		Surname		Type
Group Number		Name		A
List Number		e-mail		
Student ID		Signature		

ATTENTION:Each question has only one correct answer and is worth one point. Be sure to fill in completely the circle that corresponds to your answer on the answer sheet. Use a pencil (not a pen). Only the answers on your answer sheet will be taken into account.

1. What is the unit of angular momentum?

(a) kgm^2/s^2 (b) Nm (c) Nms (d) kgm/s^2 (e) none of them

2. In which among the following center of mass does not coincide with the center of gravity?

(a) An airplane which is flying close to surface of the Earth. (b) An airplane which is flying 30 km above surface of the Earth. (c) A skyscraper. (d) A 3 km long train travelling in a horizontal plateau. (e) A human being.

3. What can be said about this statement?: "If the total force acting on an object is zero but the total torque is not zero than the object can still be in equilibrium."

(a) Not true. (b) True. (c) More information is needed to decide if it is true or not. (d) Can be true depending on the situation. (e) True if we ignore the friction.

4. Planet 1 has radius R_1 and density ρ_1. Planet 2 has radius $R_2 = 2R_1$ and density $\rho_2 = \rho_1\ /2$. Identical objects of mass m are placed on the surfaces of the planets. What is the relationship of the gravitational potential energy U_2 on planet 2 to U_1 on planet 1? (U_∞=0)

(a) $U_2 = U_1$ (b) $U_2 = U_1/2$ (c) $U_2 = U_1/4$ (d) $U_2 = 4U_1$ (e) $U_2 = 2U_1$

5. Which of the following statements about the motion of planets about the sun is NOT correct?

(a) At perihelion, the speed of an orbiting planet is maximal (b) Planets orbiting farther from the sun move with larger orbital speeds (c) Total mechanical energy of an orbiting planet remains constant during its motion. (d) Angular momentum of an orbiting planet with respect to the sun does not change during its motion (e) Each planetary orbit lies in a plane

6. A satellite of mass m is in circular orbit of radius R around earth (mass M). What is its mechanical energy? (U_∞=0)

(a) -GMm /2R (b) GMm/R (c) 0 (d) -GMm/R (e) GMm/2R

7. In gravitational problems U_∞ is taken as 0 because of

(a) Conserving mechanical energy (b) Conserving angular momentum (c) Conserving kinetic energy (d) Conserving potential energy (e) Convenience

Questions 8-14

There is log of mass "M", radius "R".You can consider it as a uniform solid cylinder ($I=MR^2/2$).It rolls down a hill of height "H". After the hill it rolls on a flat surface and climbs the hill on the opposite side. The gravitational acceleration is "g", the angle of the second hill is ϕ.The coefficient of friction "μ" is sufficient to prevent sliding and there are no rolling losses.

8. What is the conserved quantity in this motion?

(a) Angular momentum (b) Kinetic energy (c) Linear momentum (d) Potential energy (e) Mechanical energy

9. What is the kinetic energy of the log at the bottom?

(a) MgH (b) 0 (c) 2/3MgH (d) 3/2MgH (e) 1/2MgH

10. What is the linear speed of the log at the bottom?

(a) 2gH (b) $\sqrt{1/2\text{gH}}$ (c) $\sqrt{4/3\text{gH}}$ (d) gH/2 (e) $\sqrt{2\text{gH}}$

11. What is the magnitude of the static frictional force in the flat section?

(a) μ (b) μMg/2 (c) 2/3μMg (d) μMg (e) 0

12. Is the angular momentum of the log around its axis conserved in the uphill part? If not what is the source of the external torque?

