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 - 4

A mass m attached to the end of a spring on a frictionless horizontal plane is released from rest at $t = 0$ s from an extended position x_{max}. The mass $m = 0.2$ kg and $k = 1$ N/m. At $\omega t = 5\pi/4$ with ω angular frequency of the simple harmonic motion, the speed of the mass is measured to be 1.5 m/s.

1. What is the maximum speed of the motion?
(a) $\sqrt{3}/5$ m/s (b) $3/\sqrt{3}$ m/s (c) $3/\sqrt{2}$ m/s (d) $\sqrt{3}/2$ m/s (e) $\sqrt{2}/2$ m/s

2. What is x_{max}?
(a) $3/\sqrt{7}$ m/s (b) $3/\sqrt{5}$ m/s (c) $\sqrt{10}/2$ m/s (d) $3/\sqrt{10}$ m (e) $\sqrt{10}/3$ m/s

3. What is the angular frequency of the simple harmonic motion?
(a) $\sqrt{7}$ rad/s (b) 5 rad/s (c) $\sqrt{3}$ rad/s (d) $\sqrt{5}$ rad/s (e) 3 rad/s

4. What is the total energy of the mass - spring system?
(a) 9/20 J (b) 9/10 J (c) 7/10 J (d) 3/20 J (e) 9/16 J

Questions 5 - 7

A physical pendulum of $m = 2$ kg oscillates at small angle around an axis at a distant of $h = 0.2$ m to it center of gravity. It has a moment of inertia $I = \frac{1}{2}mh^2$ with respect to its rotation axis.

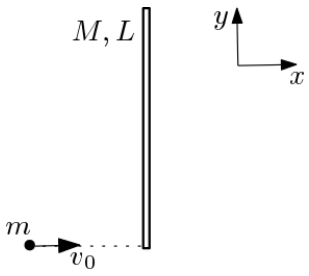
5. What is the length of a 2 kg simple pendulum that has the same period for small amplitude oscillations?
(a) $\sqrt{2}/0.1$ m (b) $\sqrt{3}/0.1$ m (c) 0.4 m (d) $0.2\sqrt{2}$ m (e) 0.1 m

6. Find the maximum value of the angular acceleration if the amplitude of oscillation is 0.3 rad.
(a) 3 rad/s^2 (b) 1/30 rad/s^2 (c) 30 rad/s^2 (d) 300 rad/s^2 (e) 1/300 rad/s^2

7. What is the angular acceleration as the pendulum passed through the equilibrium position?
(a) $30\sqrt{2}$ rad/s^2 (b) $20/\sqrt{3}$ rad/s^2 (c) 0 rad/s^2 (d) 30 rad/s^2 (e) 150 rad/s^2

Questions 8 - 12

A uniform rod of mass $M = 3m$ and length L is initially at rest on a frictionless table. A point particle of mass m and speed v_0 hits the rod and bounces back in the opposite direction with speed $v_0/2$, as shown in the figure. (For a uniform rod of mass M and length L, $I_{cm} = \frac{1}{12}ML^2$.)



8. Which of the following is the center of mass velocity of the rod just after the collision?
(a) $\frac{3v_0}{2}\hat{\imath}$ (b) $\frac{v_0}{4}\hat{\imath}$ (c) $-\frac{v_0}{2}\hat{\imath}$ (d) $\frac{v_0}{2}\hat{\imath}$ (e) $-\frac{v_0}{4}\hat{\imath}$

9. What is the angular speed of the rod about its center of mass just after the collision?
(a) $\frac{v_0}{3L}$ (b) $\frac{2v_0}{3L}$ (c) $\frac{3v_0}{2L}$ (d) $\frac{3v_0}{L}$ (e) $\frac{3v_0}{4L}$

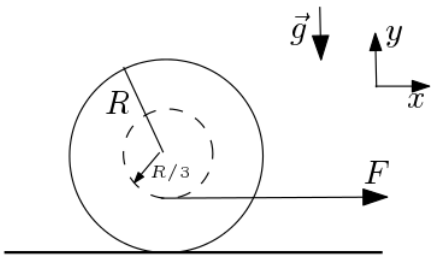
10. What is the impulse transferred to the point particle m during the collision?
(a) $\frac{3m}{4}v_0\hat{\imath}$ (b) $\frac{3m}{2}v_0\hat{\imath}$ (c) $-\frac{3m}{2}v_0\hat{\imath}$ (d) $-\frac{3m}{5}v_0\hat{\imath}$ (e) $-\frac{3m}{4}v_0\hat{\imath}$

11. If the collision were completely inelastic, what would be the center of mass velocity of the system just after the collision?
(a) $\frac{v_0}{4}\hat{\imath}$ (b) $-\frac{v_0}{3}\hat{\imath}$ (c) $-\frac{v_0}{4}\hat{\imath}$ (d) $\frac{3v_0}{4}\hat{\imath}$ (e) $\frac{v_0}{3}\hat{\imath}$

