Sample Paper for JEE-Mains

Subject: Physics (Paper-3)

Mr. Dinesh Yadav

B.Tech (IIT-Delhi)

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Only one option is correct.

1. In a vernier callipers, N divisions of the main scale coincide with N + m divisions of the vernier scale. What is the value of m for which the instrument has minimum least count ? **[Vernier callipers]**

   (a) 1 (b) N (c) $\frac{N}{10}$ (d) N/2

2. The pitch of a screw gauge having 50 divisions on its circular scale is 1 mm. When the two jaws of the screw guage are in contact with each other, the zero of the circular scale lies 6 division below the line of graduation. When a wire is placed between the jaws, 3 linear scale divisions are clearly visible while 31^{th} division on the circular scale coincide with the reference line. The diameter of the wire is **[Screw Gauge with Negative Error]**

   (a) 3.62 mm (b) 3.50 mm (c) 3.55 mm (d) 3.74 mm

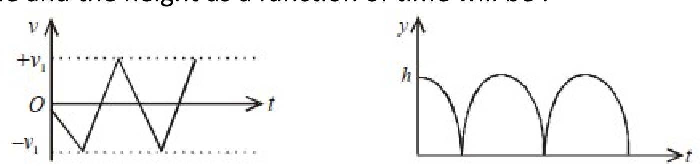
3. A shell is fired from a fixed artillery gun with an initial speed u such that it hits the target on the ground at a distance R from it. If t_1 and t_2 are the values of the time taken by it to hit the target in two possible ways, the product $t_1 t_2$ is **[Projectile Motion on Horizontal Plane]**

   (a) $\frac{R}{4g}$ (b) $\frac{R}{g}$ (c) $\frac{R}{2g}$ (d) $\frac{2R}{g}$

4. 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 u, The boy at A starts running simultaneously with velocity v to follow B and catches B in a time t where t is **[Relative Motion]**

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

5. Consider a rubber ball freely falling from a height h = 4.9 m onto a horizontal elastic plate. Assume that the duration of collision is negligible and the collision with the plate is totally elastic. Then the velocity as a function of time and the height as a function of time will be : **[Concept of Graph]**

(a)


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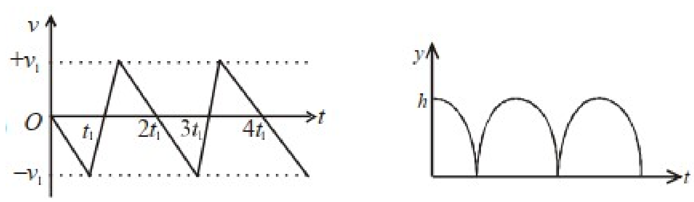

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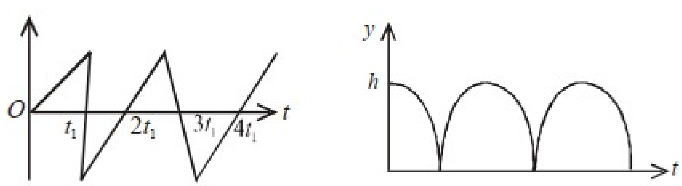

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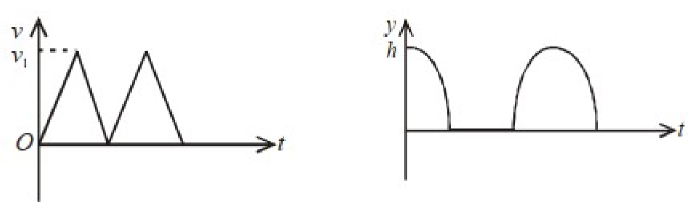
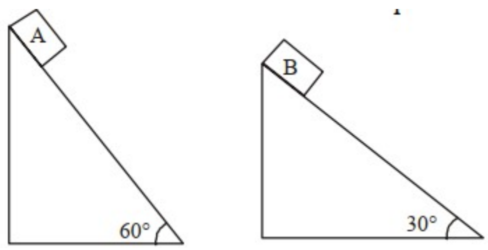


