.
(C) It relates force and momentum.
(D) It measure the work done.
9. $\left[\mathrm{M}^{0} \mathrm{~L}^{2} \mathrm{~T}^{-2}\right]$ are dimensions of $\qquad$ .
(A) gravitational potential
(B) gravitational gradient
(C) universal gravitational constant
(D) none of the above
10. Choose the correct relation for gravitational acceleration at latitude $\theta$.
(A) $g-R^{2} \omega^{2} \cos \theta$
(B) $\mathrm{g}-\mathrm{R}^{2} \omega \cos ^{2} \theta$
(C) $\mathrm{g}-\mathrm{R}^{2} \omega^{2} \cos ^{2} \theta$
(D) $g-R \omega^{2} \cos ^{2} \theta$
11. A thief is running away on a straight road in jeep moving with a speed of $10 \mathrm{~m} \mathrm{~s}^{-1}$. A police man chases him on a motor cycle moving at a speed of $15 \mathrm{~ms}^{-1}$. If the instantaneous separation of the jeep from the motorcycle is 200 m , how long will it take for the police to catch the thief?
(A) 1 s
(B) 19 s
(C) 40 s
(D) 100 s
12. A cyclist comes to skidding spot in 20 m . If the opposing force on the cycle due to the road is 250 N. The work done by the road on the cycle is

(A) 5000 J
(B) $\quad-5000 \mathrm{~J}$
(C) 1000 J
(D) -1000 J
13. A 50 kg shell is flying at $40 \mathrm{~m} / \mathrm{s}$. When it explodes, its one part of 25 kg stops, while the remaining part flies on with velocity
(A) $80 \mathrm{~m} \mathrm{~s}^{-1}$
(B) $100 \mathrm{~m} \mathrm{~s}^{-1}$
(C) $60 \mathrm{~m} \mathrm{~s}^{-1}$
(D) $48 \mathrm{~m} \mathrm{~s}^{-1}$
14. How much energy will be required if a mass of 5 quintal escapes from the earth?
$\left(\mathrm{R}_{\mathrm{e}}=6.4 \times 10^{6} \mathrm{~m}, \mathrm{~g}=10 \mathrm{~ms}^{-2}\right)$
(A) $32 \times 10^{9}$ joule
(B) $64 \times 10^{9}$ joule
(C) $1.6 \times 10^{9}$ joule
(D) $80 \times 10^{9}$ joule
15. The path followed by projectile is called
(A) ellipse
(B) projection
(C) trajectory
(D) parabola
16. The period of revolution of planet $A$ around the Sun is 12 times that of B. The distance of A from the Sun is $n$ times greater than the distance of $B$ from the sun. The value of $n$ is
(A) 5.24
(B) 8.69
(C) 12.44
(D) 16.09
17. Which of the following graph cannot be velocity-time graph?
(A)

(B)

(C)

(D)

18. The unit of torque is same as $\qquad$ .
(A) power
(B) acceleration
(C) momentum
(D) work
19. Position of a particle at any instant $t$ is given by $\vec{r}=4 t \hat{i}+2 t^{2} \hat{j}+5 \hat{k}$. Its velocity at same instant will be
(A) $4 t \hat{i}+5 k \hat{j}$
(B) $3 \hat{\mathrm{i}}+4 \hat{\mathrm{j}}+5 \hat{\mathrm{k}}$
(C) $4 \hat{i}+4 t \hat{j}$
(D) $3 t \hat{i}+4 t \hat{j}$
20. The value of universal gravitational constant G in C.G.S. system is
(A) $6.67 \times 10^{-5}$
(B) $6.67 \times 10^{-8}$
(C) $6.67 \times 10^{-9}$
(D) $6.67 \times 10^{-13}$
21. The centre of gravity for a circular ring lies
(A) away from the ring.
(B) at the geometrical centre.
(C) on the edge of the ring.
(D) none of the above.
22. A bomb is fired from a cannon with a velocity of $1500 \mathrm{~m} / \mathrm{s}$ making an angle of $30^{\circ}$ with the horizontal. What is the time taken by the bomb to reach the highest point?
(A) 77 s
(B) 23 s
(C) 38 s
(D) 51 s
23. A body of mass 4 kg , travelling at $8 \mathrm{~m} / \mathrm{s}$ makes a head-on collision with a body of mass 2 kg travelling in the opposite direction with a velocity of $3 \mathrm{~m} / \mathrm{s}$, the velocities of the two bodies after collision are
(A) $\mathrm{v}_{1}=6.8 \mathrm{~m} / \mathrm{s}, \mathrm{v}_{2}=12.2 \mathrm{~m} / \mathrm{s}$
(B) $\mathrm{v}_{1}=0 \mathrm{~m} / \mathrm{s}, \mathrm{v}_{2}=0 \mathrm{~m} / \mathrm{s}$
(C) $\mathrm{v}_{1}=0.6 \mathrm{~m} / \mathrm{s}, \mathrm{v}_{2}=11.8 \mathrm{~m} / \mathrm{s}$
(D) $\mathrm{v}_{1}=6 \mathrm{~m} / \mathrm{s}, \mathrm{v}_{2}=0 \mathrm{~m} / \mathrm{s}$
24. If both the mass and radius of Earth decrease by $4 \%$, the value of acceleration due to gravity will decrease by nearly
(A) $4 \%$
(B) $8 \%$
(C) $2 \%$
(D) $16 \%$
25. The value of ' $g$ ' at a depth of 160 km will be (Radius of earth $=6400 \mathrm{~km}$ )
(A) $990 \mathrm{~cm} / \mathrm{s}^{2}$
(B) $986 \mathrm{~cm} / \mathrm{s}^{2}$
(C) $978 \mathrm{~cm} / \mathrm{s}^{2}$
(D) $955 \mathrm{~cm} / \mathrm{s}^{2}$
26. Four blocks with masses $\mathrm{m}, 2 \mathrm{~m}, 3 \mathrm{~m}$ and 4 m are connected by strings, as shown in the figure. After an upward force F is applied on block m, the masses move upward at constant speed v . What is the net force on the block of mass 2 m ? ( g is the acceleration due to gravity)

27. A particle is projected obliquely into air with velocity of $10 \mathrm{~m} / \mathrm{s}$ at an angle of elevation of $30^{\circ}$. Neglecting air resistance the equation of motion is
(A) $\mathrm{y}=\frac{\mathrm{x}}{\sqrt{2}}-\frac{\mathrm{gx}}{200}$
(B) $\mathrm{y}=\mathrm{x}\left[\frac{1}{2}-\frac{\mathrm{gx}}{150}\right]$
(C) $y=x\left[\frac{1}{\sqrt{3}}-\frac{g x}{150}\right]$
(D) $y=x-\frac{g x^{2}}{200}$
28. In the HCl molecule, the separation between the nuclei of the two atoms is about $1.27 \AA$ ( $1 \AA=10^{-10} \mathrm{~m}$ ). The approximate location of the centre of mass of the molecule, assuming the chlorine atom to be about 35.5 times massive as hydrogen is
(A) $1 \AA$
(B) $2.4 \AA$
(C) $1.24 \AA$
(D) $1.5 \AA$
29. R is the radius of the earth and $\omega$ is its angular velocity and $g_{p}$ is the value of $g$ at the poles. The effective value of $g$ at the latitude $\theta=45^{\circ}$ will be equal to
(A) $\mathrm{g}_{\mathrm{p}}-\frac{1}{2} \mathrm{R} \omega^{2}$
(B) $g_{p}-\frac{3}{4} R \omega^{2}$
(C) $g_{p}-R \omega^{2}$
(D) $g_{p}+\frac{1}{4} R \omega^{2}$
30. The initial speed of a shell is $280 \mathrm{~m} / \mathrm{s}$. At what angle must the gun be fired if the projectile is to strike a target at the same level as the gun? [The gun and the target are 1568 m apart]
(Take $\mathrm{g}=10 \mathrm{~m} / \mathrm{s}^{2}$ ) [Take $\left.\sin \left(6^{\circ}\right)=0.1\right]$
(A) $12^{\circ}$
(B) $8^{\circ}$
(C) $0.1^{\circ}$
(D) $6^{\circ}$
31. Point masses of $3 \mathrm{~kg}, 5 \mathrm{~kg}, 7 \mathrm{~kg}$ and 9 kg are placed at the corners of a square $A B C D$ respectively whose each side is 1 m long. The position of the centre of mass of the system is

(A) $\frac{14}{24} \mathrm{~m}, \frac{8}{24} \mathrm{~m}$
(B) $\frac{12}{24} \mathrm{~m}, \frac{10}{24} \mathrm{~m}$
(C) $\frac{15}{24} \mathrm{~m}, \frac{10}{24} \mathrm{~m}$
(D) $\frac{16}{24} \mathrm{~m}, \frac{12}{24} \mathrm{~m}$
32. Escape velocity of a satellite of the earth at an altitude equal to radius of the earth is $v$. What will be the escape velocity at an altitude equal to 6 R , where $\mathrm{R}=$ radius of the earth?
(A) $\quad \mathrm{v} / 6$
(B) $\sqrt{7} \mathrm{v} / 2$
(C) $\sqrt{2} v / \sqrt{7}$
(D) $6 v$
33. A car of mass 1000 kg moves on a circular path with constant speed of $10 \mathrm{~m} / \mathrm{s}$. It turned through $90^{\circ}$ after travelling 785 m on the road. The centripetal force acting on the car is
(Take $\pi=3.14$ )
(A) 320 N
(B) 200 N
(C) 640 N
(D) 1280 N
34. Which of the following is not a property of the newton's law of gravitation?
(A) It is always attractive.
(B) It does not depend on the medium.
(C) It acts on all masses and at all the distances.
(D) It is the strongest force among all the fundamental forces.
35. The angular separation between the minute hand and the hour hand of a clock at $1: 30 \mathrm{pm}$ is
(A) $140^{\circ}$
(B) $90^{\circ}$
(C) $165^{\circ}$
(D) $145^{\circ}$
36. If two identical satellites are at $R$ and 5R away from earth surface, the wrong statement is
( $\mathrm{R}=$ Radius of earth)
(A) Ratio of their total energy will be 3 .
(B) Ratio of their kinetic energies will be 3 .
(C) Ratio of their potential energies will be 3 .
(D) None of the above.
37. Acceleration of a body when displacement equation is $4 s=8 t+2 t^{2}$ is
(A) $\frac{5}{3} \mathrm{~m} / \mathrm{s}^{2}$
(B) $1 \mathrm{~m} / \mathrm{s}^{2}$
(C) $4 \mathrm{~m} / \mathrm{s}^{2}$
(D) $2 \mathrm{~m} / \mathrm{s}^{2}$
38. The ratio of relative velocity of separation after collision to the relative velocity of approach before collision between two colliding bodies is
(A) coefficient of restitution.
(B) velocity of collision.
(C) sum of the velocities.
(D) the law of gravitation.
39. A black hole is an object whose gravitational field is so strong that even light cannot escape from it. To what approximate radius would Venus (mass $=4.9 \times 10^{24} \mathrm{~kg}$ ) have to be compressed to be a black hole?
(A) $10^{-9} \mathrm{~m}$
(B) $10^{-6} \mathrm{~m}$
(C) $10^{-2} \mathrm{~m}$
(D) $10^{2} \mathrm{~m}$
40. In the arrangement shown in the figure, the coefficient of friction between two blocks is 0.7 . The force of friction between the two blocks is (Assume that the 4 kg block is placed on a smooth horizontal surface)
(Acceleration due to gravity $=10 \mathrm{~ms}^{-2}$ )


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# Model Test Paper - 01 

*1. If a particle has zero acceleration, its velocity is
(A) increasing
(B) decreasing
(C) constant
(D) Both (A) and (B)