12. If the collision were completely inelastic, what would be the angular speed of the system about the new center of mass?
(a) $\frac{6v_0}{5L}$ (b) $\frac{5v_0}{6L}$ (c) $\frac{7v_0}{4L}$ (d) $\frac{5v_0}{7L}$ (e) $\frac{6v_0}{7L}$

Questions 13 - 15

A disk shaped yo-yo is being pulled by a constant horizontal force $F = 6\ N$, as shown in the figure. The mass of the yo-yo is $M = 500$ g and its radius is $R = 20$ cm, and F is pulling it at a distance $R/3$ from the center. Assume that the yo-yo is rolling without slipping under these conditions.
(For a disk of mass M and radius R, $I_{cm} = \frac{1}{2}MR^2$. Take $g = 10$ m/s^2.)



13. Which of the following is the acceleration of the center of mass of the yo-yo?

(a) $2\ m/s^2$ (b) $\frac{16}{3}\ m/s^2$ (c) $\frac{5}{2}\ m/s^2$ (d) $\frac{11}{3}\ m/s^2$ (e) $3\ m/s^2$

14. Which of the following is the angular speed of the yo-yo when its center of mass has moved a distance $1.5\ m$?

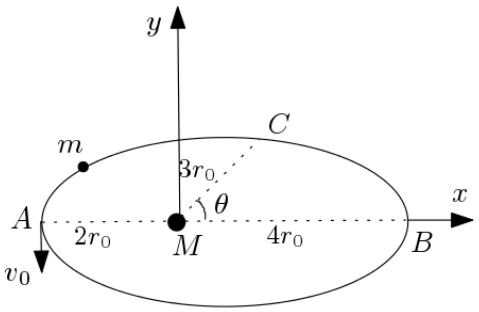
(a) $10\ rad/s$ (b) $25\ rad/s$ (c) $15\ rad/s$ (d) $30\ rad/s$ (e) $20\ rad/s$

15. Which of the following is the static friction force acting on the yo-yo?

(a) $-\left(\frac{10}{3}\ N\right)\hat{\imath}$ (b) $-\left(\frac{8}{3}\ N\right)\hat{\imath}$ (c) $-2\ N\hat{\imath}$ (d) $-4\ N\hat{\imath}$ (e) $-3\ N\hat{\imath}$

Questions 16 - 20

A planet of mass m is moving on an elliptic orbit about a star of mass M ($m \ll M$), as shown in the figure. The point A is the closest point of the planet to the star and the point B is that of farthest, and the distance of the planet to the star at point A is $2r_0$ and at B is $4r_0$. The speed of the planet at point A is $v_0 = \sqrt{\frac{2GM}{3r_0}}$.



16. Which of the following is the total energy of the system?

(a) $-\frac{2GMm}{7r_0}$ (b) $-\frac{GMm}{7r_0}$ (c) $-\frac{GMm}{8r_0}$ (d) $-\frac{3GMm}{7r_0}$ (e) $-\frac{GMm}{6r_0}$

17. Which of the following is the speed of the planet at point B?

(a) $\sqrt{\frac{2GM}{7r_0}}$ (b) $\sqrt{\frac{GM}{6r_0}}$ (c) $\sqrt{\frac{GM}{8r_0}}$ (d) $\sqrt{\frac{3GM}{8r_0}}$ (e) $\sqrt{\frac{GM}{7r_0}}$

18. Which of the following is the acceleration of the planet at point C which is at a distance $3r_0$ from the star where the radius vector makes an angle of $\theta = \pi/6\ rad$ with the x-axis? ($\sin \pi/6 = 1/2$.)

(a) $-\frac{GM}{18r_0^2}(\sqrt{3}\hat{\imath}+\hat{\jmath})$ (b) $\frac{GM}{16r_0^2}(\sqrt{3}\hat{\imath}+\hat{\jmath})$ (c) $-\frac{GM}{16r_0^2}(\sqrt{3}\hat{\imath}+\hat{\jmath})$ (d) $-\frac{GM}{18r_0^2}(\sqrt{3}\hat{\imath}-\hat{\jmath})$ (e) $-\frac{GM}{18r_0^2}(-\sqrt{3}\hat{\imath}+\hat{\jmath})$

19. Which of the following is the length of the semimajor axis of the elliptic orbit?

(a) $7r_0/2$ (b) $3r_0$ (c) $7r_0/3$ (d) $5r_0/2$ (e) $9r_0/4$

20. Which of the following is the eccentricity of the orbit?

(a) 2/3 (b) 1/3 (c) 3/4 (d) 3/5 (e) 0