6. Two forces $\vec{A}$ and $\vec{B}$ inclined at an angle have a resultant $\vec{R}$ which makes an angle α with $\vec{A}$ and angle β with $\vec{B}$. Let the magnitudes of the vectors $\vec{A}$, $\vec{B}$ and $\vec{R}$ be represented by *A, B* and *R* respectively. Which of the following relations is **not** correct ? **[Concept of Vector Addition & Lami's Theorem]**

(a) $\frac{R}{\sin(\alpha+\beta)} = \frac{A}{\sin\alpha} = \frac{B}{\sin\beta}$ (b) $R\sin\alpha = B\sin(\alpha+\beta)$

(c) $A\sin\alpha = B\sin\beta$ (d) $R\sin\beta = A\sin(\alpha+\beta)$

7. Two fixed frictionless inclined planes making an angle 30° and 60° with the vertical are shown in the figure. Two blocks A and B are placed on the two planes. What is the relative vertical acceleration of A with respect to B ?



[Relative motion & Laws of Motion]

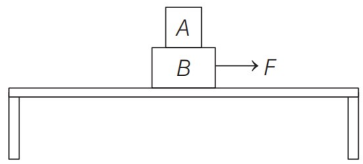
(a) 4.9 ms^{-2} in horizontal direction
(b) 9.8 ms^{-2} in vertical direction
(c) Zero
(d) 4.9 ms^{-2} in vertical direction

8. A particle moving in the *xy* plane experiences a velocity dependent force $\vec{F} = k(v_y\hat{i} + v_x\hat{j})$, where v_x and v_y are *x* and *y* components of its velocity $\vec{v}$. if $\vec{a}$ is the acceleration of the particle, then which of the following statements is true for the particle? **[Work done by Variable Force]**
(a) quantity $\vec{v} \times \vec{a}$ is constant in time
(b) $\vec{F}$ arises due to a magnetic field
(c) kinetic energy of particle is constant in time
(d) quantity $\vec{v} \cdot \vec{a}$ is constant in time

9. A uniform chain of mass *M* and length *L* is held vertically in such a way that its lower end just touches the horizontal floor. The chain is released from rest in this position. Any portion that strikes the floor comes to rest. Assuming that the chain does not form a heap on the floor, the force exerted by it on the floor when a length *x* has reached the floor is **[Impulse]**
(a) *Mgx/L* (b) *2Mgx/L* (c) *3Mgx/L* (d) *Mgx/2L*

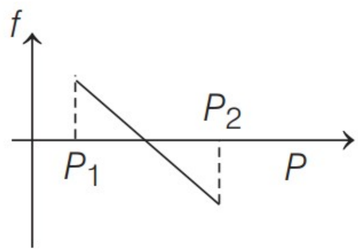
10. A body of mass '*m*' is tied to one end of a spring and whirled round in a horizontal plane with a constant angular velocity. The elongation in the spring is 1 cm. If the angular velocity is doubled, the elongation in the spring is 5 cm. The original length of the spring is : **[Centripetal Force & Spring Force]**
(a) 15 cm (b) 12 cm (c) 16 cm (d) 10 cm

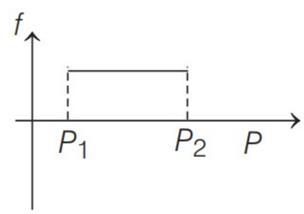
11. Two blocks *A* and *B* of masses m_A = 1kg and m_B = 3 kg are kept on the table as shown in figure. The coefficient of friction between *A* and *B* is 0.2 and between *B* and the surface of the table is also 0.2. The maximum force *F* that can be applied on *B* horizontally, so that the block *A* does not slide over the block *B* is
[Take, g = 10 m/ s^2] **[Friction Force – Two Blocks Problem]**

