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.

Questions 1-2

The potential energy function of a particle of mass 2 kg in a force field is described by $U = 3x^2 - x^3$ (for $x \leq 3$ m) and $U = 0$ (for $x \geq 3$ m) where U is in Joules and x is in meters.

1. For what values of x, the force F_x is zero?

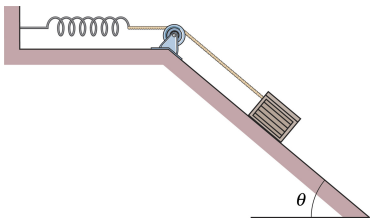
(a) 2 (b) 0 and 1 (c) 0 and 2 (d) −2 and 2 (e) 0

2. If the total energy of the particle is 12 J, what is its speed at $x = 2$ m?

(a) $\sqrt{2}$ m/s (b) 2 m/s (c) 0.5 m/s (d) 0.25 m/s (e) $2\sqrt{2}$ m/s

Questions 3-5

A 2.0 kg breadbox on a frictionless incline of angle 40^o is connected by a cord that runs over a pulley, to a spring of spring constant $k = 120$ N/m. The box is released from rest when the spring is unstrechted. Assume that the pulley is massless and frictionless.



Take $g = 10$ m/s^2, $sin40^o = 0.63$.

3. What is the speed of the box when it has moved 10 cm down the incline?

(a) $\sqrt{1.40}$ m/s (b) $\sqrt{0.66}$ m/s (c) $\sqrt{2.0}$ m/s (d) $\sqrt{1.86}$ m/s (e) $\sqrt{1.36}$ m/s

4. How far down the incline from its point of release does the box slide before momentarily stopping?

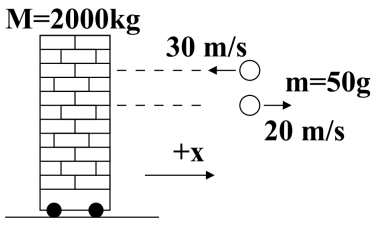
(a) 0.21 m (b) 0.56 cm (c) 0.15 cm (d) 0.42 cm (e) 0.33 cm

5. What is the magnitude of the box's acceleration at the instant it momentarily stops?

(a) 15.0 m/s^2 (b) 6.3 m/s^2 (c) 2.6 m/s^2 (d) 8.3 m/s^2 (e) 19.0 m/s^2

Questions 6-8

A tennis ball with $m = 50$ g mass approaches to a wall horizontally with 30 m/s speed as shown in the figure. After the collision, it reflects back horizontally with 20 m/s speed. The wall is massive ($M = 2000$ kg) but it is free to move on its wheels without any friction. If the collision is elastic and it takes 10 ms time.



6. What is the change in the magnitude and direction of the momentum of the ball?

(a) 5.0 k·gm/s in -x (b) 2.5 kg·m/s in +x (c) 5.0 kg·m/s in +x (d) 2.5 kg·m/s in -x
(e) none

7. What is the magnitude and direction of the force acting on the ball during the collision?

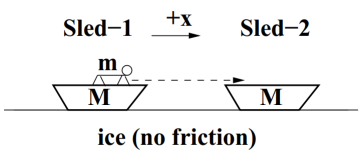
(a) 250 N, +x direction (b) 25 N, +x direction (c) 250 N, -x direction (d) 25 N, -x direction
(e) 2500 N, +x direction

8. What is the magnitude and direction of the velocity of the wall just after the impact?

(a) $(5/4).10^{-3}$ m/s, -x direction (b) $\sqrt{1/80}$ m/s, -x direction (c) $\sqrt{1/20}$ m/s, -x direction
(d) $(5/4).10^{-1}$ m/s, -x direction (e) $(5/4).10^{-2}$ m/s, -x direction

Questions 9-10

A cat with $m = 4$ kg mass sits on the sled-1 which is at rest. The cat momentarily jumps in horizontal direction from the sled-1 ($M = 20$ kg) to sled-2 ($M = 20$ kg) which is also at rest. There is no friction between the sleds and the ice. The speed of the cat is 3 m/s relative to the sled.



9. What is the velocity of the sled-1 for an observer on the ground after the jump?

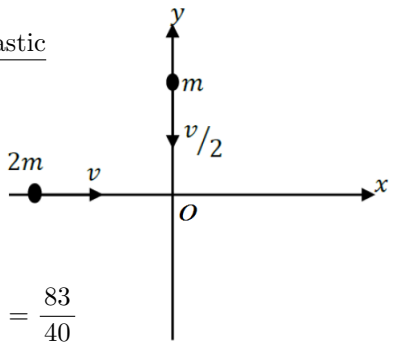
(a) $(-3$ m/s$)\hat{\imath}$ (b) $(-0.5$ m/s$)\hat{\imath}$ (c) $(0.6$ m/s$)\hat{\imath}$ (d) $(-0.6$ m/s$)\hat{\imath}$ (e) $(0$ m/s$)\hat{\imath}$

10. What is velocity of the sled-2 after the cat lands on it?

(a) $(0.5$ m/s$)\hat{\imath}$ (b) $(5/12$ m/s$)\hat{\imath}$ (c) $(0.4$ m/s$)\hat{\imath}$ (d) $(-5/12$ m/s$)\hat{\imath}$ (e) $(0.6$ m/s$)\hat{\imath}$

Questions 11-12

A collision occurs between a particle of mass $2m$ traveling with a velocity $\vec{v}_{1i} = (v)\hat{\imath}$ and a particle of mass m traveling with a velocity $\vec{v}_{2i} = -(v/2)\hat{\jmath}$. They make a completely inelastic collison at the origin and the composite system travels with a velocity $\vec{v}_f$.



