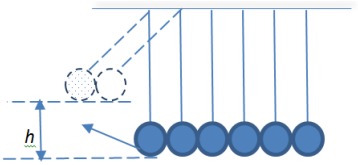
		Surname		Type
Group Number		Name		A
List Number		e-mail		
Student ID		Signature		

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. Which one of the following is not a unit of energy?

(a) J (b) N m (c) dyn cm (d) kg m^3/s^2 (e) W s

2. Consider a system of identical balanced balls shown in the figure. The balls can collide elastically with a negligible influence of air resistance on their motion. When two balls are pulled up and released from height h, which of the following statements about the collision is true?

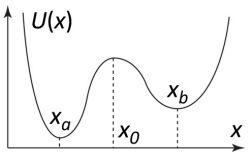


(a) One ball on the far right end rises up to $2h$ (b) Two balls on the far right end rise up to $h/2$ (c) Two balls on the far right end rise up to $2h$ (d) One ball on the far right end rises up to h (e) Two balls on the far right end rise up to h

3. You use your hand to stretch an ideal spring with a force constant k and a mass m to a final distance x_{max} from its equilibrium position and then slowly bring the spring back to equilibrium, applying a force $F = kx$ at each instant during the stretching. If the spring is stretched with a constant stretching rate v, what is the total work done by your hand?

(a) $(mv^2)/2$ (b) Zero (c) $-(kx_{max}^2)/2$ (d) None of them (e) $(kx_{max}^2)/2$

4. The potential energy function $U(x)$ of a particle moving along the x-axis has a local maximum at point x_0 located between local minima at x_a and x_b (see figure). At point x_0:



(a) The particle acceleration is in the negative x-direction (b) The particle speed is increasing (c) The particle acceleration is zero (d) The particle acceleration is in the positive x-direction (e) The particle speed is decreasing

5. A man starts to walk on a boat standing still in the water. Assume there is no friction between the boat and water. Mass of boat is twice the mass of the man. If the velocity of the man is $\vec{v}$ with respect to the boat, then what is the center of mass velocity of the boat-man system with respect to the stationary ground?

(a) $2\vec{v}$ (b) $-\vec{v}/2$ (c) $-2\vec{v}$ (d) $\vec{0}$ (e) $\vec{v}/2$

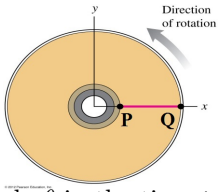
6. A sudden interaction changes the velocity of a particle of mass m from $-v\hat{j}$ to $v\hat{i}$. What is the net impulse that the particle experienced?

(a) $mv(\hat{i}-\hat{j})$ (b) $mv\hat{i}$ (c) $mv(\hat{i}\times\hat{j})$ (d) $mv(\hat{i}+\hat{j})$ (e) $\sqrt{2}mv\hat{i}$

7. Two objects of masses m and $2m$ moving in opposite directions collide head on, stick together, and stop immediately after the collision. The work done by the impulsive forces on the lighter object is W. What is the work done on the heavier one?

(a) $W/2$ (b) $4W$ (c) W (d) $W/4$ (e) $2W$

8. A DVD is rotating with an increasing speed. How do the centripetal acceleration a_{rad} and tangential acceleration a_{tan} compare at points P and Q?

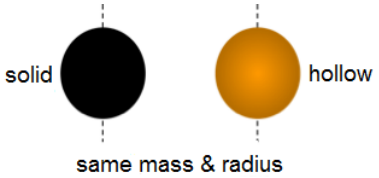


(a) Q has a greater a_{rad} and a greater a_{tan} than P. (b) P and Q have the same a_{rad}, but Q has a greater a_{tan} than P. (c) not enough information given to decide. (d) Q has a smaller a_{rad} and a greater a_{tan} than P. (e) P and Q have the same a_{rad} and a_{tan}.

9. An object at rest begins to rotate with a constant angular acceleration. If this object rotates through an angle θ in the time t, through what angle did it rotate in the time $t/2$?

(a) $(1/2)\theta$ (b) $(3/4)\theta$ (c) $(1/4)\theta$ (d) 4θ (e) 2θ

10. Two spheres have the same radius and equal masses. One is made of solid aluminum (density 2.7 g/cm^3), and the other is made from a hollow shell of gold (density 19.3 g/cm^3). Which one has the bigger moment of inertia about an axis through its center?