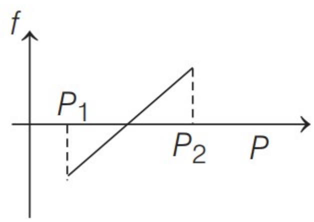


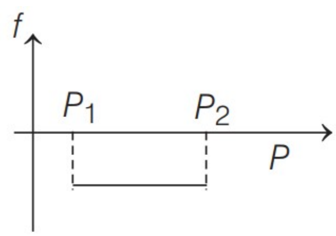
(a) 12 N (b) 16 N (c) 8 N (d) 40 N

12. A block of mass *m* is on an inclined plane of angle θ. The coefficient of friction between the block and the plane is μ and tan θ >μ .The block is held stationary by applying a force *P* parallel to the plane. The direction of force pointing up the plane is taken to be positive. As *P* is varied from $P_1 = mg(\sin\theta - \mu\cos\theta)$ to $P_2 = mg(\sin\theta + \mu\cos\theta)$ then the frictional force *f versus P* graph will look like **[Friction Force on inclined Plane]**

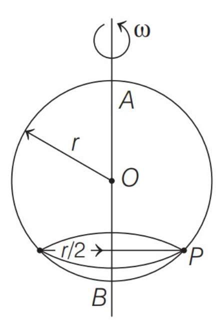
(a) 

(b) 

(c) 

(d) 

13. A smooth wire of length 2π*r* is bent into a circle and kept in a vertical plane. A bead can slide smoothly on the wire. When the circle is rotating with angular speed ω about the vertical diameter *AB*, as shown in figure, the bead is at rest with respect to the circular ring at position *P* as shown. Then, the value of ω^2 is equal to
[Dynamics of Circular Motion]



(a) $\frac{\sqrt{3}g}{2r}$ (b) $\frac{2g}{r\sqrt{3}}$

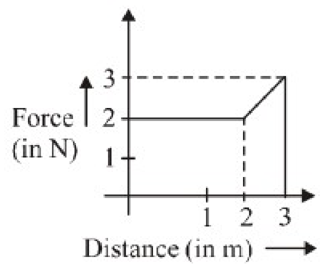
(c) $\frac{\sqrt{3}g}{r}$ (d) $\frac{2g}{r}$

14. A person pushes a box on a rough horizontal platform surface. He applies a force of 200 N over a distance of 15 m. Thereafter, he gets progressively tired and his applied force reduces linearly with distance to 100 N. The total distance through which the box has been moved is 30 m. What is the work done by the person during the total movement of the box ? ***[Work done by variable force & linear equation]***

(a) 3280 J (b) 2780 J

(c) 5690 J (d) 5250 J

15. A particle moves in one dimension from rest under the influence of a force that varies with the distance travelled by the particle as shown in the figure. The kinetic energy of the particle after it has travelled 3 m is : ***[Work done by Graph & Work energy theorem]***



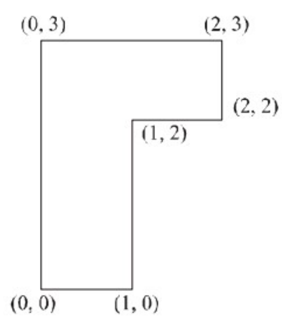
(a) 4 J (b) 2.5 J (c) 6.5 J (d) 5 J

16. A wind-powered generator converts wind energy into electrical energy. Assume that the generator converts a fixed fraction of the wind energy intercepted by its blades into electrical energy. For wind speed v, the electrical power output will be most likely proportional to **[Power]**

(a) v^4 (b) v^3 (c) v^2 (d) v

17. A moving particle of mass *m*, makes a head on elastic collision with another particle of mass 2*m*, which is initially at rest. The percentage loss in energy of the colliding particle on collision, is close to **[Elastic Collision]**
(a) 33% (b) 67% (c) 90% (d) 10%

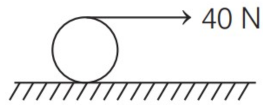
18. The coordinates of centre of mass of a uniform flag shaped lamina (thin flat plale) of mass 4 kg. (The coordinates of the same are shown in figure) are: **[Position of COM]**