B2. Air is streaming past a horizontal air-plane wing such that its speed in $130 \mathrm{~m} / \mathrm{s}$ over the upper surface and $105 \mathrm{~m} / \mathrm{s}$ at the lower surface. If the density of air is 1.1 kg per metre ${ }^{3}$ and the wing is 10 m long and has an average width of 2 m , then the difference of the pressure on the two sides of the wing is
(A) 3231 pascal
(B) 409.50 pascal
(C) 1631 pascal
(D) 864 pascal
3. When wavefronts pass from denser medium to rarer medium, the width of the wavefront
(A) increases.
(B) may increase or decrease.
(C) decreases.
(D) remains unchanged.
4. If the magnetic field linked with the coil is doubled, the e.m.f induced in coil will be
$\qquad$ .
(A) double
(B) same
(C) half
(D) four times
*5. Gravitational force between two objects separated by 36 cm is $3.24 \times 10^{-8} \mathrm{~N}$. If total mass of the two objects is 5.0 kg , then the mass of the objects in kg , are
(A) 3,2
(B) 4,1
(C) $2.5,2.5$
(D) $3.5,1.5$
6. Two tuning forks A and B produce 8 beats per second when sounded together. When $B$ is slightly loaded with wax, the beats are reduced to 6 per second. If the frequency of $A$ is 300 Hz , the frequency of $B$ is
(A) 300 Hz
(B) 306 Hz
(C) 294 Hz
(D) 350 Hz
7. A body is kept on a horizontal disc of radius 4 m at a distance of 2 m from the centre. The coefficient of friction between the body and the surface of disc is 0.8 . The speed of rotation of the disc at which the body starts slipping is ( $\mathrm{g}=10 \mathrm{~m} / \mathrm{s}^{2}$ )
(A) $2 \mathrm{rad} / \mathrm{s}$
(B) $6 \mathrm{rad} / \mathrm{s}$
(C) $0.8 \mathrm{rad} / \mathrm{s}$
(D) $0.2 \mathrm{rad} / \mathrm{s}$
8. A galvanometer has a resistance of 3774 ohm. A shunt $S$ is connected across it such that $(1 / 35)$ of the total current passes through the galvanometer. Then the value of the shunt is
(A) 3663 ohm
(B) 111 ohm
(C) 107.7 ohm
(D) 3555.3 ohm
9. The study of $\qquad$ is useful in understanding quantization of energy.
(A) binding energy curve
(B) diffraction of light
(C) photoelectric effect
(D) electric flux
*10. Two balls of masses 9 g and 5 g are moving with kinetic energies in the ratio of $4: 5$. What is the ratio of their linear momenta?
(A) $6: 5$
(B) $5: 6$
(C) $3: 4$
(D) $4: 3$
11. Emissive power of a blackbody at a temperature 200 K is $81 \mathrm{~J} / \mathrm{m}^{2} \mathrm{~s}$. Another one is an ordinary body having emissivity 0.8 at 600 K . What is the emissive power of ordinary body?
(A) $6218.2 \mathrm{~J} / \mathrm{m}^{2} \mathrm{~s}$
(B) $8000 \mathrm{~J} / \mathrm{m}^{2} \mathrm{~s}$
(C) $5248.8 \mathrm{~J} / \mathrm{m}^{2} \mathrm{~s}$
(D) $1784.6 \mathrm{~J} / \mathrm{m}^{2} \mathrm{~s}$
12. The current flowing through a straight wire produces a magnetic field
(A) antiparallel to the direction of current.
(B) parallel to the wire.
(C) in the form of concentric circle.
(D) in a parabolic path.
13. The self inductance of a coil is 5 mH . If a current of 4 A is flowing in it, then the magnetic flux produced in the coil will be
(A) 0.02 weber
(B) 20 weber
(C) zero
(D) 2 weber
*14. What should be the angular speed of an earth like planet in radian/second so that a body of 5 kg weighs zero at the equator of the planet? (Take $g_{p l a n e t}=12 \mathrm{~m} / \mathrm{s}^{2}$ and radius of planet $=$ 7200 km )
(A) $0.89 \times 10^{-3}$
(B) $1.29 \times 10^{-3}$
(C) $2.74 \times 10^{-3}$
(D) $4.16 \times 10^{-3}$
15. Standing waves are produced in a 10 m long stretched string. If the string vibrates in 6 segments and the wave velocity is $36 \mathrm{~m} / \mathrm{s}$, the frequency is
(A) 15 Hz
(B) 13 Hz
(C) 9 Hz
(D) 11 Hz
16. A hollow metal sphere of radius 12 cm is charged such that the potential on its surface is 100 volt. The potential at the centre of the sphere is
(A) 100 volt
(B) 0 volt
(C) 1 volt
(D) 10 volt
17. In a potentiometer experiment, the balancing point with a cell is at a length 240 cm . On shunting the cell with a resistance of $4 \Omega$, the balancing length becomes 120 cm . The internal resistance of the cell is
(A) $1 \Omega$
(B) $2 \Omega$
(C) $0.5 \Omega$
(D) $4 \Omega$
18. Out of the factors given below, upon which factor/s do/es photoelectric effect depend/s?
i. Temperature of metal plate
ii. Velocity of emitted photoelectron
iii. Frequency of incident light
(A) Only (iii)
(B) (i) and (iii)
(C) (ii) and (iii)
(D) (i), (ii) and (iii)
*19. A $\qquad$ medium is required for propagation of sound.
(A) denser
(B) elastic
(C) plastic
(D) chemically ionized
20. For principle specific heats at constant pressure and constant volume, $\mathrm{S}_{\mathrm{P}}$ and $\mathrm{S}_{\mathrm{V}}$ respectively, it is observed that
$S_{P}-S_{V}=$ a for hydrogen gas
$S_{P}-S_{V}=b$ for nitrogen gas
The correct relation between $a$ and $b$ is
(A) $\mathrm{a}=14 \mathrm{~b}$
(B) $a=28 b$
(C) $\mathrm{a}=\frac{1}{14} \mathrm{~b}$
(D) $\mathrm{a}=\mathrm{b}$
21. The force acting on a charge ' $q$ ' in both electric and magnetic field, simultaneously is
(A) $\overrightarrow{\mathrm{F}}=(\mathrm{q} \overrightarrow{\mathrm{E}})+\mathrm{q}(\overrightarrow{\mathrm{B}} \times \overrightarrow{\mathrm{v}})$
(B) $\overrightarrow{\mathrm{F}}=(\mathrm{q} \overrightarrow{\mathrm{E}})+\mathrm{q}(\overrightarrow{\mathrm{v}} \times \overrightarrow{\mathrm{B}})$
(C) $\quad \vec{F}=(q \times \vec{E})+q(\vec{v} \cdot \vec{B})$
(D) $\quad \overrightarrow{\mathrm{F}}=(\mathrm{q} \overrightarrow{\mathrm{E}})+\mathrm{q}(\overrightarrow{\mathrm{v}} \cdot \overrightarrow{\mathrm{B}})$
22. Out of the following graphs, which graph shows the correct relation (graphical representation) for LC parallel resonant circuit?
(A)

(B)

(A)

(D)

*23. The solids which have the negative temperature coefficient of resistance are:
(A) insulators only
(B) semiconductors only
(C) insulators and semiconductors
(D) metals
24. The length of the seconds pendulum is increased by $0.2 \%$. The clock
(A) gains 51.84 seconds per day.
(B) loses 86.4 seconds per day.
(C) neither loses nor gains time.
(D) loses 6 seconds per day.
25. The potentials of two plates of a capacitor are +15 V and -15 V . The charge on one of the plates is 75 C . The capacitance of the capacitor is
(A) 2 F
(B) 2.5 F
(C) 0.5 F
(D) 0.25 F
26. A resistance of $990 \Omega$ and a cell of emf 2 V is connected in series with a potentiometer wire having a length 4 m and resistance $10 \Omega$. The potential gradient along the wire will be
(A) $0.005 \mathrm{~V} / \mathrm{m}$
(B) $0.05 \mathrm{~V} / \mathrm{m}$
(C) $0.003 \mathrm{~V} / \mathrm{m}$
(D) $0.03 \mathrm{~V} / \mathrm{m}$
*27. Angle of minimum deviation for a prism of refractive index 1.5 , is equal to the angle of the prism. Then the angle of the prism is
$\left(\cos 41^{\circ}=0.75\right)$
(A) $62^{\circ}$
(B) $41^{\circ}$
(C) $82^{\circ}$
(D) $31^{\circ}$
28. A monatomic gas expands at constant pressure on heating. The percentage of heat supplied that increases the internal energy of the gas and that is involved in the expansion are respectively
(A) $75 \%, 25 \%$
(B) $25 \%, 75 \%$
(C) $60 \%, 40 \%$
(D) $40 \%, 60 \%$
29. A cyclotron in which flux density is 2.8 T is employed to accelerate protons. How rapidly should the field between the dees be reversed if mass of proton be taken as $1.6 \times 10^{-27} \mathrm{~kg}$ ?
(A) $4.46 \times 10^{5} \mathrm{~Hz}$
(B) $4.46 \times 10^{7} \mathrm{~Hz}$
(C) $4.46 \times 10^{4} \mathrm{~Hz}$
(D) $4.46 \times 10^{6} \mathrm{~Hz}$
30. In an LC circuit
(A) The energy stored in L as well as in C is magnetic energy
(B) The energy stored in L is magnetic but in C it is electrical.
(C) The energy stored in $L$ is electrical but in C it is magnetic.
(D) The energy stored in L as well as in C is electrical energy
31. The collector supply voltage is 4 V and the voltage drop across a resistor of $400 \Omega$ in the collector circuit is 0.4 V in a transistor connected in common emitter mode. If the current gain is 20 , the base current is
(A) 0.25 mA
(B) 0.05 mA
(C) 0.12 mA
(D) 0.02 mA
32. Two springs of spring constants $1800 \mathrm{~N} / \mathrm{m}$ and $3600 \mathrm{~N} / \mathrm{m}$ respectively are stretched with the same force. They will have potential energy in the ratio:
(A) $4: 1$
(B) $1: 4$
(C) $2: 1$
(D) $1: 2$
33. A mercury nucleus has a charge of +80 e where e is equal to $1.6 \times 10^{-19} \mathrm{C}$. If a proton is at a distance of $10^{-12} \mathrm{~m}$ from a mercury nucleus, then its potential energy is about
(A) $11.5 \times 10^{-15} \mathrm{~J}$
(B) $12.8 \times 10^{-15} \mathrm{~J}$
(C) $1.843 \times 10^{-14} \mathrm{~J}$
(D) $32 \times 10^{-38} \mathrm{~J}$
34. The area of the electron orbit for the ground state of hydrogen atom is A. What will be the area of the electron orbit corresponding to the third excited state?
(A) 256 A
(B) 9 A
(C) 81 A
(D) 3 A
®35. By sucking through a straw, a student can reduce the pressure in his lungs to 748 mm of Hg (density $=13.6 \mathrm{~g} / \mathrm{cm}^{3}$ ). Using the straw, he can drink water from a glass upto a maximum depth of
(A) 23.21 cm
(B) 16.32 cm
(C) 13.6 cm
(D) 1.36 cm
36. When the temperature of the system is uniform throughout the system, the system is said to be in
(A) mechanical equilibrium
(B) chemical equilibrium
(C) thermodynamic equilibrium
(D) thermal equilibrium
®37. Which of the following is ferromagnetic?
(A) Antimum
(B) Bismuth
(C) Nickel
(D) Mercury
38. The graphs given below depict the dependence of two reactive impedances $X_{1}$ and $X_{2}$ on the frequency of the alternating e.m.f. applied individually to them. We can then say that

(A) $X_{1}$ is an inductor and $X_{2}$ is a capacitor.
(B) $X_{1}$ is a resistor and $X_{2}$ is a capacitor.
(C) $X_{1}$ is a capacitor and $X_{2}$ is an inductor.
(D) $X_{1}$ is an inductor and $X_{2}$ is a resistor.
${ }^{\text {® }} 39$. What will be the current flowing through the $5 \mathrm{k} \Omega$ resistor in the circuit shown, where the breakdown voltage of the zener is 5 V ?

