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

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. Two objects move with the same speed v in opposite directions along a line. They meet and have a completely inelastic collision. After the collision, the composite object moves along the same line with a speed of $v/2$. What is the ratio of the masses m_1/m_2 of the two objects?

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

2. In a completely inelastic collision between object-1 of mass m_1 that is initially moving and object-2 of mass m_2 that is initially at rest, a measure of the energy dissipated is the ratio of the kinetic energy of the system after the collision to that before the collision. What is this ratio?

(a) $m_1/(m_1-m_2)$ (b) $m_2/(m_1+m_2)$ (c) m_2/m_1 (d) $m_1/(m_1+m_2)$ (e) m_1/m_2

Questions 3-5

A thin stick of length $L = 2$ m is denser at one end than the other. Its mass density is $\lambda = \frac{1}{2} - \frac{x}{5}$, where x in meters and λ in kg/m. Here x measures the distance from the heavier end of the stick. The stick is initially at rest and it starts rotation with constant angular acceleration $\alpha = 2$ rad/s^2.

3. What is the rotational inertia (moment of inertia) of the stick about an axis perpendicular to the stick through the heavy end?

(a) $\frac{8}{15}$ kg·m^2 (b) $\frac{7}{15}$ kg·m^2 (c) $\frac{9}{14}$ kg·m^2 (d) $\frac{8}{13}$ kg·m^2 (e) $\frac{11}{15}$ kg·m^2

4. What is the rotational kinetic energy of the stick at $t = 2$ s about an axis perpendicular to the stick through the heavy end?

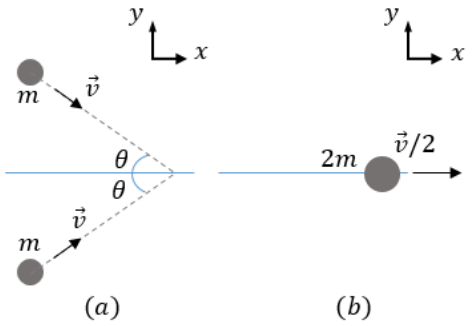
(a) $\frac{64}{15}$ J (b) $\frac{61}{13}$ J (c) $\frac{53}{15}$ J (d) $\frac{47}{15}$ J (e) $\frac{64}{19}$ J

5. What is the magnitude of the torque acting on the stick at $t = 2$ s about an axis perpendicular to the stick through the heavy end?

(a) $\frac{16}{15}\ N\cdot m$ (b) $\frac{19}{15}\ N\cdot m$ (c) $\frac{14}{15}\ N\cdot m$ (d) $\frac{17}{15}\ N\cdot m$ (e) $\frac{13}{15}\ N\cdot m$

Questions 6-7

Two objects with the same mass m and the same speed v have an inelastic collision (see the figure). After the collision the two-object system moves with speed $v/2$



6. What is the tangent of the angle θ between the final line of motion and either of the initial velocities, shown in the figure?

(a) $\sqrt{3}$ (b) $\sqrt{5/3}$ (c) $\sqrt{2}$ (d) $\sqrt{5}$ (e) $\sqrt{3/2}$

7. What is the initial velocity of the center of mass of the system?

(a) $\frac{3v}{2}\hat{\imath}$ (b) $\frac{v}{2}\hat{\imath}$ (c) $\frac{v}{3}\hat{\imath}$ (d) $v\hat{\imath}$ (e) $\frac{v}{4}\hat{\imath}$

Questions 8-10

A time-varying net force acting on a 4-kg particle causes the particle to have a displacement given by $x = 2t - 3t^2 + t^3$ where x is in meters and t is in seconds.

8. What is the kinetic energy of the particle as a function of time in units of joules?

(a) $2(4t^2-6t+1)^2$ (b) $2(3t^2+3t-2)^2$ (c) $2(3t^2-t+4)^2$ (d) $2(3t^2-6t+2)^2$ (e) $2(5t^2-6t+2)^2$

9. What is the power transferred to the particle as a function of time in units of watts?

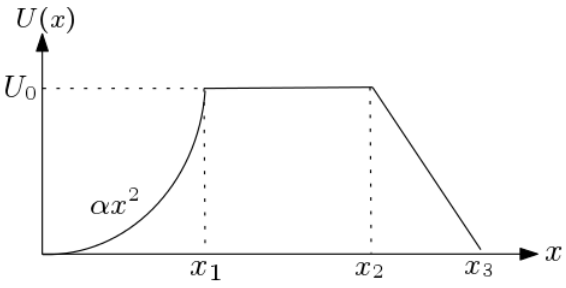
(a) $4(18t^3-54t^2+48t+12)$ (b) $4(18t^3-27t^2+48t-12)$ (c) $4(18t^3-54t^2+48t-12)$ (d) $4(18t^3-54t^2+14t+12)$ (e) $4(16t^3-54t^2+48t-12)$

10. What is the work done on the particle in between $t = 0$ and $t = 1$ s?

(a) 8 J (b) 6 J (c) −6 J (d) 9 J (e) −8 J

Questions 11-16

An object of mass $m = 4.0\ kg$ is moving along the x-direction under the effect of a force $\vec{F}$ whose potential energy function diagram is shown in the figure: $U(x) = \alpha x^2$ (α is a constant) between $x = 0$ and x_1; it is contant between x_1 and x_2 and linearly decreasing between x_2 and x_3. At $x = 0$, the speed of the object is $v_0 = 4.0\ m/s$. There is no friction, and $x_1 = 20.0\ cm$, $x_2 = 120.0\ cm$, $x_3 = 145.0\ cm$, and $U_0 = 8.0\ J$. Take $g = 10\ m/s^2$.