(a) (1.25 m, 1.50 m) (b) (0.75 m, 1.75 m) (c) (0.75 m, 0.75 m) (d) (1 m, 1.75)

19. A boy of mass 20 kg is standing on a 80 kg free to move long cart. There is negligible friction between cart and ground. Initially, the boy is standing 25 m from a wall. If he walks 10 m on the cart towards the wall, then the final distance of the boy from the wall will be **[Motion of Centre of Mass]**
(a) 15 m (b) 12.5 m (c) 15.5 m (d) 17 m

20. A string is wound around a hollow cylinder of mass 5 kg and radius 0.5 m. If the string is now pulled with a horizontal force of 40 N and the cylinder is rolling without slipping on a horizontal surface (see figure), then the angular acceleration of the cylinder will be **[Rolling Motion]**
(Neglect the mass and thickness of the string)



(a) 10 rad/ s^2 (b) 16 rad/ s^2 (c) 20 rad/ s^2 (d) 12 rad/ s^2

21. Two solid cylinders *P* and *Q* of same mass and same radius start rolling down a fixed inclined plane from the same height at the same time. Cylinder *P* has most of its mass concentrated near its surface, while *Q* has most of its mass concentrated near the axis. Which statement is correct? **[Rolling Motion on Inclined Plane]**
(a) Both cylinders *P* and *Q* reach the ground at the same time
(b) Cylinder *P* has larger linear acceleration than cylinder *Q*
(c) Both cylinders reach the ground with same translational kinetic energy
(d) Cylinder *Q* reaches the ground with larger angular speed

22. A thin smooth rod of length *L* and mass *M* is rotating freely with angular speed ω_0 about an axis perpendicular to the rod and passing through its centre. Two beads of mass *m* and negligible size are at the centre of the rod initially. The beads are free to slide along the rod. The angular speed of the system, when the beads reach the opposite ends of the rod, will be **[Conservation of Angular Momentum]**

(a) $\frac{M\omega_0}{M+3m}$ (b) $\frac{M\omega_0}{M+m}$ (c) $\frac{M\omega_0}{M+2m}$ (d) $\frac{M\omega_0}{M+6m}$

23. A cylinder rolls up an inclined plane, reaches some height and then rolls down (without slipping throughout these motions). The directions of the frictional force acting on the cylinder are
[Rolling Motion on Inclined Plane]
(a) up the incline while ascending and down the incline while descending
(b) up the incline while ascending as well as descending
(c) down the incline while ascending and up the incline while descending
(d) down the incline while ascending as well as descending

24. A smooth sphere *A* is moving on a frictionless horizontal plane with angular velocity ω and centre of mass velocity *v*. It collides elastically and head on with an identical sphere *B* at rest. Neglect friction everywhere. After the collision their angular speeds are ω_A and ω_B respectively. Then,
[Collision in Rolling Motion]
(a) $\omega_A < \omega_B$ (b) $\omega_A = \omega_B$ (c) $\omega_A = \omega$ (d) $\omega_B = \omega$

25. Let *I* be the moment of inertia of a uniform square plate about an axis *AB* that passes through its centre and is parallel to two of its sides. *CD* is a line in the plane of the plate that passes through the centre of the plate and makes an angle θ with *AB*. The moment of inertia of the plate about the axis *CD* is then equal to
[Moment of Inertia]
(a) I (b) $I\sin^2\theta$ (c) $I\cos^2\theta$ (d) $I\cos^2(\theta/2)$

Answer Key

1- a	**2- d**	**3- d**	**4- d**	**5- b**
6- a	**7- d**	**8- a**	**9- c**	**10- a**
11- b	**12- a**	**13- b**	**14- d**	**15- c**
16- b	**17- c**	**18- b**	**19- d**	**20- b**
21- d	**22- d**	**23- b**	**24- c**	**25- a**