(A) $\frac{2}{3} \mathrm{~mA}$
(B) 1 mA
(C) 10 mA
(D) $\frac{3}{2} \mathrm{~mA}$
${ }^{\text {R }} 40$. A ring and a disc roll on the horizontal surface without slipping with same linear velocity. If both have same mass and the total kinetic energy of the ring is 8 J then the total kinetic energy of the disc is
(A) 6 J
(B) 5 J
(C) 4 J
(D) 3 J
*41. Which of the following is NOT an example of static electricity?
(A) Hearing crackle when we take off synthetic clothes in dry weather.
(B) Lightening in the sky during thunderstorms.
(C) Plastic comb is electrified when it is rubbed with dry hair.
(D) Seeing spark in an electrical switch when we remove fuse.
42. Mass equivalence of energy 931.5 MeV is
(A) 1 unified atomic mass
(B) 1.6 amu
(C) 1 mg
(D) 1.67 mg
43. Two solid spheres of same metal but of mass M and $\frac{\mathrm{M}}{8}$ fall simultaneously on a viscous liquid and their terminal velocities are v and nv , then value of $n$ is
(A) 16
(B) 8
(C) 4
(D) 0.25
44. In Young's double slit experiment, when wavelength used is $8000 \AA$ and the screen is 30 cm from the slits, the fringes are 0.012 cm wide. What is the distance between the slits?
(A) 0.024 cm
(B) 2.4 cm
(C) 0.24 cm
(D) 0.2 cm

B45. What happens when a diamagnetic substance is brought near north or south pole of a bar magnet?
(A) It is attracted by the poles.
(B) It is repelled by the poles.
(C) It is repelled by the north pole and attracted by the south pole.
(D) It is attracted by the north pole and repelled by the south pole.
*46. The volume of a metal block changes by $0.75 \%$ when heated through $196^{\circ} \mathrm{C}$ then its coefficient of cubical expansion is
(A) $38.3 \times 10^{-6} /{ }^{\circ} \mathrm{C}$
(B) $84 \times 10^{-6} /{ }^{\circ} \mathrm{C}$
(C) $46.110^{-5} /{ }^{\circ} \mathrm{C}$
(D) $8.4 \times 10^{-5} /{ }^{\circ} \mathrm{C}$
47. The second overtone of a closed pipe if its fundamental frequency is 80 Hz
(A) 250 Hz
(B) 400 Hz
(C) 300 Hz
(D) 350 Hz

B48. The ratio of the accelerations for a ring (mass $m$ and radius R ) rolling down an incline of angle ' $\theta$ ' without slipping and slipping down the incline without rolling is
(A) $1: 2$
(B) $2: 1$
(C) $3: 1$
(D) $1: \sqrt{3}$
*49. A conducting sphere of radius $\mathrm{R}=30 \mathrm{~cm}$ is given a charge $\mathrm{Q}=15 \mu \mathrm{C}$. What is $\overrightarrow{\mathrm{E}}$ at centre?
(A) $3.6 \times 10^{6} \mathrm{~N} / \mathrm{C}$
(B) $1.8 \times 10^{6} \mathrm{~N} / \mathrm{C}$
(C) Zero
(D) $0.9 \times 10^{6} \mathrm{~N} / \mathrm{C}$
50. $\frac{\lambda_{\alpha}}{\lambda_{\beta}}$ in Brackett series is
(A) 1
(B) 1.37
(C) 1.54
(D) 2.67

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## Topic Test-01

1. (A)
2. (A)
$\mathrm{v}=\mathrm{u}+\mathrm{at}$
$3 \mathrm{u}=\mathrm{u}+\mathrm{at} \quad \Rightarrow 2 \mathrm{u}=\mathrm{at}$
$\therefore \quad \mathrm{t}=\frac{2 \mathrm{u}}{\mathrm{a}}$
$\therefore \quad \mathrm{t}=\frac{2 \times 8 \times 10^{3}}{10^{12}}=1.6 \times 10^{-8} \mathrm{~s}$
3. (A)

For the given condition initial height $\mathrm{h}=\mathrm{d}$ and velocity of the ball is zero. When the ball moves downward its velocity increases and it will be maximum when the ball hits the ground and just after the collision it becomes half and in opposite direction. As the ball moves upward its velocity again decreases and becomes zero at height $\mathrm{d} / 2$. This explanation matches with graph (A).
4. (A)

Using,
$\mathrm{v}=\mathrm{r} \omega=0.3 \times 60=18 \mathrm{~m} / \mathrm{s}$
5. (C)

In uniform circular motion, acceleration is caused due to change in direction and is directed radially towards centre.
6. (B)

Relative velocity of $1^{\text {st }}$ car w.r.t $2^{\text {nd }}$ car $\mathrm{v}_{12}=\mathrm{v}_{1}-\mathrm{v}_{2}=72-40=32 \mathrm{~km} / \mathrm{hr}$
7. (A)
8. (C)

The slope is maximum around the point $R$.
9. (D)
$\mathrm{T}=\frac{2 \mathrm{u} \sin \theta}{\mathrm{g}}=\frac{2 \times 115.4 \times \sin 60^{\circ}}{9.8}=20.4 \mathrm{~s}$
10. (B)

The relative velocity of boat w.r.t. water
$=\mathrm{v}_{\text {boat }}-\mathrm{V}_{\text {water }}$
$=(2 \hat{i}+5 \hat{j})-(-2 \hat{i}-5 \hat{j})$
$=4 \hat{i}+10 \hat{j}$
11. (A)

An aeroplane in flight is propelled by combustion of fuel and does not move under the effect of gravity alone.
12. (C)

Comparing with equation of projectile
$y=x \tan \theta-\frac{g x^{2}}{2 u^{2} \cos \theta}$,
$\tan \theta=1 \Rightarrow \theta=45^{\circ}$
13. (A)

Athlete completes 1 round in 50 s
$2 \mathrm{~min} 30 \mathrm{~s}=150 \mathrm{~s}$
He will complete 3 rounds in 150 s .
$\therefore \quad$ Displacement $=$ zero
14. (B)

$$
\begin{aligned}
\mathrm{R} & =\frac{\mathrm{u}^{2} \sin 2 \theta}{\mathrm{~g}}=\frac{(300)^{2} \times \sin 2\left(45^{\circ}\right)}{10} \\
=\frac{(300)^{2} \times \sin 90^{\circ}}{10}=\frac{300 \times 300 \times 1}{10} & =9000 \mathrm{~m} \\
& =9 \times 10^{3} \mathrm{~m}
\end{aligned}
$$

15. (C)

The maximum horizontal range is given by $\mathrm{R}_{\text {max }}=4 \mathrm{H}_{\text {max }}$
$120 \mathrm{~m}=4 \mathrm{H}_{\text {max }}$
$\therefore \quad H_{\max }=30 \mathrm{~m}$
16. (D)
$\mathrm{t}_{1}=\frac{\mathrm{x} / 2}{\mathrm{v}_{1}}, \mathrm{t}_{2}=\frac{\mathrm{x} / 2}{\mathrm{v}_{2}}$
Average speed $=\frac{x}{t_{1}+t_{2}}=\frac{x}{\frac{x / 2}{v_{1}}+\frac{x / 2}{v_{2}}}=\frac{2 v_{1} v_{2}}{v_{1}+v_{2}}$
17. (B)
$\mathrm{v}_{\mathrm{y}}=\frac{\mathrm{dy}}{\mathrm{dt}}=4-20 \mathrm{t}, \mathrm{v}_{\mathrm{x}}=\frac{\mathrm{dx}}{\mathrm{dt}}=6$
At $\mathrm{t}=0, \mathrm{v}=\sqrt{\mathrm{v}_{\mathrm{x}}^{2}+\mathrm{v}_{\mathrm{y}}^{2}}=\sqrt{36+16}=2 \sqrt{13} \mathrm{~m} / \mathrm{s}$
18. (C)
$20 \mathrm{~min}=0.33 \mathrm{hr}$
Let the velocity of the river be $x \mathrm{~km} / \mathrm{h}$.
$\therefore \quad(10-x) \times 0.33=2$
$\therefore \quad 10-\mathrm{x}=6.06 \Rightarrow \mathrm{x}=3.94 \mathrm{~km} / \mathrm{h} \approx 4 \mathrm{~km} / \mathrm{h}$
19. (C)
$R=\frac{u^{2} \sin 2 \theta}{g} \Rightarrow R \propto u^{2}$. So, if the speed of projection is made four times, the range becomes sixteen times,
$16 \times 50=800 \mathrm{~m}$
20. (B)
$\theta=90^{\circ}-30^{\circ}=60^{\circ}$
Horizontal velocity $=u \cos 60^{\circ}=24.6 \mathrm{~m} \mathrm{~s}^{-1}$
$\therefore \quad \mathrm{u}=\frac{24.6}{0.5}=49.2 \mathrm{~m} \mathrm{~s}^{-1}$
$H=\frac{u^{2} \sin ^{2} 60^{\circ}}{2 \mathrm{~g}}=\frac{(49.2)^{2}}{2 \times 9.8}\left(\frac{\sqrt{3}}{2}\right)^{2}$
$\therefore \quad H=92.6 \mathrm{~m}$
21. (C)

Using, $T=\operatorname{mr} \omega^{2} \Rightarrow \omega^{2}=\frac{\mathrm{T}}{\mathrm{mr}}$
$\therefore \omega=\sqrt{\frac{4.2}{0.2 \times 8}}=1.62 \mathrm{rad} / \mathrm{s}$
22. (A)

The centripetal force acting on the proton is given by,
$\mathrm{F}=\mathrm{mr} \omega^{2}=\mathrm{m} 4 \pi^{2} \mathrm{n}^{2} \mathrm{r}$
$\therefore \quad \mathrm{m} 4 \pi^{2} \mathrm{n}^{2} \mathrm{r}=6 \times 10^{-13}$
$\therefore \quad \mathrm{n}=\sqrt{\frac{6 \times 10^{-13}}{1.6 \times 10^{-27} \times 4 \times(3.142)^{2} \times 0.1}}$
$=9.7 \times 10^{6}$ cycles $/ \mathrm{s}$
$\therefore \quad \mathrm{n} \approx 10 \times 10^{6}=0.1 \times 10^{8}$ cycles/second
23. (B)

$$
\begin{array}{ll} 
& \frac{\mathrm{dv}}{\mathrm{dt}}=-2.5 \sqrt{\mathrm{v}} \\
\therefore & \frac{\mathrm{dv}}{\sqrt{\mathrm{v}}}=-2.5 \mathrm{dt} \\
\therefore & \int_{12.25}^{0} \frac{\mathrm{dv}}{\sqrt{\mathrm{v}}}=-2.5 \int_{0}^{\mathrm{t}} \mathrm{dt} \\
\therefore & |2 \sqrt{\mathrm{v}}|_{12.25}^{0}=-2.5 \mathrm{t} \\
\therefore \quad & 2 \sqrt{12.25}=2.5 \mathrm{t} \\
& \mathrm{t}=2.8 \mathrm{~s}
\end{array}
$$

24. (B)

For the coin to slip;
the frictional force $\leq$ centripetal force
$\therefore \quad \mu_{\mathrm{s}} \mathrm{mg} \leq \mathrm{mr} \omega^{2}$
$\therefore \quad \mu_{\mathrm{s}} \mathrm{g}=\mathrm{r} \omega^{2} \quad$ (For minimum angular speed)
$\therefore \quad \omega^{2}=\frac{\mu_{\mathrm{s}} \mathrm{g}}{\mathrm{r}}=\frac{0.4 \times 9.8}{8 \times 10^{-2}}=49$
$\therefore \quad \omega=7 \mathrm{rad} / \mathrm{s}$
25. (D)

Time taken by the particle $(\mathrm{t})=12 \mathrm{~s}$
Let $t_{1}$ be time for acceleration and $t_{2}$ for declaration
$\therefore \quad \mathrm{t}_{1}+\mathrm{t}_{2}=12$
$\therefore \quad \mathrm{t}_{2}=12-\mathrm{t}_{1}$
For accelerated motion,
$\mathrm{v}_{0}=\mathrm{u}+\mathrm{at}$
$\mathrm{v}_{1}=0+\mathrm{at}_{1}$
$\mathrm{v}_{1}=\mathrm{at}_{1}$
For retardation,
$\mathrm{v}=\mathrm{u}+\mathrm{at}$
$\therefore \quad \mathrm{v}_{2}=\mathrm{v}_{1}+\mathrm{at}_{2}\left(\because \mathrm{u}=\mathrm{v}_{1}\right)$
Substituting equation (i), (ii) and $\mathrm{a}=-2 \mathrm{a}$, in equation (iii)
we get,
$0=\mathrm{at}_{1}-2 \mathrm{a}\left(12-\mathrm{t}_{1}\right)$
$\therefore \quad 2 \mathrm{a}\left(12-\mathrm{t}_{1}\right)=\mathrm{at}_{1}$
$\therefore \quad 24 a-2 a t_{1}=a t_{1}$
$\therefore \quad 24 a=3 a t_{1}$
$\therefore \quad \mathrm{t}_{1}=8 \mathrm{~s}$
26. (B)

