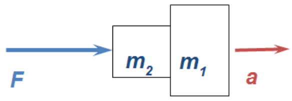
		Surname		Type
Group Number		Name		A
List Number		e-mail		
Student ID		Signature		

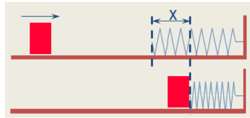
ATTENTION:Each question has only one correct answer and is worth one point. Be sure to fill in completely the circle that corresponds to your answer on the answer sheet. Use a pencil (not a pen). Only the answers on your answer sheet will be taken into account.

1. A force F acts on mass m_1 giving acceleration a_1. The same force acts on a different mass m_2 giving acceleration $a_2 = 2a_1$. If m_1 and m_2 are glued together and the same force F acts on this combination, what is the resulting acceleration?



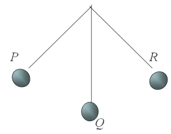
(a) 4/3 a_1 (b) 3/4 a_1 (c) 2/3 a_1 (d) 1/2 a_1 (e) 3/2 a_1

2. A box sliding on a frictionless flat surface runs into a fixed spring, which is compressed a distance x until the box stops. If the initial speed of the box were doubled, how much would the spring compress in this case?



(a) $\sqrt{2}$ times as much (b) The same amount (c) Half as much (d) Four times as much (e) Twice as much

3. A pendulum of length L with a bob of mass m swings back and forth. At the low point of its motion (point Q), the tension in the string is (3/2)mg. What is the speed of the bob at this point?



(a) $\frac{\sqrt{gL}}{2}$ (b) $2\sqrt{gL}$ (c) $\sqrt{gL}$ (d) $\sqrt{2gL}$ (e) $\sqrt{\frac{gL}{2}}$

4. One car has twice the mass of a second car, but only half as much kinetic energy. When both cars increase their speed by 7 m/s, they then have the same kinetic energy. What were the original speeds of two cars?

(a) $v_1 = \frac{7.0}{\sqrt{2}}$ m/s; $v_2 = v_1$ (b) $v_1 = 7\sqrt{2}$ m/s; $v_2 = v_1$ (c) $v_1 = 7\sqrt{2}$ m/s; $v_2 = 2v_1$ (d) $v_1 = 7\sqrt{2}$ m/s; $2v_2 = v_1$ (e) $v_1 = \frac{7.0}{\sqrt{2}}$ m/s; $v_2 = 2v_1$

5. A particle is moving along the x-axis subject to the potential energy function $U(x) = \frac{a}{x} + bx^2 + cx - d$, where $a = 3.00$ J m, $b = 12.0$ J/m^2, $c = 7.00$ J/m, and $d = 20.0$ J. Determine the x-component of the net force on the particle at the coordinate $x = 1$ m.

(a) $-2.8\,10^6$ g.cm/s^2 (b) $2.8\,10^6$ N (c) $-2.8\,10^6$ N (d) 0 (e) $2.8\,10^6$ g.cm/s^2

Questions 6-9

Two blocks shown in the figure are of mass "m" and rest on a flat frictionless air track. A spring of force constant "k" is attached to block (2). Block (1) has initial velocity in the +x direction. Block (2) is initially at rest. Block (1) also becomes attached when it hits the spring.

6. What is the center of mass velocity of the system?

(a) $v_0/2$ (b) 0 (c) v_0 (d) $2v_0$ (e) $v_0/4$

7. What is the minimum total kinetic energy consistent with the conservation laws?

(a) 0 (b) $mv_0^2/4$ (c) $2mv_0^2$ (d) mv_0^2 (e) $mv_0^2/2$

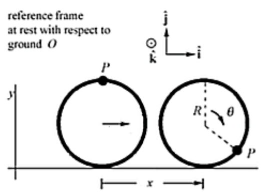
8. What is the maximum compression of the spring?

(a) $(m/2k)v_0$ (b) 0 (c) $(2k/m)v_0^2$ (d) $(m/2k)^{1/2}v_0$ (e) $(k/m)^{1/2}v_0$

9. What is the maximum velocity of block (1) after the collision?

(a) $v_0/\sqrt{2}$ (b) v_0 (c) $v_0/2$ (d) $2v_0$ (e) 0

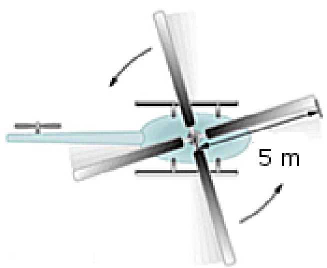
10. If a wheel of radius R rolls without slipping through an angle θ, what is the relationship between the distance the wheel rolls, x, and the product $R\theta$?



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

Questions 11-13

A typical small rescue helicopter has four blades as shown in the figure on right. Each is 5.00 m long and has a mass of 60.0 kg. The blades can be approximated as thin rods that rotate about one end of an axis perpendicular to their length. The helicopter has a total loaded mass of 2000 kg.



11. Calculate the rotational kinetic energy in the blades when they rotate at 300 rpm.

(a) 1.00x10^6 J (b) 2.00x10^5 J (c) 1.00x10^5 J (d) 4.00x10^6 J (e) 2.00x10^6J

12. When the helicopter flies at 20.0 m/s, what is the ratio of the translational kinetic energy of the helicopter with respect to the rotational energy in the blades?