11. What is the SI unit of the constant α?

(a) N/m^2 (b) $kg \cdot s/m$ (c) $kg \cdot m/s^2$ (d) N/m (e) J/m

12. Which of the following is the force $\vec{F}$ acting on the object between $x = 0$ and $x = x_1$?

(a) $-600x\hat{\imath}\,\mathrm{N}$ (b) $200x\hat{\imath}\,\mathrm{N}$ (c) $-200x\hat{\imath}\,\mathrm{N}$ (d) $-400x\hat{\imath}\,\mathrm{N}$ (e) $400x\hat{\imath}\,\mathrm{N}$

13. What is the speed of the object at $x = x_1$?

(a) $2\ m/s$ (b) $2\sqrt{3}\ m/s$ (c) $3\sqrt{2}\ m/s$ (d) $3\ m/s$ (e) $3\sqrt{3}\ m/s$

14. What is the work done by $\vec{F}$ on the object between $x = x_1$ and $x = x_2$?

(a) $10\ J$ (b) 0 (c) $8\ J$ (d) $-10\ J$ (e) $-8\ J$

15. What is the speed of the object at $x = x_3$?

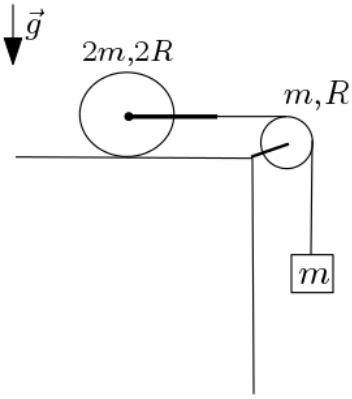
(a) $6.0\ m/s$ (b) $4.0\ m/s$ (c) $3.0\ m/s$ (d) $2.0\ m/s$ (e) 0

16. If there were friction between x_1 and x_2 ($\mu_k = 0.4$), what would be the speed of the object at $x = x_2$?

(a) $3\ m/s$ (b) $5/3\ m/s$ (c) $2\ m/s$ (d) $5/2\ m/s$ (e) $3/2\ m/s$

Questions 17-19

A uniform solid cylinder with mass $2m$ and radius $2R$ rests on a horizontal tabletop. A string is attached by a rod to a frictionless axel through the center of the cylinder so that the cylinder can rotate about the axle. The string runs over a disk shaped pulley with mass m and radius R that is mounted on a frictionless axlethrough its center. A block of mass m is suspended from the free end of the string, as shown in the figure. The string does not slip over the pulley surface, and the cylinder rolls without slipping on the tabletop. (For a solid cylinder of mass M and radius r, $I_{cm} = \frac{1}{2}Mr^2$, and for a disk of mass M and radius r, $I_{cm} = \frac{1}{2}Mr^2$.)



17. Which of the following is the magnitude of the acceleration of the block after the system is released from rest?

(a) $3g/11$ (b) $3g/7$ (c) $4g/9$ (d) $2g/11$ (e) $2g/9$

18. Which of the following is the speed of the block when it falls down a height h?

(a) $\frac{5}{3}\sqrt{gh}$ (b) $\frac{2}{7}\sqrt{gh}$ (c) $\frac{4}{3}\sqrt{gh}$ (d) $\frac{2}{5}\sqrt{gh}$ (e) $\frac{2}{3}\sqrt{gh}$

19. Which of the following is the magnitude of the friction between the table and the solid cylinder?

(a) $\frac{3mg}{11}$ (b) $\frac{2mg}{11}$ (c) $\frac{4mg}{9}$ (d) $\frac{2mg}{7}$ (e) $\frac{2mg}{9}$

20. What is the angular momentum about the origin of a particle of mass m moving along the trajectory $y = ax + b$ (a and b are constants) in the xy-plane with constant speed v?

(a) $\vec{L} = \frac{mvb}{\sqrt{1+a^2}}\hat{k}$ (b) $\vec{L} = -\frac{mvb}{\sqrt{1+a^2}}\hat{\imath}$ (c) $\vec{L} = -\frac{mvab}{\sqrt{1+b^2}}\hat{k}$ (d) $\vec{L} = -\frac{mvb}{\sqrt{1+a^2}}\hat{\jmath}$ (e) $\vec{L} = -\frac{mvb}{\sqrt{1+a^2}}\hat{k}$