Area on which bullets will spread $=\pi r^{2}$
For maximum area,
$\mathrm{r}=\mathrm{R}_{\max }=\frac{\mathrm{v}^{2}}{\mathrm{~g}}=\frac{(150)^{2}}{10}=2250 \mathrm{~m}$
$\ldots\left[\right.$ when $\left.\theta=45^{\circ}\right]$
Maximum area $\pi \mathrm{R}_{\max }^{2}=\pi(2250)^{2} \approx 1.6 \times 10^{7} \mathrm{~m}^{2}$
27. (B)

In a particle performing uniform cirular motion, the linear velocity of the particle is perpendicular to $\vec{r}$ and linear acceleration. The acceleration is directed towards the centre, thus making an angle of $90^{\circ}$.
28. (C)


Horizontal (X) component remains the same while the vertical $(\mathrm{Y})$ component changes.
Therefore, velocity at $\mathrm{B}=(3 \hat{\mathrm{i}}-4 \hat{\mathrm{j}}) \mathrm{m} / \mathrm{s}$.
29. (C)

$$
\begin{aligned}
& \overrightarrow{\mathrm{V}}_{\text {avg }}=\frac{\overrightarrow{\mathrm{v}}_{\mathrm{i}}+\overrightarrow{\mathrm{v}}_{\mathrm{f}}}{2} \\
& \mathrm{v}_{1}=\frac{\mathrm{u}+\mathrm{u}+\mathrm{at}_{1}}{2}
\end{aligned}
$$

$$
\begin{equation*}
\therefore \quad 2 v_{1}=2 u+a t_{1} \tag{i}
\end{equation*}
$$

Similarly,
$2 \mathrm{v}_{2}=2 \mathrm{u}+\mathrm{at}_{2}$
$2 v_{3}=2 u+$ at $_{3}$
Subtracting equation (ii) from equation (i), $2\left(\mathrm{v}_{1}-\mathrm{v}_{2}\right)=\mathrm{a}\left(\mathrm{t}_{1}-\mathrm{t}_{2}\right)$
Subtracting equation (iii) from equation (ii),
$2\left(\mathrm{v}_{2}-\mathrm{v}_{3}\right)=\mathrm{a}\left(\mathrm{t}_{2}-\mathrm{t}_{3}\right)$
Dividing equation (iv) by equation (v),
$\frac{v_{1}-v_{2}}{v_{2}-v_{3}}=\frac{t_{1}-t_{2}}{t_{2}-t_{3}}$
30. (A)

The horizontal component of velocity is
$\mathrm{v}_{\mathrm{x}}=\frac{\mathrm{dx}}{\mathrm{dt}}=\frac{\mathrm{d}}{\mathrm{dt}}(\mathrm{at})=\mathrm{a}$
The vertical component of velocity is $\mathrm{v}_{\mathrm{y}}=\frac{\mathrm{dy}}{\mathrm{dt}}=\frac{\mathrm{d}}{\mathrm{dt}}\left(\mathrm{bt}^{2}+\mathrm{ct}\right)=2 \mathrm{bt}+\mathrm{c}$
When $\mathrm{t}=0, \mathrm{v}_{x}=\mathrm{a}, \mathrm{v}_{y}=2 \mathrm{~b}+\mathrm{c}$
$\therefore \quad v=\sqrt{v_{x}^{2}+v_{y}^{2}}=\sqrt{a^{2}+(2 b+c)^{2}}$
Hence, the correct choice is (A).
31. (C)


For a projectile given horizontal projection, Motion along X-axis is given by,
$\mathrm{x}=\mathrm{x}_{0}+\mathrm{u}_{\mathrm{x}} \mathrm{t}+\frac{1}{2} \mathrm{a}_{\mathrm{x}} \mathrm{t}^{2}$
Here $\mathrm{x}_{0}=0, \mathrm{u}_{\mathrm{x}}=\mathrm{u}=6 \mathrm{~m} / \mathrm{s}, \mathrm{a}_{\mathrm{x}}=0, \mathrm{t}=0.3 \mathrm{~s}$
Hence, horizontal distance covered by the ball, $\mathrm{x}=\mathrm{ut}=6 \times 0.3=1.8 \mathrm{~m}$
Thus, option (A) is incorrect.
The speed with which it hits the ground,
$\mathrm{v}=\sqrt{\mathrm{v}_{\mathrm{x}}^{2}+\mathrm{v}_{\mathrm{y}}^{2}}=\sqrt{\mathrm{u}^{2}+\mathrm{g}^{2} \mathrm{t}^{2}}$

$$
\begin{equation*}
=\sqrt{36+10^{2} \times(0.3)^{2}} \approx 6.7 \mathrm{~m} / \mathrm{s} \tag{i}
\end{equation*}
$$

Thus, option (B) is incorrect.
Motion along Y-axis is given by
$y=y_{0}+u_{y} t+\frac{1}{2} a_{y} t^{2}$
Here $y_{0}=0, u_{y}=0, a_{y}=g, t=0.3 \mathrm{~s}$
Hence height of the table
$\mathrm{h}=\mathrm{y}=\frac{1}{2} \mathrm{gt}^{2}=\frac{1}{2} \times 10 \times 0.3^{2}=0.45 \mathrm{~m}$
Thus, option (C) is correct.
The angle body makes with horizontal is
$\beta=\tan ^{-1}\left(\frac{v_{y}}{v_{\mathrm{x}}}\right)$

$$
=\tan ^{-1}\left(\frac{3}{6}\right)
$$

....[Using equation (i)]

$$
\neq 60^{\circ}
$$

Thus, option (D) is incorrect.
32. (B)

$$
\begin{array}{ll} 
& \mathrm{v}^{2}=u^{2}-2 g y \Rightarrow\left(\frac{1}{4} u\right)^{2}=u^{2}-2 g y \\
\therefore & \frac{u^{2}}{16}=u^{2}-2 g y \\
\therefore \quad & u^{2}\left(1-\frac{1}{16}\right)=2 g y \\
\therefore \quad & u^{2} \times \frac{15}{16}=2 g y \Rightarrow \frac{u^{2}}{g}=\frac{16 \times 2 y}{15}=\frac{32 y}{15} \\
& H_{\max }=\frac{u^{2}}{4 g}=\frac{1}{4}\left(\frac{32 y}{15}\right)=\frac{32 y}{60}=\frac{8 y}{15}
\end{array}
$$

33. (B)

For a conical pendulum,
$\mathrm{r}=l \sin \theta$
$\mathrm{r}=20 \sin 30^{\circ} \Rightarrow \mathrm{r}=10 \mathrm{~m}, \mathrm{~T}=3 \mathrm{~s}$
$\therefore \quad \omega=\frac{2 \pi}{\mathrm{~T}}=\frac{2 \pi}{3}$

Centripetal force $=\mathrm{m} \omega^{2} \mathrm{r}=3 \times 10^{-2} \times \frac{4 \pi^{2}}{9} \times 10$

$$
=131.46 \times 10^{-2}=1.3 \mathrm{~N}
$$

34. (C)
$\mathrm{H}=\frac{\mathrm{u}^{2} \sin ^{2} \theta}{2 \mathrm{~g}}$
Differentiating partially,
$\delta \mathrm{H}=\frac{\mathrm{u}^{2}(2 \sin \theta \cdot \cos \theta) \delta \theta}{2 \mathrm{~g}}$
$\therefore \quad \frac{\delta \mathrm{H}}{\mathrm{H}}=\frac{2 \cos \theta \delta \theta}{\sin \theta}=0.2$ (given)
Similarly, $\frac{\delta T}{T}=\frac{\cos \theta \delta \theta}{\sin \theta}=0.1$
Therefore, T increases by $10 \%$.
35. (D)

From the addition of two vectors, we know that $C^{2}=A^{2}+B^{2}+2 A B \cos \theta$
From this expression it is clear that, $\mathrm{C}^{2}<\mathrm{A}^{2}+\mathrm{B}^{2}$ when $\theta>90^{\circ}$
i.e., when $\theta>90^{\circ}$, the man can cross the river with shortest time.


From diagram it is clear that man should swim in north-west direction.
36. (D)

For same range, angle of projection should be $\theta^{\circ}$ and $(90-\theta)^{\circ}$.
So, time of flights $\mathrm{t}_{1}=\frac{2 \mathrm{u} \sin \theta}{\mathrm{g}}$ and
$\mathrm{t}_{2}=\frac{2 \mathrm{u} \sin (90-\theta)}{\mathrm{g}}=\frac{2 \mathrm{u} \cos \theta}{\mathrm{g}}$
$\therefore \quad \mathrm{t}_{1} \mathrm{t}_{2}=\frac{4 \mathrm{u}^{2} \sin \theta \cos \theta}{\mathrm{~g}^{2}}=\frac{2}{\mathrm{~g}} \frac{\left(\mathrm{u}^{2} \sin 2 \theta\right)}{\mathrm{g}}=\frac{2 \mathrm{R}}{\mathrm{g}}$
$\therefore \quad \mathrm{t}_{1} \mathrm{t}_{2} \propto \mathrm{R}$
37. (B)

Time of flight $=\frac{2 \mathrm{u}}{\mathrm{g}}=\frac{2 \times 80}{32}=5 \mathrm{~s}$
38. (D)

Here, $\theta=90^{\circ}, \mathrm{t}=20 \mathrm{~s}$,
Resultant velocity $=\overrightarrow{\mathrm{v}}_{\mathrm{E}}-\overrightarrow{\mathrm{v}}_{\mathrm{N}}$

If the central angle is given then we apply the formula $\mathrm{dv}=2 \mathrm{v} \sin \frac{\theta}{2}$ to determine the change in velocity
$\mathrm{dv}=2 \mathrm{v} \sin \left(\frac{\theta}{2}\right)$

$$
=2 \times 8 \times \frac{1}{\sqrt{2}}
$$

$$
=8 \sqrt{2} \mathrm{~m} / \mathrm{s}
$$

$\therefore \quad$ Acceleration $=\frac{8 \sqrt{2}}{20}=\frac{2 \sqrt{2}}{5}$
Acceleration acts in $\mathrm{N}-\mathrm{E}$
 direction.
39. (A)

Let the two balls meet after t at distance x from the platform.
Using $\mathrm{h}=\mathrm{ut}+\frac{1}{2} \mathrm{gt}^{2}$
For the first ball
$\mathrm{u}=0 \mathrm{~m} / \mathrm{s}, \mathrm{t}=20 \mathrm{~s}, \mathrm{~g}=10 \mathrm{~m} / \mathrm{s}^{2}$
$\therefore \quad \mathrm{x}=\frac{1}{2} \times 10 \times(20)^{2}$
For the second ball
$\mathrm{u}=\mathrm{v}, \mathrm{t}=11 \mathrm{~s}, \mathrm{~g}=10 \mathrm{~m} / \mathrm{s}^{2}$
$\therefore \quad \mathrm{x}=\mathrm{v} \times 11+\frac{1}{2} \times 10 \times(11)^{2}$
From equations (i) and (ii),
$\frac{1}{2} \times 10 \times(20)^{2}=11 v+\frac{1}{2} \times 10 \times(11)^{2}$
$11 \mathrm{v}=\frac{1}{2} \times 10 \times\left[(20)^{2}-(11)^{2}\right]=\frac{1}{2} \times 10 \times 279$
$\mathrm{v}=\frac{1395}{11}=126.8 \mathrm{~m} / \mathrm{s}$
40. (A)