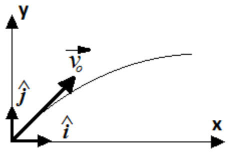
(a) 5.0 (b) 0.8 (c) 2.5 (d) 0.4 (e) 1

13. To what height could the helicopter be raised if all of the rotational kinetic energy could be used to lift it?

(a) 500.0 m (b) 50.0 m (c) 5.0 m (d) 25.0 m (e) 100.0 m

Questions 14-17

A projectile of mass m= 1 kg is fired from the ground with an initial position $\vec{r_o} = \vec{0}$ and initial velocity of $\vec{v_o} = 8\ (m/s)\hat{i} + 15\ (m/s)\hat{j}$. Acceleration due to gravity is $\vec{g} = -10\ (m/s^2)\hat{j}$. Answer the following for t=2 s.



14. Which of the following is the linear momentum of the particle in kg m/s?

(a) $5\hat{i} + 8\hat{j}$ (b) $8\hat{i} - 10\hat{j}$ (c) $5\hat{i} - 8\hat{j}$ (d) $8\hat{i} + 5\hat{j}$ (e) $8\hat{i} - 5\hat{j}$

15. Which of the following is the angular momentum of the particle in kg m^2/s?

(a) $160\hat{k}$ (b) $-80\hat{k}$ (c) $-160\hat{k}$ (d) $80\hat{i} - 80\hat{j}$ (e) $-80\hat{j}$

16. Which of the following is the rate of change of angular momentum of the particle in kg m^2/s^2?

(a) $-160\hat{k}$ (b) $-80\hat{k}$ (c) $-80\hat{j}$ (d) $80\hat{i} - 80\hat{j}$ (e) $160\hat{k}$

17. Which of the following is the net torque acting on the particle in N m?

(a) $-80\hat{k}$ (b) $160\hat{k}$ (c) $-160\hat{k}$ (d) $-80\hat{j}$ (e) $80\hat{i} - 80\hat{j}$

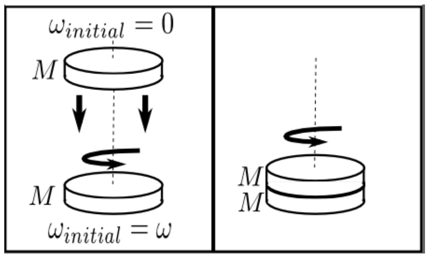
Questions 18-21

A uniform disk of mass "M", radius "R" and moment of inertia $I = MR^2/2$ is spining around its axis with angular speed ω. The system is frictionless.

18. What is its angular momentum L?

(a) $MR^2\omega^2$ (b) $MR^2\omega$ (c) $2MR^2\omega$ (d) $MR\omega^2/2$ (e) $MR^2\omega/2$

A second, identical disk is on the same axis, which is initially not spinning. It is allowed drop on the first disk. The two disks soon start turning together.



19. What quantity / quantities is /are conserved during the collision?

(a) L only. (b) Mechanical energy only. (c) Kinetic energy only. (d) L and mechanical energy. (e) L and kinetic energy.

20. What is the angular momentum L_f after the collision?

(a) $MR\omega^2/2$ (b) $MR^2\omega/2$ (c) $MR^2\omega$ (d) 0 (e) $2MR^2\omega$

21. What is the final kinetic energy KE_f after the collision?

(a) $MR^2\omega^2/2$ (b) 0 (c) $MR^2\omega^2/4$ (d) $MR^2\omega^2/8$ (e) $MR^2\omega^2$

22. Using Kepler's laws of planetary motion, decide which of the following statements are correct:
I) It takes the earth less time to complete one full revolution in its orbit around the sun than it takes Jupiter.
II) A planet moving in an orbit around the sun experiences zero net external torque.
III) Time needed by a planet to complete one full revolution around the sun increases with the mass of the planet.

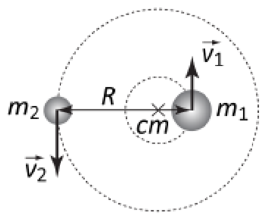
(a) Only II (b) I and II (c) I and III (d) II and III (e) I, II, and III

23. What is the magnitude of the angular momentum, L, of a satellite of mass m is in a circular orbit of radius $R = 2R_\mathrm{E}$? The mass and radius of Earth are M_E and R_E. The universal gravitational constant is G and the magnitude of the gravitational acceleration on the earth surface is g.

(a) $L = M_\mathrm{E}\sqrt{2gR_\mathrm{E}^3}$ (b) $L = m\sqrt{GgR_\mathrm{E}^3}$ (c) $L = 0$ (d) $L = (m + M_\mathrm{E})\sqrt{2gR_\mathrm{E}^3}$ (e) $L = m\sqrt{2gR_\mathrm{E}^3}$

Questions 24-25

Consider a binary star system with stars of masses $m_1 = 3M$ and $m_2 = M$, separated by distance R (see figure). The stars are in circular orbits around the center of mass of the system labeled "cm", with respective orbital speeds v_1 and v_2.



24. What is the ratio of orbital speeds v_1/v_2 of the two stars?

(a) 1/3 (b) 1/9 (c) 3 (d) 9 (e) 1

25. What is the orbital period of each star (symbol G stands for the gravitational constant)?

(a) $\frac{1}{2\pi}\frac{GM^2}{R^2}$ (b) $\frac{2\pi GM}{R}$ (c) $\sqrt{\frac{\pi^2 R^3}{GM}}$ (d) $3\sqrt{\frac{\pi^2 R^3}{GM}}$ (e) $\frac{1}{3}\sqrt{\frac{\pi^2 R^3}{GM}}$