

(7 pages)

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JMMC52

B.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2018.

Fifth Semester

Mathematics/Mathematics with CA – Main

MECHANICS

(For those who joined in July 2016 onwards)

Time : Three hours

Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer:

1. Two equal forces of magnitude P made 60° between then their resultant is of magnitude

- (a) $\sqrt{3}P$ (b) $\sqrt{2}P$
(c) $2P$ (d) $\frac{P}{\sqrt{2}}$

2. The magnitude of the resultant of two like parallel forces is their _____.

- (a) sum (b) difference
(c) one of the force (d) product

3. In a Catenary, the relation between y and ψ is

- (a) $y = c \operatorname{cosec} \psi$ (b) $y = c \tan \psi$
(c) $y = c \sec \psi$ (d) $\psi = c \cos y$

4. The lowest point of the Catenary is called _____.

- (a) origin (b) lowest point
(c) centre (d) vertex

5. The angle of projection for the maximum horizontal range is $\alpha =$ _____.

- (a) 60° (b) 45°
(c) 30° (d) 120°

6. A projectile is thrown with a velocity of 20 m/sec at an elevation of 30° . The greatest height attained by the projectile is

- (a) 5.1 m (b) 5.5 m
(c) 5.0 m (d) 5.3 m

Page 2 Code No. : 41147 E



7. The period of oscillation of the seconds pendulum is

- (a) one second (b) two seconds
(c) three seconds (d) none

8. If the amplitude of a SHM is 'a' and the greatest speed is 'u' then the period of oscillation is _____.

- (a) $\frac{2\pi a^2}{u}$ seconds (b) $\frac{2\pi u}{a}$ seconds
(c) $\frac{2\pi a}{u}$ seconds (d) $\frac{\pi a}{2u}$ seconds

9. The real velocity of a particle moving in a central orbit is

- (a) $r\dot{\theta}$ (b) 0
(c) $r^2\dot{\theta}$ (d) $\frac{1}{2}r^2\dot{\theta}$

10. The $p-r$ equation of the parabola is

- (a) $\frac{b^2}{p^2} = \frac{2a}{r} - 1$ (b) $\frac{b^2}{p^2} = \frac{2a}{r} + 1$
(c) $p^2 = ar$ (d) $p = kr$

PART B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) S is the circumcentre of the triangle ABC . Forces of magnitudes P, Q, R act along SA, SB, SC respectively and are in equilibrium. Show that
 $P : Q : R = \sin 2A : \sin 2B : \sin 2C$.

Or

- (b) Find the condition of equilibrium of three coplanar parallel forces.

12. (a) State and prove the Geometrical properties of the common Catenary.

Or

- (b) A uniform chain of length 'l' is suspended from two points A, B in the same horizontal line. If the tension at A is twice that at the lowest point then show that the span
 $AB = \frac{l}{\sqrt{3}} \log(2 + \sqrt{3})$.

13. (a) If v_1 and v_2 are the velocities of a projectile at the ends of a focal chord of its path and u is the velocity at the vertex then prove that
 $v_1^{-2} + v_2^{-2} = u^{-2}$.

Or

- (b) Prove that the path of a projectile is a parabola.



14. (a) Show that the energy of a system executing S.H.M is proportional to the square of the amplitude and of the frequency.

Or

- (b) In a SHM, if f is the acceleration, v is the velocity and T is the periodic time then prove that $f^2 T^2 + 4\pi^2 v^2$ is a constant.
15. (a) If a point moves so that its radial velocity is ' k ' times its transverse velocity then show that its path is an equiangular spiral.

Or

- (b) Find the law of force under which the curve $r^n = a^n \cos n\theta$ can be described.

PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) Find the resultant of two like parallel forces acting on a body.

Or

- (b) A weight is supported on a smooth plane of inclination ' α ' by a string inclined to the horizon at an angle ' γ '. If the slope of the plane be increased to ' β ' and the slope of the string unaltered, the tension of the string is doubled. Prove that $\cot \alpha - 2 \cot \beta = \tan \gamma$.

Page 5 Code No. : 41147 E

17. (a) A uniform chain is suspended from two point A and B . A being ' h ' meters higher than B . The inclinations of the chain to the horizontal at A and B are ψ_1 and ψ_2 . Show that the total length of the chain is $h \cos \left(\frac{\psi_1 + \psi_2}{2} \right) \operatorname{cosec} \left(\frac{\psi_1 - \psi_2}{2} \right)$ meters.

Or

- (b) Derive the Cartesian equation of a common Catenary. Also find the tension at (x, y) on the Catenary.

18. (a) A body is projected at angle ' α ' to the horizontal, so as to clear two walls of equal height ' a ' at a distance ' $2a$ ' from each other. Show that the range is $2a \cot \left(\frac{\alpha}{2} \right)$.

Or

- (b) If t_1, t_2 are the two times of flight with which a given range R on a horizontal plane can be reached by a particle projected with velocity u then prove that t_1, t_2 are the roots of the equation $g^2 t^4 - 4u^2 t^2 + 4R^2 = 0$.

Page 6 Code No. : 41147 E



19. (a) Derive the composition of two SHM's of the same period in the same straight line.

Or

- (b) The displacement x of a particle moving along a straight line is given by $x = a \cos nt + b \sin nt$. Show that the motion is simple harmonic with amplitude $\sqrt{a^2 + b^2}$ and period $\frac{2\pi}{n}$.

20. (a) A particle moves in an ellipse under a force which is always directed towards its focus. Find the law of force, its periodic time and the velocity at any point of the path.

Or

- (b) A particle moves with uniform speed ' v ' along the curve $r = a(1 + \cos \theta)$. Show that its angular velocity about the pole is $\frac{v \sec \theta / 2}{2a}$.

