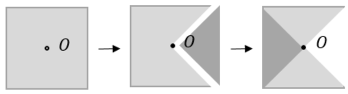
Group Number		Name		Type
List Number		Surname		A
Student ID		Signature		
E-mail				

ATTENTION: There is normally only one correct answer for each question and each correct answer is equal to 1 point. Only the answers on your answer sheet form will be evaluated. Please be sure that you have marked all of your answers on the answer sheet form by using a pencil (*not* pen).

1. The moment of inertia of a thin homogeneous square rotating about its axis of symmetry O, perpendicular to the plain of square is given as I. A triangle part from it is cut and paste as shown in figure. What is the moment of inertia of the obtained object with respect to the same rotation axis?

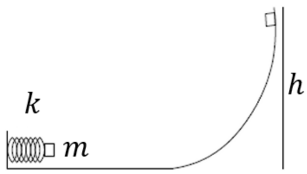


(a) I (b) $I/3$ (c) $2I/3$ (d) $3I/2$ (e) $4I/9$

2. You throw a baseball straight up. The magnitute of the drag force is proportional to the square of the speed (v^2). When the ball is moving up at half its terminal speed, what is the magnitude of its acceleration? Terminal speed is reached when gravity is balanced by the air drag force. (g is the magnitude of the acceleration due to gravity.)

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

3. A massless spring of spring constant $k = 7.5 \times 10^4$ N/m is used to launch a block of mass $m = 1.5$ kg up the curved track shown. The track is in a vertical plane. The maximum height observed for the block is given by $h = 0.4$ m. If the initial compression of the spring is 0.02 m, find the energy lost due to the friction. (g=10 m/s^2)



(a) 16/5 J (b) 9 J (c) 20/3 J (d) 8 J (e) 12 J

Questions 4-5

A door of width d and mass M, is hinged at one side so that it is free to rotate without friction about its vertical axis. A police officer fires a bullet with a mass of m and a speed of v into the the door, a distance $2d/3$ to the hinge (axis of rotation) in a direction perpendicular to the plane of the door. (The moment of inertia through the axis of the hinge is $I = \frac{1}{3}Md^2$.)

4. Find the angular speed of the door just after the bullet embeds itself in the door.

(a) $mv/[(M/2 + 2m/3)d]$ (b) $Mv/[(M/2 + 2m/3)d]$ (c) $mvd/(M/3 + 3m/2)d$ (d) $(mv)^2/(M + 2m)$ (e) $mv/[(m/2 + 2M/3)d]$

5. Find the kinetic energy of the bullet-door system just after the bullet embeds itself in the door.

(a) $(mv)^2/(3M/2 + 2m)$ (b) $(mv)^2/[(3M/4 + m)d]$ (c) $mvd/(3M/2 + 2m)$ (d) $(mv)^2/[(3M + 3m/2)d]$ (e) $(mv)^2/(M/2 + 2m/3)$

Questions 6-7

A comet is orbiting the sun in elliptical orbit. The distance of this comet to sun at the perihelion (nearest distance to the sun) is R and the distance of this comet to sun at the aphelion (farthest distance to the sun) is $10R$.

6. What is the ratio of K_p, the kinetic energy at the perihelion to K_a, the kinetic energy at the aphelion points?

(a) $\frac{K_p}{K_a}$=100 (b) $\frac{K_p}{K_a}$=1 (c) $\frac{K_p}{K_a}$=10 (d) $\frac{K_p}{K_a}=\frac{1}{10}$ (e) $\frac{K_p}{K_a}=\frac{1}{100}$

7. What is the ratio of ω_p, the angular velocity at the perihelion to ω_a, the angular velocity at the aphelion points?

(a) $\frac{\omega_p}{\omega_a}$=10 (b) $\frac{\omega_p}{\omega_a}$=1 (c) $\frac{\omega_p}{\omega_a}$=100 (d) $\frac{\omega_p}{\omega_a}=\frac{1}{10}$ (e) $\frac{\omega_p}{\omega_a}=\frac{1}{100}$

Questions 8-10

On a frictionless horizontal air track a cart of mass m and another of mass $3m$ collide. Initially the cart of mass $3m$ has a velocity of $v_o = 1.25$ m/s and the smaller cart has an initial velocity of zero. Take $m = 3.2$ kg.

8. If the collision is completely inelastic, calculate the final velocity in m/s.

(a) 5/6 (b) 15/16 (c) 3/4 (d) 5/3 (e) 4/3

9. If the collision is completely inelastic, how much mechanical energy is lost?

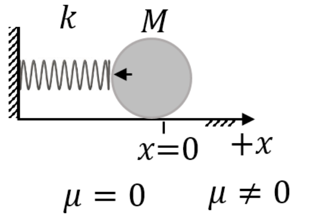
(a) 45/8 J (b) 15/8 J (c) 25/8 J (d) 5/8 J (e) 105/8 J

10. If the collision is elastic, calculate the final velocity of mass m in m/s.

(a) 15/4 (b) 18/5 (c) 5/4 (d) 16/7 (e) 15/8

Questions 11-13

A solid sphere of mass M=10 kg and radius R=1 m is held against a spring (massless) of force constant k=4000 N/m, compressed by an amount of 0.2 m. The spring is released and the sphere skids on a frictionless horizontal surface as it leaves the spring at x=0. It then enters a region with friction, so it begins to rotate and still skids, until it starts *rolling without slipping.* ($I_{\text{cm}} = \frac{2}{5}MR^2$ for solid sphere.)



