		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 skater spins with extended arms. (Assume no frictional torque.) Upon pulling his arms towards his chest, the skater's rotational velocity doubles. Which of the following is INCORRECT?

(a) The increased angular velocity occurs without applying a torque. (b) the skater's moment of inertia decreases to half its original value. (c) Muscle's of the skater perform work. (d) the rotational kinetic energy doubles (e) The angular momentum doubles

2. Five objects of mass m move at velocity **v** at a distance r from an axis of rotation perpendicular to the page through point A, as shown in figure page. At which one the angular momentum is zero about that axis?

(a) V (b) I (c) IV (d) III (e) II

3. A solid cylinder has a moment of inertia of 2 kg $\cdot$ m^2. It is at rest at time zero when a net torque given by $\tau = 6t^2 + 6$ (SI units) is applied. Find angular velocity of the cylinder after 2s.

(a) 14 rad/s (b) 28 rad/s (c) 3.0 rad/s (d) 12 rad/s (e) 24 rad/s

4. A solid ball of radius "R_1", and mass "M_1" (I_1=(2/5)M_1 R_1^2) and a hollow ball of mass "M_2" and radius "R_2". (I_2=(3/5)M_2 R_2^2) are released from the top of an inclined plane at the same time with zero initial velocity. Which ball will reach the bottom of the incline first? (Neglect air friction and assume balls are rolling without slipping.)

(a) Both at the same time (b) The ball with larger radius (c) Hollow ball, (d) Heavier ball, (e) Solid ball,

5. Which of the following(s) is/are true?
i. $\sum_i \vec{F}_i = 0$ is <u>sufficient</u> for static equilibrium to exist.
ii. $\sum_i \vec{F}_i = 0$ is <u>necessary</u> for static equilibrium to exist.
iii. In static equilibrium, the net torque about any point is zero.

(a) only ii (b) only i (c) only iii (d) ii and iii (e) i and iii

6. A cylinder is placed by a frictionless surface formed by a plane inclined at angle θ to the horizontal on the left as shown in the figure. In which θ $\vec{F}$ has the largest value? (Look at the figures page)

(a) 60° (b) 45° (c) 40° (d) 80° (e) 30°

7. A mass m is hung from a clothesline stretched between two poles. As a result, the clothesline sags slightly as shown in figure. The tension on the clothesline is

(a) considerably greater than mg/2 (b) slightly greater than mg/2 (c) mg (d) mg/2 (e) considerably less than mg/2

8. Which is stronger, Earth's pull on the Moon, or the Moon's pull on Earth?

(a) the Moon pulls harder on the Earth (b) they pull on each other equally (c) the Earth pulls harder on the Moon (d) there is no force between the Earth and the Moon (e) it depends upon where the Moon is in its orbit at that time

9. If the distance to the Moon were doubled, then the force of attraction between Earth and the Moon would be:

(a) the same (b) two times (c) one quarter (d) one half (e) four times

10. Two satellites A and B of the same mass are going around Earth in concentric orbits. The distance of satellite B from Earth's center is twice that of satellite A. What is the ratio of the centripetal force acting on B compared to that acting on A?

(a) 1/8 (b) it's the same. (c) 2 (d) 1/4 (e) 1/2

Questions 11-15

An open door of mass M is hinged to a wall and at rest. A ball of putty (macun) of mass m (m<<M) strikes the door at a point that is a distance D from an axes through the hinges (see figure a). The initial velocity, $\vec{V}$, of the putty makes an angle θ with a normal to the door, and the putty sticks to the door after the collision (see figure b). The door has a uniform mass density and width ℓ. Neglect friction in the hinges during the time interval of the collision.

11. Find the total angular momentum of the system (door plus putty) about the hinge before the collosion?

(a) $L_i = \ell mV \sin\theta$ (b) $L_i = DmV \cos\theta$ (c) $L_i = DmV \sin\theta$ (d) $L_i = DmV$ (e) $L_i = \ell mV$

12. Find the total moment of inertia of the system about the hinge.

(a) $I = M\ell^2/3$ (b) $I = \ell^2(2m + M/3)$ (c) $I = mD^2 + M\ell^2/3$ (d) $I = m\ell^2$ (e) $I = 2mD^2/3 + M\ell^2$