For $1^{\text {st }}$ part,
$\mathrm{v}=\mathrm{u}+\mathrm{at}=0+3 \times 20=60 \mathrm{~m} \mathrm{~s}^{-1}$
$\mathrm{s}_{1}=\mathrm{ut}+\frac{1}{2} \mathrm{at}^{2} \Rightarrow \mathrm{~s}_{1}=\frac{1}{2} \times 3 \times 400$
$\therefore \quad \mathrm{s}_{1}=600 \mathrm{~m}$
For $2^{\text {nd }}$ part,
$\mathrm{s}_{2}=\mathrm{ut} \quad \Rightarrow \mathrm{s}_{2}=60 \times 30$
$\therefore \quad \mathrm{s}_{2}=1800 \mathrm{~m}$
For $3{ }^{\text {rd }}$ part,
$\mathrm{v}^{2}=\mathrm{u}^{2}+2 \mathrm{as}_{3}$
$0=(60)^{2}+2 \times(-4) \times \mathrm{s}_{3}=3600-8 \mathrm{~s}_{3}$
$\therefore \quad \mathrm{s}_{3}=\frac{3600}{8}=450 \mathrm{~m}$
$\therefore \quad \mathrm{s}=\mathrm{s}_{1}+\mathrm{s}_{2}+\mathrm{s}_{3}=600+1800+450$
$\therefore \quad \mathrm{s}=2850 \mathrm{~m}$

## Topic Test - 02

1. (B)
2. (C)

The gravitational force of attraction is given by,

$$
\begin{aligned}
\mathrm{F} & =\frac{\mathrm{Gm}_{1} \mathrm{~m}_{2}}{\mathrm{r}^{2}} \\
& =\frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times 2 \times 10^{27}}{\left(8.5 \times 10^{11}\right)^{2}} \\
& \approx 1.11 \times 10^{18} \mathrm{~N}
\end{aligned}
$$

3. (A)

Using the law of conservation of momentum,
$\mathrm{m} \times \mathrm{v}=\mathrm{M} \times \mathrm{V}$
Where, $\mathrm{m}=$ mass of bullet, $\mathrm{v}=$ velocity of bullet, $\mathrm{M}=$ mass of rifle, $\mathrm{V}=$ velocity of rifle
$\therefore \quad \mathrm{v}=\frac{\mathrm{MV}}{\mathrm{m}}=\frac{1000 \times 40}{2}=2 \times 10^{4} \mathrm{~cm} / \mathrm{s}$
4. (B)
5. (C)

If the fingers of the right hand are curled from the direction of $\vec{r}$ towards the direction of $\vec{F}$ then the thumb points in the direction of torque $\vec{\tau}$.

6. (D)

The inertial frame of reference will either will be at rest or moving with a constant velocity.
7. (B)

The work done is given by,

$$
\begin{aligned}
W=\int_{x=0}^{x=4} F d x & =\int_{x=0}^{x=4}(0.2 x+14) d x \\
& =\int_{x=0}^{x=4} 0.2 x d x+\int_{x=0}^{x=4} 14 d x \\
& =0.2\left[\frac{x^{2}}{2}\right]_{x=0}^{x=4}+14[x]_{x=0}^{x=4} \\
& =0.2\left[\frac{4^{2}-0}{2}\right]+14[4-0]
\end{aligned}
$$

$\therefore \quad \mathrm{W}=1.6+56=57.6 \mathrm{~J}$
8. (D)
9. (B)
10. (C)
11. (B)


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To see complete chapter buy Target Notes or Target E-Notes
35. (B)
$\mathrm{R}_{\mathrm{m}}=\frac{\mathrm{R}_{\mathrm{e}}}{4}, \rho_{\mathrm{m}}=\frac{2}{3} \rho_{\mathrm{e}}$
Energy spent $=\mathrm{mg}_{\mathrm{e}} \mathrm{h}_{\mathrm{e}}=\mathrm{mg}_{\mathrm{m}} \mathrm{h}_{\mathrm{m}}$
$\therefore \quad \mathrm{h}_{\mathrm{m}}=\mathrm{g}_{\mathrm{e}} \mathrm{h}_{\mathrm{e}} / \mathrm{g}_{\mathrm{m}}$
$\therefore \quad h_{m}=\frac{\left(\frac{4}{3} \pi R_{e} \rho_{e} G\right) \times h_{e}}{\frac{4}{3} \pi R_{m} \rho_{m} G}$
$\therefore \quad h_{m}=\frac{R_{e}}{R_{m}} \times \frac{\rho_{\mathrm{e}}}{\rho_{\mathrm{m}}} \times \mathrm{h}_{\mathrm{e}}=\frac{3}{2} \times \frac{4}{1} \times 0.6=3.6 \mathrm{~m}$
36. (A)

We know that, $\mathrm{F} \propto \mathrm{m}_{1} \mathrm{~m}_{2}$
$\therefore \quad \mathrm{F} \propto(\mathrm{xm}) \times(1-\mathrm{x}) \mathrm{m}=\mathrm{xm}^{2}(1-\mathrm{x})$
For maximum force,
$\frac{\mathrm{dF}}{\mathrm{dx}}=0$
$\therefore \quad \frac{\mathrm{dF}}{\mathrm{dx}}=\mathrm{m}^{2}-2 \mathrm{xm}^{2}=0 \quad \Rightarrow \mathrm{x}=\frac{1}{2}$
37. (A)
$\mathrm{g}_{\mathrm{d}}=\mathrm{g}\left(1-\frac{\mathrm{d}}{\mathrm{R}}\right)=9.8\left(1-\frac{800}{6400}\right)$
$\mathrm{g}_{\mathrm{d}}=9.8 \times \frac{7}{8}=8.58 \mathrm{~ms}^{-2}$
38. (A)

When satellite is in orbit, K.E. $=\mathrm{E}=\frac{1}{2} \mathrm{mv}_{\mathrm{c}}^{2}$
For satellite to escape $v_{c}=v_{e}$
$\therefore \quad$ K.E. to escape,
$K_{e}=\frac{1}{2} \operatorname{mv}_{\mathrm{e}}^{2}=\frac{1}{2} \mathrm{~m}\left(\sqrt{2} \mathrm{~V}_{\mathrm{c}}\right)^{2}$

$$
=2 \mathrm{E} \quad \ldots .\left(\because \mathrm{v}_{\mathrm{e}}=\sqrt{2} \mathrm{v}_{\mathrm{c}}\right)
$$

$\therefore \quad$ Extra K.E. required $=2 \mathrm{E}-\mathrm{E}=\mathrm{E}$
39. (B)
$\frac{\mathrm{v}_{\mathrm{B}}}{\mathrm{v}_{\mathrm{A}}}=\sqrt{\frac{\mathrm{r}_{\mathrm{A}}}{\mathrm{r}_{\mathrm{B}}}}=\sqrt{\frac{9 \mathrm{R}}{\mathrm{R}}}=3$
$\Rightarrow \mathrm{v}_{\mathrm{B}}=3 \times \mathrm{v}_{\mathrm{A}}=3 \times \mathrm{nv}=3 \mathrm{nv}$
40. (D)

## Revision Test-01

1. (D)
2. (C)
3. (A)

Average speed $=\frac{\mathrm{s}}{\frac{\mathrm{s} / 2}{60}+\frac{\mathrm{s} / 2}{80}}=\frac{\mathrm{s}}{\frac{\mathrm{s}}{120}+\frac{\mathrm{s}}{160}}$

$$
=\frac{480}{7}=68.57 \mathrm{~km} / \mathrm{hr}^{-1}
$$

4. (A)
$\frac{\rho_{1}}{\rho_{2}}=3: 2, \quad \frac{d_{1}}{d_{2}}=5: 2$
Since, $g=\frac{4}{3} G \pi R \rho \Rightarrow g \propto \rho R$
$\Rightarrow g_{1} \propto \rho_{1} R_{1}$ and $g_{2} \propto \rho_{2} R_{2}$
$\therefore \quad \frac{\mathrm{g}_{1}}{\mathrm{~g}_{2}}=\frac{\rho_{1} \mathrm{R}_{1}}{\rho_{2} \mathrm{R}_{2}}=\frac{3}{2} \times \frac{5}{2}=\frac{15}{4}$
5. (D)
6. (C)

At height $\left(h=\frac{R}{n}\right)$, the value of acceleration due to gravity is given by, $g_{h}=\left(\frac{n}{n+1}\right)^{2} g$.
Here, $\mathrm{n}=\frac{1}{2}$

$$
\begin{aligned}
& \therefore \quad \frac{\mathrm{g}_{\mathrm{h}}}{\mathrm{~g}}=\left(\frac{\mathrm{n}}{\mathrm{n}+1}\right)^{2}=\left(\frac{\frac{1}{2}}{\frac{1}{2}+1}\right)^{2}=\left(\frac{1}{3}\right)^{2}=\frac{1}{9} \\
& \therefore \quad \mathrm{~g}_{\mathrm{h}}=\frac{\mathrm{g}}{9} \quad \Rightarrow \mathrm{~g}_{\mathrm{h}} \approx 11 \%
\end{aligned}
$$

7. (C)

Since body returns to the starting point,
$\mathrm{h}=0$

$$
\begin{aligned}
& \text { Also } h=u t-\frac{1}{2} g^{2} \\
\therefore \quad & 0=u(10)-\frac{1}{2} \times 9.8 \times(10)^{2} \Rightarrow 10 u=9.8 \times 50 \\
& 10 u=490 \Rightarrow u=\frac{490}{10}
\end{aligned}
$$

$\therefore \quad u=49 \mathrm{~m} / \mathrm{s}$
8. (C)
9. (A)
10. (D)
11. (C)

The relative speed of policeman w.r.t. thief
$=15-10=5 \mathrm{~m} / \mathrm{s}$.
$\therefore \quad$ Time taken by police to catch the thief $=\frac{200}{5}$

$$
=40 \mathrm{~s}
$$

12. (B)

Work done is given by,
$\mathrm{W}=\mathrm{Fs}=\mathrm{F} \mathrm{s} \cos (180)^{\circ}$

$$
=-\mathrm{Fs}=-250 \times 20=-5000 \mathrm{~J}
$$

13. (A)

Using the law of conservation of momentum, $\mathrm{MV}=\mathrm{m}_{1} \mathrm{v}_{1}+\mathrm{m}_{2} \mathrm{v}_{2}$
Where, $\mathrm{M}, \mathrm{V}=$ total mass and velocity of the shell, $\mathrm{m}_{1}, \mathrm{v}_{1}=$ mass and velocity of the first part, $\mathrm{m}_{2}, \mathrm{v}_{2}=$ mass and velocity of the second part
$\mathrm{v}_{2}=\frac{\mathrm{MV}}{\mathrm{m}_{2}}$
$\ldots .\left[\because \mathrm{v}_{1}=0 \mathrm{~m} / \mathrm{s}\right]$
$=\frac{50 \times 40}{25}=80 \mathrm{~m} \mathrm{~s}^{-1}$
14. (A)

We know, 5 quintal $=500 \mathrm{~kg}$
B.E. $=\frac{G m M}{R}=m g R$

$$
=500 \times 10 \times 6.4 \times 10^{6}=32 \times 10^{9} \mathrm{~J}
$$

15. (C)
16. (A)

Using Kepler's third law, $\frac{T_{A}^{2}}{T_{B}^{2}}=\frac{r_{A}^{3}}{r_{B}^{3}}$
$\therefore \quad \frac{\left(12 \mathrm{~T}_{\mathrm{B}}\right)^{2}}{\mathrm{~T}_{\mathrm{B}}^{2}}=\left(\frac{\mathrm{r}_{\mathrm{A}}}{\mathrm{r}_{\mathrm{B}}}\right)^{3} \quad \ldots .\left(\because \mathrm{T}_{\mathrm{A}}=12 \mathrm{~T}_{\mathrm{B}}\right)$
$\therefore\left(\frac{r_{A}}{r_{B}}\right)^{3}=(144)^{3} \Rightarrow \frac{r_{A}}{r_{B}}=(144)^{1 / 3} \Rightarrow r_{A}=5.24 r_{B}$
17. (D)

Graph (D) indicates 2 values of velocity for a given instant. This is not possible.
18. (D)
19. (C)

$$
\begin{aligned}
& \overrightarrow{\mathrm{r}}=4 t \hat{i}+2 \mathrm{t}^{2} \hat{j}+5 \hat{\mathrm{k}} \\
& \overrightarrow{\mathrm{v}}=\frac{\mathrm{dr}}{\mathrm{dt}}=\frac{d}{d t}\left(4 t \hat{i}+2 t^{2} \hat{j}+5 \hat{k}\right)=4 \hat{i}+4 t \hat{j}
\end{aligned}
$$