11. What is the center-of-mass speed in m/s of the sphere when it leaves the spring at $x = 0$?

(a) 8 (b) 6 (c) 4 (d) 5 (e) 2

12. What is the center-of-mass speed in m/s of the sphere when it is rolling without slipping?

(a) 2/3 (b) 5/3 (c) 8/5 (d) 4/5 (e) 20/7

13. Calculate the energy lost to friction.

(a) 175/3 J (b) 175/9 J (c) 545/9 J (d) 160/7 J (e) 105/3 J

Questions 14-15

A satellite of mass m revolves in a circular orbit about the Earth at height h from the surface of the Earth. M_{E} and R_{E} are the mass and the radius of the Earth, respectively.

14. What is the total mechanical energy E of the satellite-Earth system?
(a) $E = \frac{GM_{\text{E}}m}{(R_{\text{E}}+h)}$ (b) $E = \frac{GM_{\text{E}}m}{2(R_{\text{E}}+h)}$ (c) $E = -\frac{GM_{\text{E}}m}{2(R_{\text{E}}+h)}$ (d) $E = -\frac{GM_{\text{E}}m}{(R_{\text{E}}+h)}$ (e) $E = -\frac{GM_{\text{E}}m}{2h}$

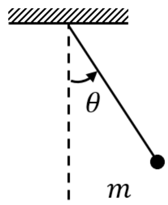
15. If the satellite is not at a high altitude, it will lose mechanical energy because of the air friction. In this case which of the following will happen?

(a) Nothing changes. (b) Its temperature decreases. (c) The satellite approaches to the Earth. (d) The satellite recedes away from the Earth. (e) The satellite slows down.

16. Consider the Earth and an astronaut at height h from the surface of the Earth. Which of the following is always correct?

(a) The potential energy of the astronaut is $U = -\frac{GM_{\text{E}}m}{R_{\text{E}}+h}$.
(b) The potential energy of the Earth-astronaut system is $U = mgh$.
(c) The potential energy of the astronaut is $U = mgh$.
(d) The potential energy of the Earth-astronaut system is $U = -\frac{GM_{\text{E}}m}{R_{\text{E}}+h}$.
(e) The potential energy of the Earth-astronaut system decreases with increasing h.

17. Which of the following is/are in fact always correct for a simple pendulum?



(i) $F_\theta = -mg\theta$ (ii) $F_\theta = -mg\sin\theta$ (iii) $T = 2\pi\sqrt{\frac{L}{g}}$ (iv) $T > 2\pi\sqrt{\frac{L}{g}}$

(a) i and iii (b) i and ii (c) i (d) ii and iv (e) i and iv

Questions 18-19

An object of a mass m is oscillating with amplitude A at the end of a spring (massless) on a frictionless horizontal surface along the x axis. The spring is unstreched as the mass is at $x = 0$.

18. What is the position of this mass when the elastic potential energy equals the kinetic energy?

(a) $x = \pm\frac{A}{\sqrt{3}}$ (b) $x = \pm\frac{A}{\sqrt{5}}$ (c) $x = \pm\frac{A^2}{\sqrt{2}}$ (d) $x = \pm\frac{A}{\sqrt{2}}$ (e) $x = \pm\frac{A}{2}$

19. What is the magnitude of the momentum of this mass when the elastic potential energy equals the kinetic energy?

(a) $p_x = \frac{1}{2}\sqrt{mk}A$ (b) $p_x = \sqrt{\frac{mk}{3}}A$ (c) $p_x = \sqrt{\frac{kmA}{2}}$ (d) $p_x = \sqrt{\frac{mk}{5}}A$ (e) $p_x = \sqrt{\frac{mk}{2}}A$

20. A block of mass M attached to a horizontal spring (massless) with force constant k is moving in simple harmonic motion with amplitude A and period T_1. A lump of putty mass m is dropped from a small height and sticks to it, when it is at $x = -A$. What is the new period T_2 of the motion?

(a) $T_2 = T_1\sqrt{\frac{M}{m}}$ (b) $T_2 = T_1\left(1+\frac{m}{M}\right)$ (c) $T_2 = T_1\left(1+\frac{M}{m}\right)$ (d) $T_2 = T_1\sqrt{1+\frac{M}{m}}$ (e) $T_2 = T_1\sqrt{1+\frac{m}{M}}$