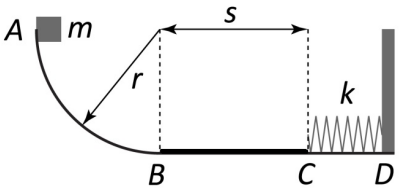
(a) solid aluminum = (1/2) hollow gold (b) solid aluminum (c) hollow gold (d) hollow gold = (1/2) solid aluminum (e) same

Questions 11-15

Consider the path ABCD shown in the figure. The section AB is one quadrant of a circle with radius $r = 5$ m and it is frictionless. The horizontal section BC has a length $s = 6$ m and a coefficient of kinetic friction $\mu_k = 0.3$. The section CD under the ideal spring with a force constant k is frictionless. A small block with mass $m = 2$ kg is released from rest at position A. After sliding along the path, if it compresses the spring by a distance $\Delta = 0.8$ m (take $g = 10$ m/s^2):

11. What is the speed of the block at point B?

(a) 10 m/s (b) 40 m/s (c) 15 m/s (d) 5 m/s (e) 20 m/s



12. What is the work done by the friction force while the block slides from B to C?

(a) -18 J (b) -36 J (c) 18 J (d) 36 J (e) -10 J

13. What is the speed of the block at point C?

(a) 4 m/s (b) 5 m/s (c) 2 m/s (d) 8 m/s (e) 10 m/s

14. What is the force constant k of the spring?

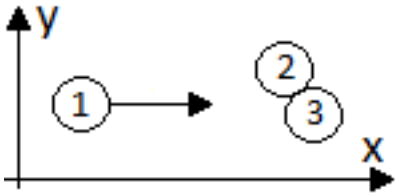
(a) 20 N/m (b) 400 N/m (c) 50 N/m (d) 100 N/m (e) 200 N/m

15. Consider now that the kinetic friction coefficient in the section CD under the spring is $\mu_k = 0.3$ and the spring still gets compressed by $\Delta = 0.8$ m. What is the force constant k of the spring?

(a) 50 N/m (b) 185 N/m (c) 250 N/m (d) 100 N/m (e) 370 N/m

Questions 16-20

The particle 1 moves parallel to the x axis and collides elastically with the other two particles which are initially at rest (see figure). Velocities of the particles 2 and 3 after the collision in (m/s) are $\vec{v}_2 = 5\hat{i} - 3\hat{j}$ and $\vec{v}_3 = 3\hat{i} + \hat{j}$ respectively. Collision occurs in the frictionless xy plane and $m_1 = m_2 = m_3 = 0.6$ kg.



16. What is the y component of velocity of the first particle after the collision?

(a) 1 m/s (b) -1 m/s (c) 2 m/s (d) 0 m/s (e) 3 m/s

17. What is the kinetic energy lost by the first particle?

(a) 13.2 J (b) 9.3 J (c) 28.5 J (d) 22.8 J (e) 17.7 J

18. What is the speed of the first particle before the collision?

(a) 7 m/s (b) 8 m/s (c) 9 m/s (d) 10 m/s (e) 6 m/s

19. What is the velocity of the center of mass in m/s?

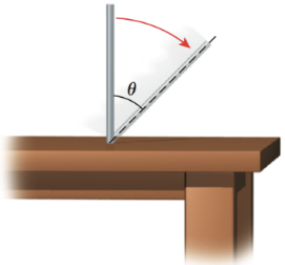
(a) $3\,\hat{i}$ (b) $10/3\,\hat{i}$ (c) $8/3\,\hat{i}$ (d) $2\,\hat{i}$ (e) $7/3\,\hat{i}$

20. If the initial speed is the same, but all three particles stick together after the collision, what is the kinetic energy lost? (In this case collision is not elastic.)

(a) 7.2 J (b) 16.2 J (c) 12.8 J (d) 20 J (e) 9.8 J

Questions 21-25

A uniform thin rod of mass M and length L is hinged at one end to a horizontal table and is released from vertical position with zero initial velocity. (Hinge is frictionless)



21. Which of the real forces are acting on the rod while it is falling?

i. centrifugal force
ii. gravitational force
iii. contact forces

(a) i, ii (b) only ii (c) ii, iii (d) only i (e) only iii

22. Which of the following integrals gives the moment of inertia of the rod around the hinge?

(a) $\frac{M}{L}\int_0^L x^2dx$ (b) $ML\int_0^L x^2dx$ (c) $\frac{M}{L}\int_{-L}^L x^2dx$ (d) $\frac{M}{L}\int_{-L/2}^{L/2} x^2dx$ (e) $ML\int_{-L/2}^{L/2} x^2dx$

23. What is the kinetic energy of the rod just before it hits the table?

(a) $MgL/2$ (b) 0 (c) MgL (d) $MgL/3$ (e) $MgL/12$

24. What is the angular speed of the tip (end of rod) at this instant?

(a) $\sqrt{3g/2L}$ (b) $\sqrt{5g/4L}$ (c) $\sqrt{3g/L}$ (d) 0 (e) $\sqrt{3gL}$

25. What is the linear speed of the tip at this instant?

(a) $\sqrt{5g/4L}$ (b) $\sqrt{5gL/4}$ (c) $\sqrt{3gL}$ (d) $\sqrt{3g/L}$ (e) 0