11. Determine the final speed v_f in terms of v.

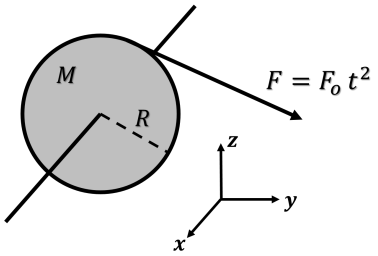
(a) $\frac{17}{\sqrt{6}}\,v$ (b) $\frac{\sqrt{2}}{5}\,v$ (c) $\sqrt{\frac{17}{6}}\,v$ (d) $\sqrt{\frac{2}{5}}\,v$ (e) $\frac{\sqrt{17}}{6}\,v$

12. What is the ratio of the energy loss to the initial energy?

(a) $\frac{|\Delta K|}{K_i} = \frac{27}{10}$ (b) $\frac{|\Delta K|}{K_i} = \frac{25}{74}$ (c) $\frac{|\Delta K|}{K_i} = \frac{10}{27}$ (d) $\frac{|\Delta K|}{K_i} = \frac{40}{83}$ (e) $\frac{|\Delta K|}{K_i} = \frac{83}{40}$

Questions 13-16

A string is wound around the rim of a uniform disk that is pivoted to rotate without friction about a fixed axis through its center. The mass of the disk is $m = 3$ kg and its radius is $R = 20$ cm. The string is initially at rest and is pulled with a time dependent force $F = F_0\,t^2$ where F_0 is given as 10 N/s^2.



13. What is the moment of inertia of this disk in kg·m^2?

(a) 0.48 (b) 0.12 (c) 0.03 (d) 0.06 (e) 0.24

14. What is the magnitude and direction of torque on the disk at $t = 2$ s ?

(a) 8 N·m, +x (b) 16 N·m, -z (c) 16 N·m, +y (d) 8 N·m, -x (e) 16 N·m, +z

15. What is the magnitude and direction of angular acceleration of the disk at $t = 2$ s?

(a) 800/3 rad/s^2, -z (b) 400/3 rad/s^2, +x (c) 800/3 rad/s^2, +y (d) 400/3 rad/s^2, -x
(e) 800/3 rad/s^2, +z

16. What is the magnitude and direction of the angular velocity of the disk at $t = 2$ s?

(a) 400 rad/s, -x (b) 800/9 rad/s, -x (c) 800 rad/s, +z (d) 800 rad/s, -z (e) 800 rad/s, +y

Questions 17-18

A 5-kg particle starts form the origin at time zero. Its position vector as a function of time is given by $\vec{r} = (2t^3)\hat{\imath} + (\mathrm{t}^2)\hat{\jmath}$ where $\vec{r}$ is in meter t is in seconds.

17. What are the net torque about the origin exerted on the particle and the angular momentum of the particle as a function of time?

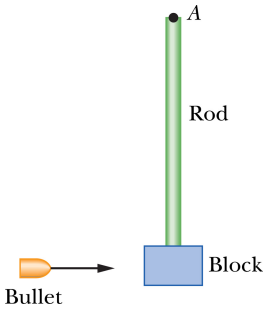
(a) $\vec{\tau} = -24t^3\hat{k}$ N·m , $\vec{L} = -24t^4\hat{k}$ J·s (b) $\vec{\tau} = 40t^3\hat{k}$ N·m , $\vec{L} = -110t^4\hat{k}$ J·s (c) $\vec{\tau} = 140t^3\hat{k}$ N·m , $\vec{L} = 200t^4\hat{k}$ J·s
(d) $\vec{\tau} = -140t^3\hat{k}$ N·m , $\vec{L} = 110t^4\hat{k}$ J·s (e) $\vec{\tau} = -40t^3\hat{k}$ N·m , $\vec{L} = -10t^4\hat{k}$ J·s

18. What is the power injected into the system of the particle as a function of time?

(a) $(360t^3 + 20t)$ W (b) $(36t^3 + 2t)$ W (c) $(36t^3 + 10t)$ W (d) $(36t^3 + 240t)$ W (e) $(81t^3 + 120t)$ W

Questions 19-20

A 1.0 g bullet is fired into a 499 g block attached to the end of a nonuniform rod of length 0.6 m. The block-rod-bullet system then rotates in the plane of the figure, about a fixed axis A. The moment of inertia of the rod alone about the axis A is 0.060 kg·m^2. Treat the block as a point particle.



19. What is the moment of inertia of the block-rod-bullet system about the axis A?

(a) 0.15 kg·m^2 (b) 0.24 kg·m^2 (c) 0.30 kg·m^2 (d) 0.42 kg·m^2 (e) 0.56 kg·m^2

20. If the angular speed of the system about A just after the impact is 4.5 rad/s, what is the bullet's speed just before the impact?

(a) 1125 m/s (b) 760 m/s (c) 2250 m/s (d) 1800 m/s (e) 3100 m/s