13. Find the total angular momentum of the system about the hinge after the collosion?

(a) $L_f = \omega(M\ell^2)$ (b) $L_f = \omega\ell^2(2m + M/3)$ (c) $L_f = \omega(m\ell^2/3)$ (d) $L_f = \omega(mD^2 + M\ell^2/3)$ (e) $L_f = \omega(M\ell^2/3)$

14. Determine an expression for the resulting angular speed ω of the door in terms of the quantities introduced.

(a) $\omega = DmV/(mD^2 + M\ell^2/3)$ (b) $\omega = DmV\sin\theta/(mD^2)$ (c) $\omega = lmV\cos\theta/(M\ell^2/3)$ (d) $\omega = DmV\cos\theta/(mD^2 + M\ell^2/3)$ (e) $\omega = DmV\sin\theta/\ell^2(m + M/3)$

15. Find the change in kinetic energy of the system.

(a) $\Delta K = (V^2/2)[(D^2m^2\cos^2\theta/(mD^2 + M\ell^2/3)) - m]$ (b) $\Delta K = V^2[(D^2m^2\sin^2\theta/(M\ell^2/3)) - m]$ (c) $\Delta K = (V^2/2)[(\ell^2m/D^2) - m]$ (d) $\Delta K = (V^2/2)[(D^2m^2/(mD^2 + M\ell^2/3)) - m]$ (e) $\Delta K = (V^2/2)[(D^2m/\ell^2) - m]$

Questions 16-18

A rigid rod of mass m_3 is pivoted at point A, and masses m_1 and m_2 are hanging from it, and they are stayed in equilibrium as shown in the figure.

16. What is the magnitude of the normal force acting on the pivot point?

(a) 0 (b) $\frac{2m_2+m_3}{2m_1+m_3}g$ (c) m_3g (d) $(m_1 + m_2)g$ (e) $(m_1 + m_2 + m_3)g$

17. What is the ratio of L_1 to L_2, where these are the distances from the pivot point to m_1 and m_2, respectively?

(a) $\frac{2m_2+m_3}{2m_1+m_3}$ (b) 1 (c) $\frac{m_2+m_3}{m_1+m_3}$ (d) $\frac{m_1+m_2}{m_1+m_2+m_3}$ (e) $\frac{m_3}{m_1+m_2+m_3}$

18. What is the tension in rope holding the mass m_1.

(a) m_1g (b) $(m_1 + m_3)g$ (c) $\frac{m_1m_2}{m_1+m_2}g$ (d) $(m_1 - m_2)g$ (e) m_3g

Questions 19-20

A massless uniform board and a length of L, is supported by two vertical ropes, as shown in the figure. Rope A is connected to one end of the board, and rope B is connected at a distance of d from the other end of the board. A box with a weight M is placed on the board with its center of mass at d from rope A.

19. What is the tension in rope B?

(a) $Mg/2$ (b) $\frac{d}{(L-d)}Mg$ (c) $\frac{(L-d)}{(L+d)}g$ (d) $\left(\frac{(L-2d)(2M)}{(2L-d)}\right)g$ (e) Mg

20. What is the tension in rope A?

(a) $\frac{(M)(L-2d)g}{(L-d)}$ (b) $\frac{(2M)(L-2d)g}{2(L+d)}$ (c) $\frac{(M)(L-2d)g}{(2L-d)}$ (d) Mg (e) $\left(M - \frac{(L-2d)(2M)}{2(L-d)}\right)g$

Questions 21-25

Four masses are arranged as shown in figure.

21. Determine the gravitational force on (m) exerted by $(2m)$

(a) $\vec{F} = G\frac{(2m)m}{{y_0}^2}\hat{\mathbf{i}}$ (b) $\vec{F} = G\frac{(2m)m}{x_0}\hat{\mathbf{j}}$ (c) $\vec{F} = G\frac{(2m)m}{{x_0}^2}\hat{\mathbf{i}}$ (d) $\vec{F} = G\frac{(m)m}{x_0}\hat{\mathbf{i}}$ (e) $\vec{F} = G\frac{(m)m}{{x_0}^2}\hat{\mathbf{i}}$