20. (B)

$$
\begin{aligned}
\mathrm{G} & =6.67 \times 10^{-11} \mathrm{Nm}^{2} / \mathrm{kg}^{2} \\
& =6.67 \times 10^{-11} \times \frac{10^{5} \text { dyne } \times 10^{4} \mathrm{~cm}^{2}}{10^{6} \mathrm{~g}} \\
& =6.67 \times 10^{-11+3}=6.67 \times 10^{-8} \text { dyne } \mathrm{cm}^{2} / \mathrm{g}^{2}
\end{aligned}
$$

21. (B)
22. (A)
$\mathrm{t}_{\mathrm{A}}=\frac{\mathrm{u} \sin \theta}{\mathrm{g}}=\frac{1500 \times \frac{1}{2}}{9.8}=\frac{750}{9.8}$
$\therefore \quad \mathrm{t}_{\mathrm{A}}=76.55 \approx 77 \mathrm{~s}$
23. (C)

From law of conservation of momentum,
$\mathrm{m}_{1} \mathrm{u}_{1}+\mathrm{m}_{2} \mathrm{u}_{2}=\mathrm{m}_{1} \mathrm{v}_{1}+\mathrm{m}_{2} \mathrm{v}_{2}$
$4 \times 8+2 \times(-3)=4 \times v_{1}+2 \mathrm{v}_{2}$
$\therefore \quad 32-6=4 \mathrm{v}_{1}+2 \mathrm{v}_{2}$
$\therefore \quad 26=2\left(2 \mathrm{v}_{1}+\mathrm{v}_{2}\right)$
$\therefore \quad 13=2 \mathrm{v}_{1}+\mathrm{v}_{2}$
$\therefore \quad \mathrm{v}_{2}=13-2 \mathrm{v}_{1}$
Also, kinetic energy is conserved during elastic collision,

$$
\begin{array}{ll}
\therefore & \frac{1}{2}\left[\mathrm{~m}_{1} \mathrm{u}_{1}^{2}+\mathrm{m}_{2} \mathrm{u}_{2}^{2}\right]=\frac{1}{2}\left[\mathrm{~m}_{1} \mathrm{v}_{1}^{2}+\mathrm{m}_{2} \mathrm{v}_{2}^{2}\right] \\
\therefore & 4 \times(8)^{2}+2 \times(-3)^{2}=4 \times\left(\mathrm{v}_{1}^{2}\right)+2\left(\mathrm{v}_{2}^{2}\right) \\
\therefore & 256+18=4 \mathrm{v}_{1}^{2}+2 \mathrm{v}_{2}^{2} \\
\therefore & 274=2\left[2 \mathrm{v}_{1}^{2}+\mathrm{v}_{2}^{2}\right]
\end{array}
$$

$\therefore \quad 137=2 \mathrm{v}_{1}^{2}+\mathrm{v}_{2}^{2}$
$\therefore \quad 137=2 \mathrm{v}_{1}^{2}+\left(13-2 \mathrm{v}_{1}\right)^{2} \quad \ldots .[$ [From (i)]
$\therefore \quad 137=2 \mathrm{v}_{1}^{2}+169-52 \mathrm{v}_{1}+4 \mathrm{v}_{1}^{2}$
$\therefore \quad 6 \mathrm{v}_{1}^{2}-52 \mathrm{v}_{1}+32=0$
$\therefore \quad 3 v_{1}^{2}-26 v_{1}+16=0$
Solving the above quadratic equation, we get,
$\mathrm{v}_{1}=8 \mathrm{~m} / \mathrm{s}$ or $\mathrm{v}_{1}=0.6 \mathrm{~m} / \mathrm{s}$
when $v_{1}=8 \mathrm{~m} / \mathrm{s}, \mathrm{v}_{2}=-3 \mathrm{~m} / \mathrm{s}$ and
when $\mathrm{v}_{1}=0.6 \mathrm{~m} / \mathrm{s}, \mathrm{v}_{2}=11.8 \mathrm{~m} / \mathrm{s}$.
24. (A)
$\mathrm{g}^{\prime}=\mathrm{G} \frac{0.96 \mathrm{M}}{(0.96 \mathrm{R})^{2}}=\frac{25}{24} \frac{\mathrm{GM}}{\mathrm{R}^{2}}=1.04 \frac{\mathrm{GM}}{\mathrm{R}^{2}}=1.04 \mathrm{~g}$
$\therefore \quad \frac{\mathrm{g}^{\prime}}{\mathrm{g}}-1=0.04$
$\therefore \quad \frac{\mathrm{g}^{\prime}-\mathrm{g}}{\mathrm{g}} \times 100=4 \%$
25. (D)

$$
\begin{aligned}
\mathrm{g}^{\prime} & =\mathrm{g}\left(1-\frac{\mathrm{d}}{\mathrm{R}}\right)=9.8\left(1-\frac{160}{6400}\right) \\
& =9.8\left(1-\frac{1}{40}\right)=\frac{9.8 \times 39}{40} \\
& =9.55 \mathrm{~m} / \mathrm{s}^{2}=955 \mathrm{~cm} / \mathrm{s}^{2}
\end{aligned}
$$

26. (A)

Since all four blocks are moving up with a constant speed v , acceleration a is zero.
$\Rightarrow \mathrm{F}=0$
$\therefore \quad$ Net force is zero.
27. (C)

The equation of motion is given by,
$y=(\tan \theta) x-\left(\frac{g}{2 u^{2} \cos ^{2} \theta}\right) x^{2}$
For $\theta=30^{\circ}, u=10 \mathrm{~m} / \mathrm{s}$
$y=\left(\tan 30^{\circ}\right) x-\left(\frac{g}{2(10)^{2} \cos ^{2} 30^{\circ}}\right) x^{2}$
$y=\frac{1}{\sqrt{3}} x-\left(\frac{g}{200 \times \frac{3}{4}}\right) x^{2}$
$\therefore \quad \mathrm{y}=\frac{\mathrm{x}}{\sqrt{3}}-\left(\frac{\mathrm{g}}{150}\right) \mathrm{x}^{2}$
$\therefore \quad y=x\left(\frac{1}{\sqrt{3}}-\frac{g x}{150}\right)$
28. (C)
$\overrightarrow{\mathrm{r}_{1}}=\frac{\mathrm{m}_{1} \overrightarrow{\mathrm{r}}_{1}+\mathrm{m}_{2} \overrightarrow{\mathrm{r}}_{2}}{\mathrm{~m}_{1}+\mathrm{m}_{2}}$
$\overrightarrow{\mathrm{r}}=\frac{35.5 \times 1.27}{1+35.5} \hat{\mathrm{i}}$
$\overrightarrow{\mathrm{r}}=\frac{35.5}{36.5} \times 1.27 \hat{\mathrm{i}} \approx 1.24 \hat{\mathrm{i}}$

29. (A)
$g=g_{p}-R \omega^{2} \cos ^{2} \theta=g_{p}-\omega^{2} R \cos ^{2} 45^{\circ}=g_{p}-\frac{1}{2} R \omega^{2}$
30. (D)
$\begin{aligned} & R=\frac{\mathrm{u}^{2} \sin 2 \theta}{\mathrm{~g}} \\ \therefore \quad & 1568=\frac{(280)^{2} \times \sin 2 \theta}{10}\end{aligned}$
$\therefore \quad \sin 2 \theta=\frac{10 \times 1568}{(280)^{2}}$
$\therefore \quad \sin 2 \theta=0.2$
But, $\sin ^{-1}(0.5)=30^{\circ} \Rightarrow \sin ^{-1}(0.2)<15^{\circ}$
$\therefore \quad \theta<7.5^{\circ} \quad \Rightarrow \theta \approx 6^{\circ}$
31. (D)

Using the equation for the centre of mass,
$\mathrm{x}=\frac{\mathrm{m}_{1} \mathrm{x}_{1}+\mathrm{m}_{2} \mathrm{x}_{2}+\mathrm{m}_{3} \mathrm{x}_{3}+\mathrm{m}_{4} \mathrm{x}_{4}}{\mathrm{~m}_{1}+\mathrm{m}_{2}+\mathrm{m}_{3}+\mathrm{m}_{4}}$
$\mathrm{x}=\frac{(3 \times 0)+(5 \times 0)+(7 \times 1)+(9 \times 1)}{3+5+7+9}=\frac{16}{24} \mathrm{~m}$
$y=\frac{(3 \times 0)+(5 \times 1)+(7 \times 1)+(9 \times 0)}{3+5+7+9}=\frac{12}{24} \mathrm{~m}$
32. (C)

$$
\begin{array}{rlrl} 
& \mathrm{v}_{\mathrm{e}} & =\sqrt{\frac{2 \mathrm{GM}}{\mathrm{R}+\mathrm{h}}} \\
& \therefore & \left(\mathrm{v}_{\mathrm{e}}\right)_{1} & =\sqrt{\frac{2 \mathrm{GM}}{2 \mathrm{R}}}=\mathrm{v} \text { and }\left(\mathrm{v}_{\mathrm{e}}\right)_{2}=\sqrt{\frac{2 \mathrm{GM}}{7 \mathrm{R}}} \\
& \therefore & \frac{\left(\mathrm{v}_{\mathrm{e}}\right)_{2}}{\left(\mathrm{v}_{\mathrm{e}}\right)_{1}} & =\sqrt{\frac{2 \mathrm{GM}}{7 \mathrm{R}} \times \frac{2 \mathrm{R}}{2 \mathrm{GM}}}=\sqrt{\frac{2}{7}} \\
& \therefore & \left(\mathrm{v}_{\mathrm{e}}\right)_{2} & =\sqrt{\frac{2}{7}}\left(\mathrm{v}_{\mathrm{e}}\right)_{1}=\frac{\sqrt{2} \mathrm{v}}{\sqrt{7}}
\end{array}
$$

33. (B)

Since car turns through $90^{\circ}$ after travelling 785 m on the circular road, the distance 785 m is quarter of the circumference of the circular path. If R is the radius of the circular path, then
$\frac{1}{4}(2 \pi \mathrm{R})=785 \mathrm{~m}$
$\therefore \quad \mathrm{R}=\frac{785 \times 2}{\pi}=\frac{785 \times 2}{3.14}=500 \mathrm{~m}$
$\mathrm{v}=10 \mathrm{~m} / \mathrm{s}, \mathrm{m}=1000 \mathrm{~kg}$
$\therefore \quad$ Centripetal force,
$\mathrm{F}_{\mathrm{cp}}=\frac{\mathrm{mv}^{2}}{\mathrm{R}}=\frac{1000 \times(10)^{2}}{500}=200 \mathrm{~N}$
34. (D)
35. (C)

Degree moved by hour hand,
for 1 revolution $=360^{\circ}$
for 1 hour $=\frac{360^{\circ}}{12}=30^{\circ}$
for $1 \mathrm{~min}=\frac{30}{60}=0.5^{\circ}$
$\therefore \quad$ for $30 \mathrm{mins}=30 \times 0.5^{\circ}=15^{\circ}$
Degree moved by the minute hand,
for 60 minutes $=360^{\circ}$
for 1 minute $=6^{\circ}$
for $30 \mathrm{mins}=6^{\circ} \times 30=180^{\circ}$
Hence, at 1:30 pm
Angular seperation $=180^{\circ}-15^{\circ}=165^{\circ}$
36. (D)

Orbital radius of satellites: $r_{1}=R+R=2 R$

$$
r_{2}=R+5 R=6 R
$$

P.E $E_{1}=\frac{-\mathrm{GMm}}{\mathrm{r}_{1}}$ and P.E $\mathrm{E}_{2}=\frac{-\mathrm{GMm}}{\mathrm{r}_{2}}$
K.E. $._{1}=\frac{\mathrm{GMm}}{2 \mathrm{r}_{1}}$ and $\mathrm{K} . \mathrm{E}_{2}=\frac{\mathrm{GMm}}{2 \mathrm{r}_{2}}$
$\mathrm{T} \cdot \mathrm{E}_{1}=\frac{-\mathrm{GMm}}{2 \mathrm{r}_{1}}$ and $\mathrm{T} \cdot \mathrm{E}_{2}=\frac{-\mathrm{GMm}}{2 \mathrm{r}_{2}}$

