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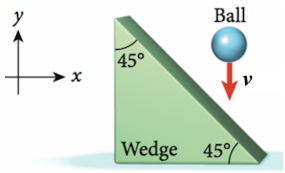
| Group Number | | Name | | A |
| List Number | | e-mail | | |
| Student Number | | Signature | | |

**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.**

## Questions 1-2

A ball falls straight down onto a wedge that is sitting on frictionless ice. The ball has a mass of 2 kg, and the wedge has a mass of 4 kg. The ball is moving a speed of $v = 4$ m/s when it strikes the wedge, which is initially at rest (see the figure). Assuming that the collision is instantaneous and perfectly elastic.




**1.** What is the velocity of the wedge after the collision in m/s?

(a) $-2\sqrt{6}/3$ (b) $-3\sqrt{6}/2$ (c) $-2\sqrt{6}/5$ (d) $-4\sqrt{6}/5$ (e) $-2\sqrt{6}$

**2.** What is the velocity of the ball after the collision in m/s?

(a) $4\sqrt{6}/3$ (b) $7\sqrt{6}/3$ (c) $2\sqrt{6}/3$ (d) $\sqrt{6}$ (e) $5\sqrt{6}/3$

## Questions 3-5

In a tape recorder, the magnetic tape moves at a constant linear speed of 6.4 cm/s. To maintain this constant linear speed, the angular speed of the driving spool (the take-up spool) has to change accordingly.

**3.** What is the angular speed in rad/s of the take-up spool when it is empty (the figure on the left), with radius $r_1$=0.80 cm?

(a) 0.8 (b) 4 (c) 8 (d) 5.12 (e) 3.2

**4.** What is the angular speed in rad/s when the spool is full (the figure on the right), with radius $r_2 = 2.20$ cm?

(a) 2.9 (b) 6.4 (c) 1.5 (d) 3.8 (e) 3.3

**5.** If the total length of the tape is 128 m, what is the average angular acceleration of the take-up spool in rad/s$^2$ while the tape is being played?

(a) $-0.150$ (b) $-0.255$ (c) $-0.200$ (d) $-0.285$ (e) $-0.325$

**6.** A system initially at rest explodes into three pieces. Piece A mass of 2 kg, B has a mass of 3 kg and C has a mass of 1 kg. After the explosion A's velocity is (3 m/s)$\hat{\imath}$ and B's velocity is (-2 m/s)$\hat{\jmath}$. What is the speed of piece C (m/s) after the explosion?

(a) 0 (b) $5\sqrt{2}$ (c) $3\sqrt{2}$ (d) $4\sqrt{2}$ (e) $6\sqrt{2}$

**7.** Assume that your particle rotates about axis z. If the direction of rotation is counter-clock wise direction what is the direction of angular velocity?

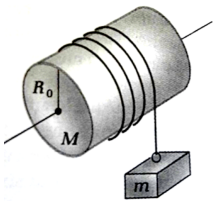
(a) $-\hat{k}$ (b) $+\hat{\jmath}$ (c) $+\hat{\imath}$ (d) $+\hat{k}$ (e) $-\hat{\imath}$

**8.** A 0.1 kg mass travels along a horizontal air track at a speed of 1 m/s. It makes an elastic collision with another mass that is initially at rest on the track. During the collision, which of the following is always true?

(a) All of them is wrong.
(b) The total momentum and kinetic energy are the same as before the collision.
(c) The momentum is shared equally between two masses after the impact.
(d) The kinetic energy is conserved but the momentum after the impact is less than before.
(e) The total momentum is the same as before the impact but the total kinetic energy is less.

## Questions 9-10

A block of mass $m$ is tied to a string of negligible mass that is wrapped around a uniform cylinder of mass $M$ and radius $R_0$. The cylinder is free to rotate with negligible friction about a fixed axis through its center. After the block has dropped a vertical distance $h$ from rest; (Moment of inertia of cylinder about center of mass is $I = (1/2)MR_0^2$)




**9.** What is the linear speed of the block?

(a) $\sqrt{2gh}$ (b) $\sqrt{\frac{gh}{1+(\frac{M}{m})}}$ (c) $\sqrt{\frac{2gh}{2+(\frac{M}{2m})}}$ (d) $\sqrt{\frac{2gh}{1+(\frac{M}{2m})}}$ (e) 0

**10.** What is the angular speed of the cylinder about its axis of rotation?

(a) $\sqrt{\frac{2gh}{1+(\frac{M}{2m})}}$ (b) $\frac{1}{R_0}\sqrt{\frac{2gh}{\frac{M}{2m}}}$ (c) $\frac{1}{R_0}\sqrt{\frac{2gh}{1+(\frac{M}{2m})}}$ (d) $\frac{1}{R_0}\sqrt{2gh}$ (e) 0

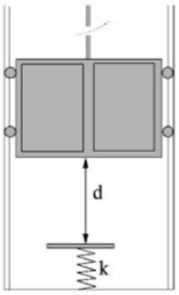
**11.** A stone is tied to a string and rotate in a horizontal plane at constant angular velocity. During the motion,

(a) Both linear and angular momentum change. (b) Linear and angular momentum are constant. (c) All is wrong. (d) Linear momentum is constant but angular momentum changes. (e) Angular momentum is conserved but linear momentum changes.

