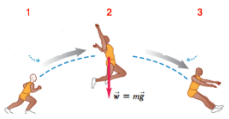
		Surname		Type
Group Number		Name		A
List Number		e-mail		
Student ID		Signature		

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. According to the figure in the right, which of the following is true for mechanical energy of the athlete when he jumps from point 1 to 2? What will be the total energy at point 3?



(a) Gravitational potential energy stays the same and nothing is changed for total energy

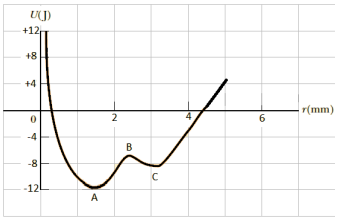
(b) Kinetic energy decreases, gravitational potential energy increases, the total energy is conserved

(c) Kinetic energy stays the same, gravitational potential energy increases, the total energy is conserved

(d) Kinetic energy decreases, gravitational potential energy increases, the total energy is not conconserved

(e) Kinetic energy increases, gravitational potential energy decreases, the total energy is conserved

2. An object moves along a line where the potential energy depends on its position r, as seen in the figure. Which point/points is/are equilibrium position for this object?

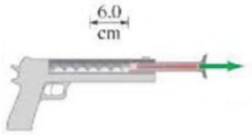


(a) A, B and C (b) A and C (c) none of them (d) only A (e) only B

3. You drop a ball from a height of 2.0 m, and it bounces back to a height of 1.5 m. What fraction of its initial energy is lost during the bounce?

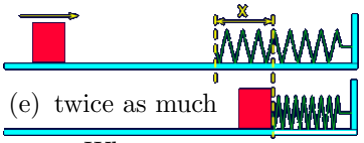
(a) 50% (b) 15% (c) 75% (d) 25% (e) 5%

4. A dart of mass 0.100 kg is pressed against the spring of a toy dart gun as shown in the figure. The spring (with spring constant $k = 250$ N /m and ignorable mass) is compressed 6.0 cm and released. If the dart detaches from the spring when the spring reaches its natural length, what speed does the dart acquire?



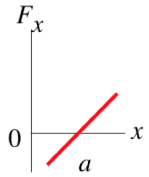
(a) 12.0 m/s (b) 3.0 m/s (c) 9.0 m/s (d) 6.0 m/s (e) 1.0 m/s

5. A box sliding on a frictionless flat surface runs into a fixed spring, which compresses a distance x to stop the box. If the initial speed of the box were doubled, how much would the spring compress in this case?



(a) half as much (b) the same amount (c) four times as much (d) $\sqrt{2}$ times as much (e) twice as much

6. Suppose the potential energy of an object is given by $U(x) = -ax/(b^2+x^2)$, where a and b are constants.What is the conservative force F as a function of x?



(a) $a(b^2-x^2)/(b^2+x^2)^3$ (b) $-a(b^2-x^2)/(b^2+x^2)^2$ (c) $-a(b^2+x^2)/(b^2+x^2)^2$ (d) $a(b^2-x^2)/(b^2+x^2)^2$
(e) $a(b^2+x^2)/(b^2+x^2)^2$

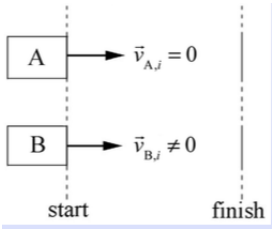
7. The graph shows a conservative force F_x as a function of x in the vicinity of $x = a$. As the graph shows, $F_x = 0$ at $x = a$. Which statement about the associated potential energy function U at $x = a$ is correct?

(a) U is a minimum at $x = a$ (b) Any of the above could be correct (c) U is neither a minimum or a maximum at $x = a$
(d) $U = 0$ at $x = a$ (e) U is a maximum at $x = a$

8. A body with mass m_A collides completely inelastically with a body with mass m_B that is initially at rest. What is the ratio of final to initial kinetic energy?