(a) No, F_{static} (b) No, angular velocity (c) No, gravity (d) Yes (e) No, inertia

13. How high will the log roll in the uphill part?

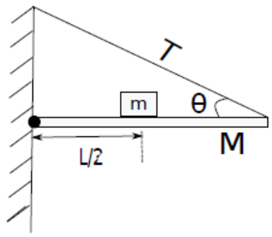
(a) 0 (b) 2/3 H (c) H (d) R (e) 2/3 R

14. What is the magnitude and direction of the static frictional force in the uphill part?

(a) Uphill, Mgsin(ϕ)/3 (b) Downhill, μMgcos(ϕ) (c) Upward, Mgcos(ϕ) (d) Downward, Mgsin(ϕ)/2 (e) Upward, μMgcos(ϕ)

Questions 15-19

A rod of length L with non-uniform mass distribution is hinged horizontally to a vertical wall from one end. The rod is supported by a rope from the other end as shown in the figure such that the rope makes an angle of 30° with the horizontal. The linear mass density (mass per unit of length) of the rod is $\lambda(x)=8Cx^3/L^4$ where x is the distance from the hinge ($x \leq L$) and C is a constant. The unit of C is kg. The distance between point mass m and the hinge is L/2.



15. What is mass M of the rode?

(a) 8C/3 (b) 2C (c) C/2 (d) C (e) 2C/3

16. Find distance L_G between the hinge and the centre of gravity of the rode (do not take into account point mass m).

(a) 2L/3 (b) L/5 (c) L/3 (d) 4L/5 (e) 3L/4

17. Find the tension in the rope (as mass m is much smaller than the mass of the rode M neglect mass m)

(a) $gML_G/L\tan(30)$ (b) $gML_G/L\cos(30)$ (c) $gML_G\sin(30)/L$ (d) $gML_G/L\sin(30)$ (e) $gML/L_G\sin(30)$

18. What is moment of inertia of the rode (I_0) with respect to the hinge (neglect m)?

(a) $4CL^2/5$ (b) $7CL^2/3$ (c) CL^2 (d) C/L^2 (e) $4CL^2/3$

19. The rope breaks off at t = 0. What is the magnitude of the normal force that the rode applies to mass m for $t \to 0^+$?

(a) mg (b) $mg(1-(LL_GM/2I_0))$ (c) $mg(1+(LL_GM/2I_0))$ (d) 0 (e) mgL_G/L

Questions 20-25

A satellite of mass "m" is in an elliptic orbit. Its apogee (farthest point from earth) "A" is at $R_A=6R_E$ and perigee (closest point to earth) "P" is at $R_P=2R_E$ from the center of earth. (Note that at these points its velocity is tangential.) Its velocity at apogee is V_A. The mass and radius of earth are M_E and R_E.

20. What are the conserved quantities in its orbital motion?

(a) P and kinetic energy (b) Linear momentum P only (c) L only (d) L and kinetic energy (e) Angular momentum "L" and mechanical energy "ME"

21. What is its angular momentum L at apogee?

(a) 0 (b) $L=6mR_EV_A$ (c) $6mR_AV_A$ (d) $6MR_EV_A$ (e) $6mR_EV_A^2$

22. What is its kinetic energy at apogee

(a) $KE_A=P^2/2m(R_P+R_A)^2$ (b) $KE_A=P^2/2mR_A^2$ (c) $KE_A=L^2/2mR_A^2$ (d) $KE_A=P^2/2mR_P^2$ (e) $KE_A=L^2/2mR_P^2$

23. How much work is done by gravity while the satellite is moving from apogee to perigee

(a) $W=GMm/R_E$ (b) $W=Mm/3R_E$ (c) $W=GMm/3R_E$ (d) $W=GMm/3R_A$ (e) 0

24. What is its kinetic energy at perigee?

(a) $KE_P=L^2/2mR_A^2$ (b) $KE_P=L^2/2mR_P^2$ (c) $KE_P=P^2/2m(R_P+R_A)^2$ (d) $KE_P=P^2/2mR_A^2$ (e) $KE_P=P^2/2mR_P^2$

25. What is V_A in terms of R_E?

(a) $V_A=\sqrt{GM/12R_E}$ (b) $V_A=\sqrt{Gm/6R_E}$ (c) $V_A=\sqrt{Gm/12R_E}$ (d) $V_A=\sqrt{GMm/12R_E}$ (e) $V_A=\sqrt{GM/6R_E}$