**12.** What is the unit of impulse?

(a) kgm/s$^3$ (b) Nm/s (c) kgm/s (d) N/s (e) kgm$^2$/s$^2$

**13.** The cable of the 4000 N elevator snaps when the elevator is rest at the first floor, where the bottom is a distance d=12 m above from the spring with a constant of k=$10^3$ N/m as shown in the figure. A safety device clamps the elevator against guide rails so that a constant frictional force of 1000 N opposes the motion of the elevator. Find the maximum distance x in m that the spring is compressed. ($\sqrt{324} = 18$, g = 10 m/s$^2$)




(a) 6 (b) 9 (c) 11 (d) 12 (e) 8

**14.** The angular momentum of a system remains constant

(a) all the time since it is a conserved quantity. (b) when no torque acts on the system. (c) when no net external force acts on the system. (d) when the linear momentum and the energy are constant. (e) when the total kinetic energy is constant.

**Questions 14-15**

A 4 kg box starts up a 30 degree inclined with 120.8 J of kinetic energy. (g=10 m/s$^2$, sin(30)=1/2, cos(30)=$\sqrt{3}/2$ and $\sqrt{3} = 1.7$)

**15.** How far will it slide up the plane if the coefficient of friction is 0.3?

(a) 5 (b) 3 (c) 4 (d) 1 (e) 2

**16.** What will be the final energy of the box in J?

(a) 80 (b) 20 (c) 100 (d) 60 (e) 40

**17.** Which of the following is true?

(a) In an isolated system, total energy of the system always remains constant.
(b) The internal energy of a system is equal to the elastic potential energy of the system.
(c) If a frictional force does work on a system, the total mechanical energy is equal to its potential energy change.
(d) Kinetic energy change is always equal to the work done by the system.
(e) The total energy of a system is always the sum of its kinetic and its potential energies.

**Questions 17-18**

Two 2 kg balls are attached to the ends of a thin rod of negligible mass and 6 cm long. The rod is free to rotate in a vertical plane without friction through its center. While the rod is horizontal a 1 kg wax drops onto one of the balls with a speed of 3 m/s and sticks to it.

**18.** What is the angular speed of the system just after the wax hits in rad/s?

(a) 5 (b) 20 (c) 25 (d) 10 (e) 15

**19.** What is the ratio of the kinetic energy of the entire system after the collision to that of before?

(a) 0.4 (b) 0.6 (c) 0.3 (d) 0.2 (e) 0.8

**Questions 19-20**

A uniform thin rod is pivoted at its center and it is free to rotate in a horizontal circle without friction. Two object each with a mass 2 kg sit on opposite ends of the rod with length 6 m and mass 2 kg. (Moment of inertia of rod about center of mass is $I = (1/12)Ml^2$)

**20.** What is the angular momentum of the system if it is rotating with angular speed $\omega_0$ in a clockwise direction?

(a) $42\omega_0$ (b) $6\omega_0$ (c) $36\omega_0$ (d) $56\omega_0$ (e) $12\omega_0$

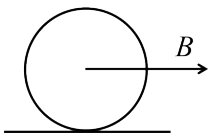
**21.** While the system is rotating, objects move towards the center of the rod until they are half as far from the center as before. What is the resulting angular speed in terms of $\omega_0$?

(a) 7/12 (b) 24 (c) 14 (d) 1 (e) 14/5

**22.** A 1.25 kg ball begins rolling from rest with constant angular acceleration down a hill. If it takes 3 s for it to make the first complete revolution, how long will it take to make the next complete revolution?

(a) 2.10 (b) 1.53 (c) 1.80 (d) 1.65 (e) 1.24

**23.** A lawn roller in the form of a uniform solid cylinder is being pulled horizontally by a horizontal force B applied to an axle through the center of the roller, as shown in the figure. The roller has radius 0.65 meters and mass 50 kg and rolls without slipping. What magnitude of the force B is required to give the center of mass of the roller an acceleration of 3 m/s$^2$? ($I = (1/2)MR^2$)




(a) 180 (b) 275 (c) 225 (d) 450 (e) 300

**24.** The only force acting on an object moving along the x-axis is the conservative force given by F(x) = (2.00 N/m)x + (1.00 N/m$^3$)x$^3$. What is the change in potential energy when the object moves from x = 1.00 m to x = 2.00 m?

(a) -7.65 (b) 8 (c) -6.75 (d) -8 (e) 6.65

**25.** A dumbbell-shaped object is composed by two equal masses, m, connected by a rod of negligible mass and length r. If $I_1$ is the moment of inertia of this object with respect to an axis passing through the center of the rod and perpendicular to it and $I_2$ is the moment of inertia with respect to an axis passing through one of the masses, then what is the value of $I_2$ in term of $I_1$?

(a) $I_2 = (2/3)I_1$ (b) $I_2 = 4I_1$ (c) $I_2 = I_1$ (d) $I_2 = 0.5I_1$ (e) $I_2 = 2I_1$