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SARDAR PATEL UNIVERSITY

BSc Sem V Examination

Mathematics

US05CMTH06-Mechanics-I

Date : 22-11-19, Friday **Time : 10:00 TO 01:00** P.M.

Q. 1 Answer the following by selecting correct choice from the options. **(10)**

1. The resultant of two force is minimum, then angle between them is _______

A. 0° B. π
C. $\frac{\pi}{2}$ D. $\frac{\pi}{4}$

2. ________ is not a vector quantity .

A. Velocity B. Force
C. Speed D. Acceleration

3. 1 mile =________km

A. 16.2 B. 1.62
C. 1.26 D. 1.6

4. The point of concurrence of the altitudes of a triangle is called_______

A. Orthocentre B. Circumcentre
C. Incentre D. Centroid

5. If particle is in equilibrium then the sum of the moments about a line of all external forces is ______

A. 1 B. 2
C. 0 D. −1

6. The mass centre of the area in the first quadrant of the curve $x^2 + y^2 = a^2$.

E. $\left(\frac{4a}{3\pi}, \frac{4a}{3\pi}\right)$ F. $\left(\frac{3a}{4\pi}, \frac{3a}{4\pi}\right)$
G. $\left(\frac{4a}{\pi}, \frac{4a}{\pi}\right)$ H. $\left(\frac{4a}{3\pi}, \frac{a}{3\pi}\right)$

7. $1\ hp. =$ ________ .

A. $550\ g\ cm^2\ sec^{-2}$ B. $550\ ft\ lb\ wt\ sec^{-1}$
C. $550\ lb\ wt\ sec^{-1}$ D. $550\ ft\ lb\ wt\ sec^{-2}$

8. Work done is $\delta w =$________

A. $F\cos\theta\delta S$ B. $F\delta S$
C. $F\sin\theta\delta S$ D. FS

9. $\sqrt{\dot{x}^2 + \dot{y}^2} =$ ______

A. a B. v
C. $\sqrt{a}$ D. $\sqrt{v}$

10. Radial component of velocity of a particle moving in a plane is _____

A. $\dot{v}$ B. $\dot{r}$
C. $\dot{r}\,\theta$ D. $r\,\dot{\theta}$

 (PTO)

Q. 2 Answer any TEN. **(20)**

1) Define (i) Rigid body (ii) Frame of reference.
2) State Fundamental laws of Newtonian Mechanics.
3) Explain addition of vectors by parallelogram.
4) Define moment and discuss its geometric interpretation.
5) Three forces acting at a point are in equilibrium. If $|\bar{P}| = |\bar{Q}| = |\bar{R}|$ then find the angle between two forces.
6) Define equipollent system of forces.
7) In usual notations prove that $M = \pm pa$.
8) Define conservative system.
9) Define the work done.
10) A particle moves in a plane with constant speed. Prove that it's acceleration is perpendicular to the velocity.
11) Explain the term Hodograph.
12) In usual notations prove that $S = c\ sinh\frac{x}{c}$.

Q. 3 (a) Explain gradient vector. Find the component of gradient of V along coordinate axis. **(5)**

(b) A particle moves on a straight line under a retardation v^{m+1} , where v is the velocity

At time t, show that $ks = \frac{1}{m-1}\left[\frac{1}{v^{m-1}} - \frac{1}{u^{m-1}}\right]$ and $kt = \frac{1}{m}\left[\frac{1}{v^{m}} - \frac{1}{u^{m}}\right]$ where u is the initial velocity. **(5)**

OR

Q.3 (c) If $V = x^2 + y^2 + z^2 + xy + x$, at what point in the space $grade\ V$ is parallel to Z –axis? **(5)**

(d) Forces of magnitudes 3, 4 and 5 $lbwt.$ act at a point in the direction parallel to the sides of equilateral triangle taken in order. Find their resultant force. **(5)**

Q.4 (a) State and prove Lamy's theorem. **(5)**

(b) If O is the orthocenter of ΔABC. Forces $\bar{P}, \bar{Q}$ and $\bar{R}$ are acting along $\overline{OA}, \overline{OB}$ and $\overline{OC}$ are in equilibrium. If $BC = a, CA = b, AB = c$ then show that

$$\frac{P}{a^2(b^2+c^2-a^2)} = \frac{Q}{b^2(a^2+c^2-b^2)} = \frac{R}{c^2(b^2+c^2-a^2)}$$ **(5)**

OR

Q. 4(c) State and prove theorem of triangle of forces. **(5)**

(d) Three forces $\bar{P}, \bar{Q}$ and $\bar{R}$ acting at a point are in equilibrium and angle between $\bar{P}$ and $\bar{Q}$ is double of the angle between $\bar{P}$, and $\bar{R}$. Prove that $R^2 = Q(Q - P)$. **(5)**

Q. 5 (a) State and prove principle of virtual work. **(5)**

(b) In usual notations prove that $\delta x = \delta a - (y - b)\delta\theta$ and $\delta y = \delta b + (x - a)\delta\theta$. **(5)**

OR

Q. 5 (c) Find the mass center of the area in the first quadrant bounded by $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$. **(5)**

(d) State and prove Pappu's theorem for a plane curve. **(5)**

Q.6 (a) Derive the general formula for the flexible cable hanging freely. **(5)**

(b) In usual notations, prove that $T = wy + H$, where $w = \frac{H}{c}$. **(5)**

OR

Q.6 (c) In usual notations, prove that $T = T_0 e^{\mu\theta}$, where T_0 is constant and μ is the coefficient of friction **(5)**

(d) Obtain tangential and normal component of velocity and acceleration of a particle moving in a plane. **(5)**

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