22. Determine the gravitational force on (m) exerted by $(3m)$

(a) $\vec{F} = G\frac{(3m)m}{{x_0}^2}\cos\theta\,\hat{\mathbf{j}} + G\frac{(3m)m}{{x_0}^2+{y_0}^2}\sin\theta\hat{\mathbf{i}}$ (b) $\vec{F} = G\frac{(3m)m}{{x_0}^2+{y_0}^2}\cos\theta\,\hat{\mathbf{i}} + G\frac{(3m)m}{{x_0}^2+{y_0}^2}\sin\theta\,\hat{\mathbf{j}}$ (c) $\vec{F} = G\frac{(3m)m}{{x_0}^2}\hat{\mathbf{i}}$ (d) $\vec{F} = G\frac{(3m)m}{{x_0}^2}\sin\theta\hat{\mathbf{i}}$ (e) $\vec{F} = G\frac{(2m)m}{{x_0}^2}\hat{\mathbf{j}}$

23. Determine the gravitational force on (m) exerted by $(4m)$

(a) $\vec{F} = G\frac{(4m)m}{{x_0}^2}\cos\theta\hat{\mathbf{i}}$ (b) $\vec{F} = G\frac{(4m)m}{y_0}\hat{\mathbf{i}}$ (c) $\vec{F} = G\frac{(4m)m}{x_0}\sin\theta\hat{\mathbf{j}}$ (d) $\vec{F} = G\frac{(4m)m}{{y_0}^2}\hat{\mathbf{j}}$ (e) $\vec{F} = G\frac{(4m)m}{x_0}\cos\theta\hat{\mathbf{j}}$

24. Determine the x and y components of the gravitational field on the mass at the origin (m).

(a) $g = \left(G\frac{2m^2}{{x_0}^2} + G\frac{3m^2}{{x_0}^2+{y_0}^2}\frac{x_0}{\sqrt{{x_0}^2+{y_0}^2}}\right)\hat{\mathbf{j}} + \left(G\frac{4m^2}{{y_0}^2} + G\frac{3m^2}{{x_0}^2+{y_0}^2}\frac{y_0}{\sqrt{{x_0}^2+{y_0}^2}}\right)\hat{\mathbf{i}}$

(b) $g = \left(G\frac{2m^2}{{x_0}^2} + G\frac{3m^2}{{x_0}^2+{y_0}^2}\right)\hat{\mathbf{i}} + \left(G\frac{4m^2}{{y_0}^2} + G\frac{3m^2}{{x_0}^2+{y_0}^2}\right)\hat{\mathbf{j}}$

(c) $g = \left(G\frac{2m}{{x_0}^2} + G\frac{3m}{{x_0}^2+{y_0}^2}\frac{x_0}{\sqrt{{x_0}^2+{y_0}^2}}\right)\hat{\mathbf{i}} + \left(G\frac{4m}{{y_0}^2} + G\frac{3m}{{x_0}^2+{y_0}^2}\frac{y_0}{\sqrt{{x_0}^2+{y_0}^2}}\right)\hat{\mathbf{j}}$

(d) $g = \left(G\frac{2m}{{x_0}^2} + G\frac{3m^2}{{x_0}^2+{y_0}^2}\frac{y_0}{\sqrt{{x_0}^2+{y_0}^2}}\right)\hat{\mathbf{i}} + \left(G\frac{4m}{{y_0}^2} + G\frac{3m}{{x_0}^2+{y_0}^2}\frac{x_0}{\sqrt{{x_0}^2+{y_0}^2}}\right)\hat{\mathbf{j}}$

(e) $g = \left(G\frac{2m}{{x_0}^2} + G\frac{3m}{{x_0}^2+{y_0}^2}\frac{1}{\sqrt{{x_0}^2+{y_0}^2}}\right)\hat{\mathbf{i}} + \left(G\frac{4m}{{y_0}^2} + G\frac{3m}{{x_0}^2+{y_0}^2}\frac{1}{\sqrt{{x_0}^2+{y_0}^2}}\right)\hat{\mathbf{j}}$

25. What is the angle with x-axis of force between (m) and $(3m)$?

(a) $\theta = \tan^{-1}\frac{x_0}{y_0}$ (b) $\theta = \sin^{-1}\frac{x_0}{y_0}$ (c) $\theta = \tan^{-1}\frac{y_0}{x_0}$ (d) $\theta = \tan\frac{y_0}{x_0}$ (e) $\theta = \cos^{-1}\frac{x_0}{y_0}$