(a) m_A/m_B (b) m_B/m_A (c) $(m_A+m_B)/m_A$ (d) $m_A/(m_A+m_B)$ (e) $m_B/(m_A+m_B)$

9. Identical constant forces push two identical objects A and B continuously from a starting line to a finish line. If A is initially at rest and B is initially moving to the right, which of the following is true for the event? (Neglect friction)

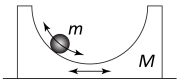


(a) Object A has a larger change in momentum (b) Object B experiences larger impulse than object A (c) Both objects have the same change in momentum (d) Not enough information is given to decide (e) Object B has a larger change in momentum

10. Some cars are designed with active deformation zones in the front that get severely damaged during head-on collisions. The purpose of this design is to

(a) make the repair as expensive as possible (b) reduce the impulse experienced by the driver during the collision
(c) increase the impulse experienced by the driver during the collision (d) reduce the force acting on the driver by reducing the collision time (e) reduce the force acting on the driver by increasing the collision time

11. A particle of mass m slides without friction along the surface of a circular bowl of mass M (see figure). The circular bowl itself is free to slide along the horizontal surface without friction. What quantities of the joint system "particle + bowl" are conserved during their motion?



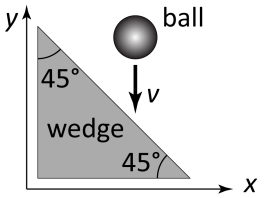
(a) both horizantal and vertical components of total momentum (b) neither horizontal nor vertical components of total momentum (c) horizontal component of total momentum (d) vertical component of total momentum (e) not enough information to decide

12. You are standing on a wooden board that in turn is resting on a frozen lake. Assume there is no friction between the board and the ice. The board has a weight five times smaller than your weight. If you begin walking along the board at 2 m/s relative to the ice, with what speed, relative to the ice, does the board move?

(a) the board does not move (b) 0.4 m/s (c) 5 m/s (d) 2 m/s (e) 10 m/s

Questions 13-14

A ball of mass m falls straight down onto a 45° wedge and collides with it completely elastically. At the instant when the ball hits the wedge, it is moving with a downward speed v (see the figure). In the following, assume the wedge is solidly attached to the ground and does not move during the collision.



13. What is the direction of the velocity of the ball just after the collision?

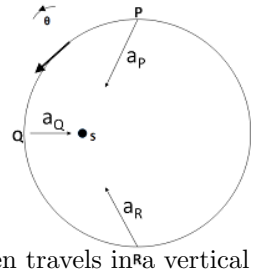
(a) horizontal to the right (b) vertical up (c) it depends on v (d) it depends on m (e) perpendicular to the surface of the wedge

14. What is the magnitude of the momentum change of the ball in the collision?

(a) $2mv$ (b) not enough information to decide (c) $\sqrt{2}mv$ (d) mv (e) $mv/2$

15. An object moves counter-clockwise along the circular path as shown in the figure. As it moves along the path, its acceleration vector continuously points toward the point S. The object

(a) Slows down at P and speeds up at Q (b) No object can have such a motion (c) Speeds up at P and slows down at R (d) Speeds up at P, Q and R (e) Speeds up at Q

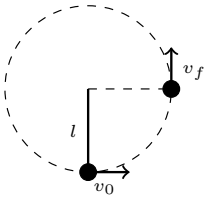


Questions 16-17

A ball of negligible radius and mass m hangs from a string of length l. It is hit in such a way that it then travels in a vertical circle (i.e., the tension in the string is always greater than zero). The initial speed of the ball after being struck is v_0. You may ignore air resistance. Let g denote the gravitational constant.

