STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086
(For candidates admitted from the academic year 2023 – 2024)

B. Sc. DEGREE EXAMINATION, APRIL 2024
BRANCH III - PHYSICS
SECOND SEMESTER

COURSE : MAJOR CORE
PAPER : MECHANICS
SUBJECT CODE : 23PH /MC/ME24
TIME : 3 HOURS MAX. MARKS : 100

Q. No.	SECTION A **Answer ALL the questions (20 x 1 = 20 marks)**	CO	KL
1	Which of the following is the SI unit of force? (a) Kg m (b) Kg m^2 (c) Kg m^2/s (d) Kg m/s^2	1	1
2	The sun is positioned _____ of the planet's orbit according to Kepler's law of orbit. (a) in the center (b) in one of the foci (c) in both foci (d) along the semi-minor axis	1	1
3	What is the minimum velocity required for an object of mass 'm' to escape the gravitational pull of a planet of mass 'M' and radius 'R' from its surface? (a) $[(G*M)/R]^{1/2}$ (b) $[(2*G*M)/R]^{2-}$ (c) $[(G*M*m)/R]^{1/2}$ (d) $[(2*G*M)/R]^{1/2}$	1	1
4	When a bus starts suddenly, the passengers are pushed back. This is an example of which of the following (a) Newton's first law (b) Newton's second law (c) Newton's third law (d) None of the above	1	1
5	A system of two particles is undergoing a perfect collision. Which of the following quantity is not constant during the collision. (a) Linear momentum of the system (b) Kinetic energy of the system (c) Total energy of the system (d) Linear momentum of each particles.	1	1
6	Newton's second law of motion can be used to prove (a) Law of conservation of torque (b) Law of conservation of angular momentum (c) Law of conservation of linear momentum (d) Law of conservation of energy	1	1

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7	The total angular momentum of a body or a group of the bodies remains unchanged if (a) External momentum is absent (b) External force is absent (c) External moment of inertia is absent (d) External torque is absent	1	1
8	Two bodies of masses 5 kg and 15 kg are located in the Cartesian plane at (1,0) and (0,1). What is the location of their centre of mass? (a) 1/4, 1/4 (b) 3/4, 3/4 (c) 3/4, 1/4 (d) 1/4, 3/4	1	1
9	The dimensions of energy are (a) $[ML^2T^{-2}]$ (b) $[MLT^{-2}]$ (c) $[ML^2T^{-1}]$ (d) $[MLT^{-1}]$	1	1
10	Which of the following is not a conservative force? (a) Gravitational force (b) Frictional force (c) Spring force (d) None of these	1	1
11	The work done in conservative force is (a) Negative (b) Zero (c) Positive (d) infinite	1	1
12	The potential energy of a system increases, if work is done (a) by the system against a conservative force (b) by the system by against a non-conservative force (c) upon the system by a conservative force (d) upon the system by a non-conservative force	1	1
13	A solid disc has a mass of 10kg and radius 1m. Find its radius of gyration. (a) 1.414m (b) 0.707m (c) 1m (d) 1.732m	1	1
14	Moment of inertia of a spinning body about an axis doesn't depend on which of the following factors? (a) Distribution of mass around axis. (b) Orientation of axis (c) Mass (d) Angular velocity	1	1

15	Which of the following apparatus is used to find the moment of inertia of an object? (a) Simple pendulum (b) Compound pendulum (c) Bifilar pendulum (d) Spring pendulum	1	1
16	The distance between the points of suspension and centre of oscillation for the compound pendulum is (a) $(k^2-l^2)/2$ (b) $(k^2+l^2)/l$ (c) $(k^2+l^2)/2l$ (d) $k+(l^2/k)$	1	1
17	The degree of freedom for a free particle in space are (a) 0 (b) 1 (c) 2 (d) 3	1	1
18	_____ constraints are time dependent. (a) Holonomic (b) Non holonomic (c) Scleronomous (d) Rheonomous	1	1
19	Principle of virtual work is applicable to _____ equilibrium. (a) Static (b) Dynamic (c) Both static and dynamic (d) None of the above	1	1
20	The Lagrangian function is defined by (a) L = T - V (b) L = T + V (c) L = 2T + V (d) L = 2T – V	1	1
Q. No.	**SECTION B** **Answer ALL the questions (10 x 2 = 20 marks)**	**CO**	**KL**
21	State the law of inertia.	2	2
22	What is a parking orbit?	2	2
23	State the law of conservation of angular momentum.	2	2
24	What is elastic collision? Give example.	2	2
25	Define work-energy principle.	2	2
26	Write a note on conservative force with suitable example.	2	2
27	Distinguish translational motion and rotational motion.	2	2
28	Why the center of oscillation and the center of suspension are interchangeable?	2	2
29	State the principle of virtual work.	2	2
30	What are constraints?	2	2
Q. No.	**SECTION C** **Answer any TWO questions (2 x 20 = 40 marks)**	**CO**	**KL**
31	**A.** Describe the experimental determination of gravitational constant (G) by Boys method.	3	3

	B. Enunciate Kepler's laws and deduce Newton's law of gravitation from Kepler's law.	4	4
32	A. Derive an expression for torque produced by gravity about an arbitrary point other than the center of mass. Also evaluate the total angular momentum of such a body.	3	3
	B. State and prove law of conservation of energy in case of a freely falling body.	4	4
33	**A.** State and prove parallel axes theorem and perpendicular axes theorem for a plane lamina.	3	3
	B. Obtain an expression for the time period of oscillation of a bifilar pendulum with parallel threads.	4	4
34	**A.** State D'Alembert's principle and hence derive Lagrange's equation of motion for a holonomic conservative system.	3	3
	B. Apply Lagrange's equation to determine the equation of motion for simple pendulum.	4	4
Q. No.	**SECTION D** **Answer any FOUR questions (4 x 5 = 20 marks)**	**CO**	**KL**
35	Estimate the mass of the sun, assuming the orbit of the earth round the sun to be a circle. The distance between the sun and earth is 1.49 x 10^{13} cm and G = 6.66 x 10^{-8} c.g.s. units.	5	5
36	A 500g mass is whirled round in a circle at the end of a string 40cm long, the other end of which is held in the hand. If the mass makes 5 rev/sec, what is its angular momentum?	5	5
37	An object is displaced from position vector $\boldsymbol{r_1 = (2\hat{\imath} + 3\hat{\jmath})}$ m to $\boldsymbol{r_2 = (4\hat{\imath} + 6\hat{\jmath})}$ m under a force $\boldsymbol{F = (3x^2\hat{\imath} + 2y\hat{\jmath})}$N. Find the work done by this force.	5	5
38	Three particles of masses 1g, 2g, 3g are kept at points (2cm, 0), (0, 6cm), (4 cm, 3 cm). Find moment of inertia of all three particles (in g-cm^2) about (a) x-axis (b) y- axis (c) z- axis	5	5
39	A bead slides on a smooth rod which is rotating about one end in a vertical plane with uniform angular velocity ω. Find potential energy and kinetic energy of the system and show that the equation of motion is $\boldsymbol{m\ddot{r} = mr\omega^2 - mg\sin\omega t}$	5	5
40	A spaceship is launched into a circular orbit close to the earth's surface. What additional velocity has now to be imparted to the spaceship in the orbit to overcome the gravitational pull? Radius of earth = 6400 km, g = 9.8 m/s^2	5	5

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