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PHYSICS

BOOKS - IE IRODOV PHYSICS (HINGLISH)

FUNDAMENTALS OF MECHANICS

Others

1. A material particle is moving along a straight line in such a manner that its velocity

varies as shown in the figure. At which moment in time numbered successively on the time axis will the acceleration of the particle be maximal? How should one use the graph to determine the average velocity of motion over the time interval from t_1 to t_2 ?

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2. An object is thrown upward with an initial velocity v_o. The drag on the object is assumed to be proportional to the velocity. What time

will it take the object to move upward and what maximal altitude will it reach?

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3. At a certain moment in time the angle between the velocity vector v of a material particle and the acce leration vector w of that particle is θ. What will be the motion of the particle at this moment for different θs: rectilinear or curvilinear, accelerated or uniform or decelerated?

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4. A particle is moving along an expanding spiral in such a manner that the particle's normal acceleration remains constant. How will the linear and angular velocities change in the process?

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5. A particle is moving in a circular orbit with a constant tangential acceleration. After a

certain time t has elapsed after the beginning of motion, the between the total acceleration a and the direction along the radius r becomes equal to 45°. What is the angular acceleration of the particle.

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6. An object is thrown at an angle α to the horizontal $(0^\circ < \alpha < 90^\circ)$ with a velocity yo. How do the normal acceleration w_n and the

tangential acceleration w_t` vary in the process of ascent if the drag is ignored?

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7. At the foot of a hill a certain velocity is imparted to a sled, as a result of which the sled moves up the hill to a point A and then down the hill. What are the directions of the normal and tangential components of the acceleration at point A ?

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8. An object moves without friction along a concave surface. What are the directions of the normal and tangential components of the acceleration at the lowest possible point ?

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9. A stunt rider on a unicycle is riding around thearena of a circus in a circle of radius R. The radius of the wheel of the unicycle is r and the angular velocity with which the wheel rotates

is ω. What is the angular acceleration of the wheel ? (Ignore the fact that the wheel axis is inclined.)

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10. A liquid has been poured into a cylindrical vessel of mass M (the mass of the vessel bottom can be ighored) and height H. The linear density of the liquid, that is, the ratio of the mass of the liquid column to its height, is δ. What is the height x of the column of liquid

at which the common center of gravity of the liquid plus the vessel is in the lowest position?

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11. A cone-shaped funnel is being rotated with constant angular velocity ω An object is placed on the inner wall of the funnel. The object can freely move along the generatrlx of the cone, but during the motion of the funnel the body is in a state of equilibrium. Is this equilibrium stable or unstable?

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12. A vessel filled with water is moving horizontally with constant acceleration w. What shape will the surface of the liquid have?

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13. A liquid has been poured into a cylindrical vessel. What shape will the surface of the liquid have if the vessel is rotated uniformly about its axis with an angular velocity ω ?

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14. A piece of cork has been attached to the bottom of a cylindical vessel that has been filled with water and is rotating about the vertical axis with a constant angular velocity ω. At some moment the cork gets free and comes to the surface. What is the trajectory along which the cork moves to the surface: does it approach the wall or the axis or does it move vertically upward?

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15. A force acting on a material particle of mass m first grows to a maximum value F_m and then decreases to zero. The force varies with time according to a linear law, and the total time of motion is $t_m -$ What will be the velocity of the particle by the end of this time interval if the initial velocit is zero?

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16. Along which of the two trajectories, the horizontal line $ac'b$ or the broken line consisting of two straight segments $(ac \text{ and } cb)$, will the work performed by a force in displacing an object be greater if the friction is the same for all three straight segments?

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17. An object of mass m slides down a hill of arbitrary shape and after travelling a certain horizontal path stops because of friction. The total vertical height descended is h. The friction coefficient is different for different segments for the entire path but is independent of the velocity and direction of motion. The work that a tangerial force must perform to return the object to its initial position along the same path is

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18. An object whose density is Pob falls from a certain height into a liquid whose density is pliq In the figure the potential energy W of the object is plotted along the vertical axis and the position of the object (its altitude) is plotted along the horizontal axis. The potential energy of the object at the level of the liquid is taken zero and the positive direction of the vertical axis (the W axis) is the one pointing upward from the liquid's surface. Determine which of the five straight lines, $1-5$, corresponds to an object with the

highest density and which to an object with the lowest density. Is there a straight line among these five for which $Pob = (112)Pliq$? The arrows on the straight lines point in the direction of motion of the object.

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19. The dependence of tho potential energy W of the interaction between objects on the distance r separating thorn is shown ill t.he figure. What will be the distances between the

objects that correspond 1.0 equilibrium positions? At what dislancc will the equilibrium be stable? (Answer the same question for unstable equilibrium.) What segments of the curve correspond to a repulsive force and what segments, to an attractive force?

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20. A load of mass m_2 is hanging from a string. A bullet flying horizontally hits the load.

Three cases are possible here, namely, (1) the bullet pierces the load and, retaining a fraction of its velocit.y, rontinues its flight., (2) the bullet gets stuck in the load, and (3) the bullet. recoils from the load. In which of these three cases will the load he deflected by an angle a with the greatest magnitude and in which wi ll it be deflected by an angle with the smallest magnitude?

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21. Two spheres of equal mass collide, with the collision being absolutely elastic but not central. Prove that in this case the angle between the velocities after collision must be 90°.

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22. A sphere of mass m_1 moving with a velocity v_o hits a sphere of mass m_2 that is at rest. The collision is absolutely elastic "and

central. The velocities of the spheres after collision are u_1 and u_2, respectively. What are the mass ratios for the following values of velocities: $u_1 = 0, u_1 < 0,$ and $u_1 > 0$?

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23. A vacuum cleaner standing on the floor turns through a small angle when switched on and then stops. Why does this happen?

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24. A shaft whose diameter is d and length is l is rotating without friction in bearings with an angular velocity ω_0. A sleeve of height h and outer diameter D is fitted on the shaft (the materials of the sleeve nod the shaft are the same). At first the sleeve is not connected with the shaft and is a t rest. Then at some moment the sleeve is clamped to the shaft. What will be the common angular velocity of the shaft plus the sleeve?

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25. A disk and a sphere roll off two inclined planes of the same altitude and length. Which of the two objects will get to the bottom of the respective plane first ? How does the result depend on the masses and diameters of the disk and the sphere?

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26. Several artificial satellites of the same mass are circling the earth along circular orbits of different radii. How do the kinetic, potential,

and total energies and angular momenta of the satellites depend on the radii of the orbits?

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