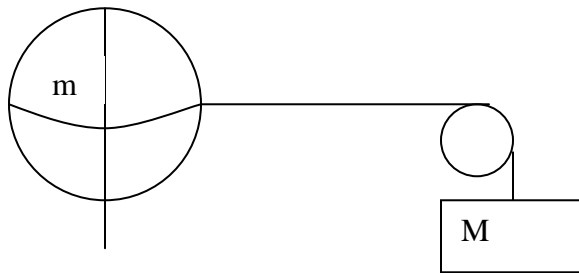


**Be prepared to answer the following questions. One– sheet of notes (both sides) may be used. The teacher does not guarantee that these are the exact questions. Initial conditions may be modified**

1a) A solid sphere is constructed to rotate about a vertical axis passing through the center of the sphere. A cord is wrapped around what would be the equator, passes over a pulley of negligible mass, and is attracted to an object that is allowed to fall under the influence of gravity. Write a mathematical conservation of energy statement for the system.



1b) the sphere has dimensions  $m = 2.0$  kg and  $r = 0.30$  m. The hanging object's mass is  $0.80$  kg and it falls  $h = 1.5$  m. Find the velocity of the object after it starts from rest and the angular momentum of the sphere.

2) Given that  $KE = 1/2m_0v^2$  and  $U = -Gm_0mr^{-1}$  derive the equation for escape velocity. Start with  $KE + U = 0$ . Solve problems if given  $G$ ,  $m$ ,  $r$ , or  $v$ .

3a) given that  $F_c = m_0v^2r^{-1}$  and  $F_g = Gm_0mr^{-2}$  derive the equation for a satellite to maintain circular orbit. Solve problems if given  $G$ ,  $m$ ,  $r$ , or  $v$ .

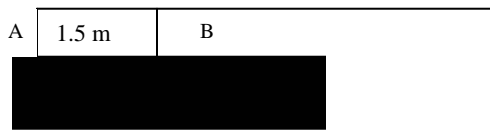
3b) given that  $v = 2\pi r/T$ , where  $T$  is orbital period, determine an equation that expresses  $T$  in terms of  $r$  and  $m$ .

3c) given that  $r_e = 6.4 \times 10^6$  m, a satellite is  $400$  km above the Earth's surface, and that it circles the Earth once every  $93$  minutes, determine the mass of the Earth in kilograms.

4) Suppose a grinding wheel of  $30$  cm diameter is rotating with initial angular speed of  $3.0$  rad/s and is slowing under constant acceleration of  $-3.0$  rad/s<sup>2</sup>.

- what is the angular velocity at  $0.40$  s?
- what angle has been turned through in this  $0.40$  s?
- What is the tangential velocity on the rim at  $0.20$  s?
- with this acceleration, how long will it take for the wheel to come to rest?
- How much angle is turned as it comes to rest?

5.) A 500 N diver is on the end of a 4.0 m diving board of negligible mass. The board is on pedestals as shown below. What are the forces and direction that each pedestal exerts on the diving board?



6.) Halley’s comet has a perihelion distance of 0.6 AU and an orbital period of 76 years. What is the aphelion distance of Halley’s comet from the Sun?

7) Given

Name	Discovery Date	Discoverer	Distance from Jupiter ( $\times 10^3$ km)	Orbital Period (days)	Mass (1020 kg)	Radius (km)
Io (JI)	1610	Galileo Galilei	421.6	1.769138	893.2	1821.6
Europa (JII)	1610	Galileo Galilei	670.9	3.551181	480	1560.8
Ganymede (JIII)	1610	Galileo Galilei	1070.4	7.154553	1481.9	2631.2
Callisto (JIV)	1610	Galileo Galilei	1882.7	16.689018	1075.9	2410.3

a) Determine the mass of Jupiter.

8) Given an ellipse, determine the eccentricity, Major-axis, the distance between the foci.

9) Explain the 1<sup>st</sup> and 2<sup>nd</sup> Laws of Thermodynamics. Explain Entropy.

10) Starting with Newton’s Law of Universal Gravitation, derive the Schwarzschild Radius equation. Explain the role of the Event Horizon. Compare and contrast Newton’s and Einstein’s version of Gravity.