37. (B)
$4 \mathrm{~s}=8 \mathrm{t}+2 \mathrm{t}^{2} \Rightarrow \mathrm{~s}=\frac{1}{4}\left(8 \mathrm{t}+2 \mathrm{t}^{2}\right)$
Velocity $=\frac{\mathrm{ds}}{\mathrm{dt}}=\frac{1}{4}(8+4 \mathrm{t})$
Acceleration $=\frac{\mathrm{d}}{\mathrm{dt}}\left(\frac{\mathrm{ds}}{\mathrm{dt}}\right)=\frac{\mathrm{d}^{2} \mathrm{~s}}{\mathrm{dt}^{2}}=\frac{4}{4} \mathrm{~m} / \mathrm{s}^{2}=1 \mathrm{~m} / \mathrm{s}^{2}$
38. (A)
39. (C)
$\mathrm{v}_{\mathrm{e}}=\sqrt{\frac{2 \mathrm{GM}}{\mathrm{R}}}=\mathrm{c}$
(As escape velocity for a black hole is same as speed of light in vacuum)

$$
\begin{aligned}
\Rightarrow \mathrm{R} & =\frac{2 \mathrm{GM}}{\mathrm{c}^{2}}=\frac{2 \times 6.67 \times 10^{-11} \times 4.9 \times 10^{24}}{\left(3 \times 10^{8}\right)^{2}} \\
& =\frac{2 \times 6.67 \times 4.9}{9} \times 10^{-3} \mathrm{~m}=7.26 \times 10^{-3} \mathrm{~m}
\end{aligned}
$$

$\therefore \quad$ Order of magnitude $=10^{-2} \mathrm{~m}$
40. (D)

$\mathrm{F}_{\max }=\mu \mathrm{mg}=0.7 \times 3 \times 10$
$\therefore \quad \mathrm{F}_{\max }=21 \mathrm{~N}$
Acceleration of the system,
$\mathrm{a}=\frac{\mathrm{F}_{2}+\mathrm{F}_{1}}{\mathrm{~m}_{1}+\mathrm{m}_{2}} \frac{20+(-2)}{4+3}=2.57 \mathrm{~m} / \mathrm{s}$
Force of friction opposing the motion of 3 kg block
$=\mathrm{ma}+$ force acting in direction of friction.
$=(3 \times 2.57)+2=9.71 \mathrm{~N}$

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## Model Test Paper - 01

1. (C)
2. (A)

From the Bernoulli's Principle

$$
\begin{aligned}
\mathrm{P}_{1}-\mathrm{P}_{2} & =\frac{1}{2} \rho\left(\mathrm{v}_{2}^{2}-\mathrm{v}_{1}^{2}\right) \\
& =\frac{1}{2} \times 1.1 \times\left[(130)^{2}-(105)^{2}\right] \\
& =3231 \mathrm{~N} / \mathrm{m}^{2} \text { or pascal }
\end{aligned}
$$

3. (C)
4. (A)

Since $\mathrm{e} \propto \mathrm{B}$, so when magnetic field is doubled, induced e.m.f. will also becomes double.
5. (A)
$\mathrm{r}=36 \times 10^{-2} \mathrm{~m}$, total mass $=5 \mathrm{~kg}$
Let m and $(5-\mathrm{m})$ be the two masses
$\mathrm{F}=\frac{\mathrm{Gm} \mathrm{m}_{1} \mathrm{~m}_{2}}{\mathrm{r}^{2}}$
$\therefore \quad 3.24 \times 10^{-8}=\frac{6.67 \times 10^{-11} \times \mathrm{m} \times(5-\mathrm{m})}{\left(3.6 \times 10^{-1}\right)^{2}}$
$\therefore \quad 1 \times 10^{-8}=6.67 \times \frac{\mathrm{m}(5-\mathrm{m})}{4} \times 10^{-9}$
$\therefore \quad 10=\frac{40}{6} \times \frac{\mathrm{m}(5-\mathrm{m})}{4}$
$\therefore \quad \mathrm{m}^{2}-5 \mathrm{~m}+6=0 \Rightarrow(\mathrm{~m}-2)(\mathrm{m}-3)=0$
$\therefore \quad m=3$ or $m=2$
6. (B)
$\mathrm{n}_{\mathrm{A}}=300 \mathrm{~Hz}$,
Given that, $\left|\mathrm{n}_{\mathrm{A}}-\mathrm{n}_{\mathrm{B}}\right|=8$ b.p.s
When $B$ is loaded with wax, the number of beats reduces to 6 per second.
$\left|\mathrm{n}_{\mathrm{A}}-\mathrm{n}_{\mathrm{B}}\right|=6$ b.p.s
$\therefore \quad \mathrm{n}_{\mathrm{B}}=306 \mathrm{~Hz}$ or 294 Hz
The frequency 306 meets both the conditions
$\therefore \quad \mathrm{n}_{\mathrm{B}}>\mathrm{n}_{\mathrm{A}}$
$\therefore \quad \mathrm{n}_{\mathrm{B}}-\mathrm{n}_{\mathrm{A}}=6$ is the correct equation.
$\mathrm{n}_{\mathrm{B}}=\mathrm{n}_{\mathrm{A}}+6=300+6=306 \mathrm{~Hz}$
7. (A)

Using formula,
$\mu m g=m \omega^{2} r$
$\therefore \quad \omega=\sqrt{\frac{\mu \mathrm{g}}{\mathrm{r}}}$
$\omega=\sqrt{\frac{0.8 \times 10}{2}}=\sqrt{4}=2 \mathrm{rad} / \mathrm{s}$
8. (B)

$$
\begin{array}{ll} 
& \frac{\mathrm{I}_{\mathrm{g}}}{\mathrm{I}}=\frac{1}{34}=\frac{\mathrm{S}}{\mathrm{~S}+3774} \\
\therefore \quad & \mathrm{~S}=\frac{3774}{34}=111 \Omega
\end{array}
$$

9. (C)
10. (A)
$\mathrm{K}=\frac{1}{2} \mathrm{mv}^{2}=\frac{1}{2} \times \frac{\mathrm{m}\left(\mathrm{mv}^{2}\right)}{\mathrm{m}}=\frac{(\mathrm{mv})^{2}}{2 \mathrm{~m}} \Rightarrow \mathrm{~K}=\frac{\mathrm{p}^{2}}{2 \mathrm{~m}}$
$\therefore \quad \frac{\mathrm{K}_{1}}{\mathrm{~K}_{2}}=\frac{\mathrm{p}_{1}^{2}}{2 \mathrm{~m}_{1}} \times \frac{2 \mathrm{~m}_{2}}{\mathrm{p}_{2}^{2}} \Rightarrow \frac{4}{5}=\left(\frac{\mathrm{p}_{1}}{\mathrm{p}_{2}}\right)^{2} \times \frac{5}{9}$
$\therefore \quad \mathrm{p}_{1}: \mathrm{p}_{2}=6: 5$
11. (C)

For the blackbody,
Using, $\mathrm{Q}_{\mathrm{b}}=\sigma \mathrm{T}^{4}$,
$\therefore \quad 81=\sigma(200)^{4}$
For ordinary body, Using,
$\mathrm{Q}=\mathrm{e} \sigma \mathrm{T}^{4}$,
$\therefore \quad Q=0.8 \times \sigma \times(600)^{4}$
$=0.8 \times \frac{81}{(200)^{4}} \times(600)^{4} \quad$....From (i)
$\therefore \quad \mathrm{Q}=0.81 \times 81 \times 81=5248.8 \mathrm{~J} / \mathrm{m}^{2} \mathrm{~s}$
12. (C)
13. (A)
$\phi=\mathrm{LI}=5 \times 10^{-3} \times 4=0.02$ weber
14. (B)
$\theta=0^{\circ}, g^{\prime}=g_{P}-R \omega^{2} \cos ^{2} \theta=0$
$\therefore \quad \omega=\sqrt{\mathrm{g}_{\mathrm{P}} / \mathrm{R}}=\sqrt{12 /\left(7200 \times 10^{3}\right)}=1.29 \times 10^{-3} \mathrm{rad} / \mathrm{s}$
15. (D)

Here each segment of string is equivalent to wavelength $\frac{\lambda}{2}$.
$\therefore \quad 6$ segments cover a distance of 10 m
$10=6 \frac{\lambda}{2}$ or $\lambda=3.33 \mathrm{~m}$
Now $\mathrm{v}=\mathrm{n} \lambda$ or $\mathrm{n}=\frac{36}{3.33} \approx 11 \mathrm{~Hz}$
16. (A)

The potential at the centre is same as on surface i.e., 100 volt.
17. (D)

Internal resistance of a cell,
$\mathrm{r}=\mathrm{R}\left(\frac{l_{1}-l_{2}}{l_{2}}\right)=4\left(\frac{240-120}{120}\right)=4 \Omega$
18. (B)

Photoelectric current varies with variation in temperature, especially in lower temperature range, i.e., below $0^{\circ} \mathrm{C}$. Also, decrease in temperature causes increase in work function, there by affecting photoelectric emission.
19. (B)
20. (A)

Let molar heat capacity at constant pressure $=C_{P}$
and molar heat capacity at constant volume $=\mathrm{C}_{\mathrm{V}}$
$\therefore \quad \mathrm{C}_{\mathrm{P}}-\mathrm{C}_{\mathrm{V}}=\mathrm{R}$
Now, principal specific heat, $\mathrm{S}=\frac{\mathrm{C}}{\mathrm{M}}$

$$
\therefore \quad \mathrm{S}_{\mathrm{P}}-\mathrm{S}_{\mathrm{V}}=\frac{\mathrm{R}}{\mathrm{M}} \quad \therefore \quad \text { For } \mathrm{H}_{2}, \mathrm{a}=\frac{\mathrm{R}}{2}
$$

For $\mathrm{N}_{2}, \mathrm{~b}=\frac{\mathrm{R}}{28} \quad \therefore \quad \frac{\mathrm{a}}{\mathrm{b}}=14$
$\Rightarrow \mathrm{a}=14 \mathrm{~b}$
21. (B)
22. (D)

According to condition of parallel resonance for LC circuit, at resonant frequency ( $f_{r}$ ) impedance of circuit is maximum and current is minimum.
23. (C)
24. (B)
$\mathrm{T}_{1}=2 \mathrm{~s}$,
Original Length $=L_{1}$
Length after increase $=\mathrm{L}_{1}+\frac{0.2 \mathrm{~L}_{1}}{100}=\frac{100.2 \mathrm{~L}_{1}}{100}$
$\frac{\mathrm{T}_{1}}{\mathrm{~T}_{2}}=\sqrt{\frac{100}{100.2}}$
$\mathrm{T}_{2}=2 \sqrt{\frac{100.2}{100}}=2.0019 \approx 2.002$
Change in $2 \mathrm{sec}=2.002-2=0.002 \mathrm{~s}$
Change in one sec $=\frac{0.002}{2}=0.001 \mathrm{~s}$
Change in one day $=0.001 \times 86400=86.4 \mathrm{~s}$
This is loss as time period increases.
25. (B)
$\mathrm{C}=\frac{\mathrm{Q}}{\mathrm{V}}=\frac{75}{15-(-15)}=\frac{75}{30}=2.5 \mathrm{~F}$
26. (A)
$I=\frac{E}{R+r}=\frac{2}{990+10}=\frac{2}{1000} A$
$\therefore \quad \mathrm{V}=\mathrm{IR}=\frac{2}{1000} \times 10$
$\therefore \quad$ Potential gradient $=\frac{\mathrm{V}}{\mathrm{L}}=\frac{2}{100} \times \frac{1}{4}=0.005 \mathrm{~V} / \mathrm{m}$
27. (C)
$\mathrm{n}=1.5=\frac{\sin \left(\frac{\mathrm{A}+\delta_{\mathrm{m}}}{2}\right)}{\sin \left(\frac{\mathrm{A}}{2}\right)}$
Since $A=\delta_{m}$
$1.5=\frac{\sin \left(\frac{2 \mathrm{~A}}{2}\right)}{\sin \frac{\mathrm{A}}{2}}=\frac{2 \sin \frac{\mathrm{~A}}{2} \cos \frac{\mathrm{~A}}{2}}{\sin \frac{\mathrm{~A}}{2}}$
$\cos \frac{\mathrm{A}}{2}=0.75$
$\frac{\mathrm{A}}{2}=\cos ^{-1}(0.75)=41^{\circ}$
$\therefore \quad \mathrm{A}=2 \times 41^{\circ}=82^{\circ}$
28. (C)