16. What is the tension in the string when the string is horizontal and the ball is moving with the speed v_f?

(a) $\frac{4mv_f^2}{l}$ (b) $\frac{mv_f^2}{l}$ (c) $\frac{mv_f^2}{2l}$ (d) $\frac{2mv_f^2}{l}$ (e) $\frac{mv_f^2}{4l}$

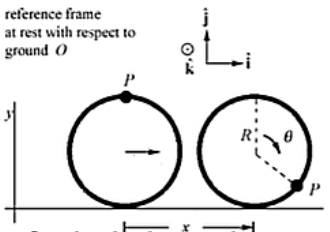


17. What is the speed of the ball v_f when the string is horizontal?

(a) $\sqrt{\frac{1}{2}v_0^2 - 4gl}$ (b) $\sqrt{2v_0^2 - 2gl}$ (c) $\sqrt{v_0^2 - gl}$ (d) $\sqrt{v_0^2 - 2gl}$ (e) $\sqrt{2v_0^2 - 3gl}$

18. If a wheel of radius R rolls without slipping through an angle θ, what is the relationship between the distance the wheel rolls, x, and the angle θ?

(a) $x < R\theta$ (b) $x = R\theta$ (c) $R = x\theta$ (d) $x > R\theta$ (e) $R > x\theta$



Questions 19-20

A flywheel with a radius of 0.300 m starts from rest and accelerates with a constant angular acceleration of 0.600 rad/s^2 .

19. Compute the magnitude of the tangential acceleration and the radial acceleration of a point on the flywheel edge at the start. (π=3)

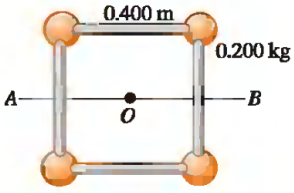
(a) (0180;0.600) m/s^2 (b) (0.600;0.180) m/s^2 (c) (0.180; 0) m/s^2 (d) (0.30;0) m/s^2 (e) (0;0) m/s^2

20. Compute approximate resultant linear acceleration of a point on the flywheel edge after it has turned through 60^o.

(a) 0.3 m/s^2 (b) 0.6 m/s^2 (c) 0 m/s^2 (d) 0.8 m/s^2 (e) 0.4 m/s^2

Questions 21-23

Four small spheres each of which you can regard as a point of mass 0.200 kg. are arranged in a square 0.400 m on a side and connected by extremely light rods shown in the figure. What is the moment of inertia of the system



21. about an axis through the center of the square, perpendicular to its plane (an axis through point 0 in the figure);

(a) 0.016 kg m^2 (b) 0.032 kg m^2 (c) 0.64 kg m^2 (d) 0 kg m^2 (e) 0.064 kg m^2

22. about an axis bisecting two opposite sides of the square (an axis along the line AB in the figure)

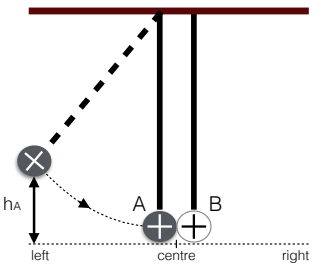
(a) 0.032 kg m^2 (b) 0 kg m^2 (c) 0.32 kg m^2 (d) 0.064 kg m^2 (e) 0.16 kg m^2

23. about an axis that passes through the centers of the upper left and lower right spheres and through point O.

(a) 0.032 kg m^2 (b) 0.16 kg m^2 (c) 0 kg m^2 (d) 0.064 kg m^2 (e) 0.01 kg m^2

Questions 24-25

In the Figure, a **solid sphere** (A) and a **thin-walled hollow sphere** (B) are **fixed** at the ends of two separate massless rigid rods that can rotate freely about their other ends. The length of the rods are the same and both spheres have the same mass and radius, and are initially stationary. Sphere A is displaced to the outlined position and released from the height h_A and then the spheres collide elastically and sphere B reaches the maximum height h_B.



24. Which of the following statements is correct?

(a) $h_A \leq h_B$ (b) $h_A > h_B$ (c) $h_A \geq h_B$ (d) $h_A = h_B$ (e) $h_A < h_B$

25. Where would these two spheres collide if we release them from the same height at the same time with zero initial velocities?

(a) At the center (b) The question cannot be answered with available information (c) On the right of the center (d) It depends on the initial height of the spheres (e) On the left of the center