For monatomic gas, $\gamma=\frac{\mathrm{C}_{\mathrm{P}}}{\mathrm{C}_{\mathrm{v}}}=\frac{5}{3}$
The fraction of heat energy used to increase the internal energy of gas is,
$\frac{\Delta \mathrm{U}}{\Delta \mathrm{Q}}=\frac{1}{\gamma}$.
$\frac{\Delta U}{\Delta \mathrm{Q}}=\frac{\mathrm{C}_{\mathrm{V}}}{\mathrm{C}_{\mathrm{P}}}=\frac{3}{5}=0.6$
Similarly, from Fraction of given heat energy utilised in doing external work is given by the formula,

$$
\begin{aligned}
& \left(\frac{\Delta \mathrm{W}}{\Delta \mathrm{Q}}\right)=\left(1-\frac{1}{\gamma}\right) \\
& \frac{\Delta \mathrm{W}}{\Delta \mathrm{Q}}=1-\frac{1}{\gamma}=\frac{2}{5}=0.4
\end{aligned}
$$

$\therefore \quad$ Percentage of heat utilized in increasing internal energy,
$\frac{\Delta \mathrm{U}}{\Delta \mathrm{Q}} \times 100=0.6 \times 100=60 \%$
$\frac{\Delta W}{\Delta \mathrm{Q}} \times 100=0.4 \times 100=40 \%$
29. (B)

Cyclotron frequency, $\mathrm{f}=\frac{\mathrm{qB}}{2 \pi \mathrm{~m}}$
where, $\mathrm{q}=$ charge of proton
$\therefore \quad \mathrm{f}=\frac{1.6 \times 10^{-19} \times 2.8}{\left(2 \times \frac{22}{7} \times 1.6 \times 10^{-27}\right)}=4.46 \times 10^{7} \mathrm{~Hz}$
30. (B)
31. (B)

The collector current is given by,
$\mathrm{I}_{\mathrm{C}}=\frac{\mathrm{V}_{\mathrm{C}}}{\mathrm{R}_{\mathrm{C}}}=\frac{0.6 \mathrm{~V}}{600 \Omega}=1 \times 10^{-3} \mathrm{~A}=1 \mathrm{~mA}$
$\beta=\frac{I_{C}}{I_{B}} \Rightarrow I_{B}=\frac{I_{C}}{\beta}=\frac{1}{20}=0.05 \mathrm{~mA}$
32. (C)

Given: $\mathrm{k}_{1}=1800 \mathrm{~N} / \mathrm{m}$ and $\mathrm{k}_{2}=3600 \mathrm{~N} / \mathrm{m}$
Potential energy $E=\frac{1}{2} \mathrm{kx}^{2} \ldots$.(i)

Also $\mathrm{F}_{1}=\mathrm{F}_{2}$ (Given)
$\because \quad \mathrm{F}=\mathrm{kx}$
$\therefore \quad \mathrm{x}=\frac{\mathrm{F}}{\mathrm{k}}$
Substituting in equation (i),
$\mathrm{E}=\frac{1}{2} \mathrm{k} \frac{\mathrm{F}^{2}}{\mathrm{k}^{2}}$
$\therefore \quad \mathrm{E}=\frac{\mathrm{F}^{2}}{2 \mathrm{k}}$
$\therefore \quad \mathrm{E} \propto \frac{1}{\mathrm{k}}$
$\therefore \quad \frac{\mathrm{E}_{1}}{\mathrm{E}_{2}}=\frac{\mathrm{k}_{2}}{\mathrm{k}_{1}}=\frac{3600}{1800}=\frac{2}{1}$
33. (C)

Potential energy $U=\frac{1}{4 \pi \varepsilon_{0}} \frac{\mathrm{q}_{1} \mathrm{q}_{2}}{\mathrm{r}}$
where, $\mathrm{q}_{1}=80 \mathrm{e}=80 \times 1.6 \times 10^{-19} \mathrm{C}$,

$$
\mathrm{q}_{2}=1.6 \times 10^{-19} \mathrm{C}, \mathrm{r}=10^{-12} \mathrm{~m}
$$

$\mathrm{U}=\frac{9 \times 10^{9} \times 80 \times 1.6 \times 10^{-19} \times 1.6 \times 10^{-19}}{10^{-12}}$

$$
=1.843 \times 10^{-14} \mathrm{~J}
$$

34. (A)
$\mathrm{r}_{\mathrm{n}} \propto \mathrm{n}^{2}$
$\therefore \quad \mathrm{A} \propto \mathrm{r}^{2} \propto \mathrm{n}^{4}$
Third excited state refers to fourth energy level,
$\therefore \quad \frac{\mathrm{A}_{2}}{\mathrm{~A}_{1}}=\left(\frac{\mathrm{n}_{2}}{\mathrm{n}_{1}}\right)^{4}=\left(\frac{4}{1}\right)^{4}=256$
$\therefore \quad \mathrm{A}_{2}=256 \mathrm{~A}_{1}=256 \mathrm{~A}$
35. (B)

Pressure difference between lungs and atmosphere $=760 \mathrm{~mm}-748 \mathrm{~mm}=12 \mathrm{~mm}=$ 1.2 cm of Hg

Also, pressure difference $=\mathrm{h} \rho \mathrm{g}$
$\therefore \quad(\mathrm{h} \rho \mathrm{g})_{\text {mercury }}=(\mathrm{h} \rho \mathrm{g})_{\text {water }}$
$\therefore \quad 1.2 \times 13.6 \times \mathrm{g}=\mathrm{h}_{\mathrm{w}} \times 1 \times \mathrm{g}$

$$
\ldots\left(\because \rho_{\text {water }}=1 \mathrm{~g} / \mathrm{cm}^{3}\right)
$$

$\therefore \quad h_{w}=1.2 \times 13.6=16.32 \mathrm{~cm}$
36. (D)
37. (C)
38. (C)

We have, $\mathrm{X}_{\mathrm{C}}=\frac{1}{\mathrm{C} \times 2 \pi \mathrm{f}}$ and $\mathrm{X}_{\mathrm{L}}=\mathrm{L} \times 2 \pi \mathrm{f}$
39. (B)

Zener breakdown voltage $=5 \mathrm{~V}$
$\therefore \quad$ Potential across $2.5 \mathrm{k} \Omega=5 \mathrm{~V}$
and potential across $5 \mathrm{k} \Omega=(10-5)=5 \mathrm{~V}$
Current through the $5 \mathrm{k} \Omega=\frac{5}{5000}$

$$
=\frac{1}{1000} \mathrm{~A}=1 \mathrm{~mA}
$$

40. (A)

Total (K.E) $)_{\text {ring }}=\mathrm{Mv}^{2}$
$\operatorname{Total}(K . E)_{\text {disc }}=\frac{3}{4} \mathrm{Mv}^{2}$
Dividing equation (ii) by equation (i)
$\frac{(\mathrm{K} . \mathrm{E})_{\text {disc }}}{(\mathrm{K} . \mathrm{E})_{\text {ring }}}=\frac{\frac{3}{4} \mathrm{Mv}^{2}}{\mathrm{Mv}^{2}}$
$\therefore \quad(\mathrm{K} . \mathrm{E})_{\text {disc }}=(\mathrm{K} . \mathrm{E})_{\text {ring }} \times \frac{3}{4}=8 \times \frac{3}{4}=6 \mathrm{~J}$
41. (D)
42. (A)
43. (D)

Mass $=$ Volume $\times$ Density $\Rightarrow M=\frac{4}{3} \pi r^{3} \times \rho$
As the density remains constant
$\therefore \quad \mathrm{M} \propto \mathrm{r}^{3}$
$\therefore \quad \frac{\mathrm{r}_{1}}{\mathrm{r}_{2}}=\left(\frac{\mathrm{M}_{1}}{\mathrm{M}_{2}}\right)^{1 / 3}=\left(\frac{\mathrm{M}}{\mathrm{M} / 8}\right)^{1 / 3}=2$
Terminal velocity, $v=\frac{2}{9} \frac{r^{2}(\rho-\sigma) g}{\eta}$
$\therefore \quad \mathrm{v} \propto \mathrm{r}^{2}$
$\therefore \quad \frac{\mathrm{v}_{1}}{\mathrm{v}_{2}}=\left(\frac{\mathrm{r}_{1}}{\mathrm{r}_{2}}\right)^{2}$
$\frac{\mathrm{v}}{\mathrm{nv}}=\left(\frac{\mathrm{r}_{1}}{\mathrm{r}_{2}}\right)^{2}$ or $\frac{1}{\mathrm{n}}=(2)^{2} \quad \ldots .[\operatorname{Using}(\mathrm{i})]$
$\Rightarrow \mathrm{n}=\frac{1}{4}=0.25$
44. (D)

The bandwidth is given by,
$\mathrm{W}=\frac{\lambda \mathrm{D}}{\mathrm{d}} \Rightarrow \mathrm{d}=\frac{\lambda \mathrm{D}}{\mathrm{W}}$
$\therefore \quad \mathrm{d}=\frac{8000 \times 10^{-10} \times\left(30 \times 10^{-2}\right)}{0.012 \times 10^{-2}}=0.2 \mathrm{~cm}$
45. (B)

Repelled due to induction of similar poles.
46. (A)

$$
\begin{aligned}
\gamma & =\frac{\text { change in volume }}{\text { original volume } \times \text { change in temperature }} \\
& =\frac{0.75}{100 \times 196}=38.3 \times 10^{-6} /{ }^{\circ} \mathrm{C}
\end{aligned}
$$

47. (B)

Fundamental frequency $n_{1}=80 \mathrm{~Hz}$
For closed organ pipe, second overtone means fifth harmonic so its frequency is
$\mathrm{n}_{5}=5 \mathrm{n}_{1}=5 \times 80=400 \mathrm{~Hz}$
48. (A)

The acceleration of the slipping ring is,
$\mathrm{a}_{\text {slipping }}=\mathrm{g} \sin \theta$
The acceleration of the rolling ring is,
$a_{\text {rolling }}=\frac{g \sin \theta}{\left(1+\frac{\mathrm{K}^{2}}{\mathrm{R}^{2}}\right)}=\frac{\mathrm{g} \sin \theta}{\left(1+\frac{1}{1}\right)}=\frac{\mathrm{g} \sin \theta}{2}$
$\therefore \quad \frac{\mathrm{a}_{\text {rolling }}}{\mathrm{a}_{\text {slipping }}}=\frac{1}{2}$
49. (C)

Electric field inside a conductor is always zero.
50. (C)
$\because \quad \frac{1}{\lambda}=\mathrm{R}\left[\frac{1}{\mathrm{n}^{2}}-\frac{1}{\mathrm{~m}^{2}}\right]$
For Brackett series,
$\frac{1}{\lambda_{\mathrm{Br}}}=\mathrm{R}\left[\frac{1}{4^{2}}-\frac{1}{\mathrm{~m}^{2}}\right]$
$\therefore \quad \frac{1}{\lambda_{\alpha}}=\mathrm{R}\left[\frac{1}{4^{2}}-\frac{1}{5^{2}}\right]=\frac{9 \mathrm{R}}{400}$
$\frac{1}{\lambda_{\beta}}=\mathrm{R}\left[\frac{1}{4^{2}}-\frac{1}{6^{2}}\right]=\frac{5 \mathrm{R}}{144}$
$\therefore \quad$ Dividing equation (ii) by equation (i),
$\frac{\lambda_{\alpha}}{\lambda_{\beta}}=\frac{5 \mathrm{R}}{144} \times \frac{400}{9 \mathrm{R}}=\frac{125}{81}=1.54$


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