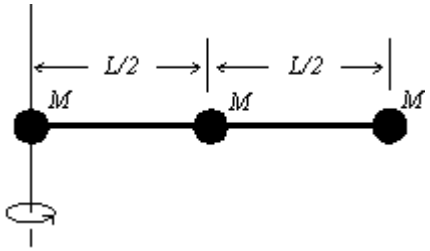
1. A phonograph turntable, initially rotating at 4.24 rad/s, slows down and stops in 30 s. Through how many radians does the turntable turn in this period?
   A) 56.34
   B) 44.32
   C) **63.60**
   D) 21.98
   E) none of these

2. A wheel initially has an angular velocity of 36.84 rad/s. During the next six seconds the wheel turns through 124 radians. What is is angular speed in rad/s at the end of this time period?
   A) 8.21
   B) 11.22
   C) **4.49**
   D) 6.20
   E) none of these

3. A wheel starts from rest and has an angular acceleration given by the function $\alpha = 4t^2$, in rad/s^2, and t is in seconds. Through approximately how many radians will this wheel have turned after 4.3 seconds?
   A) 2090
   B) 4100
   C) 1860
   D) 870
   E) **none of these**

4. Three identical balls, each of mass M, are fastened to a rod of length L, also of mass M. The rotational inertia about the left end of the rod is:



   A) $7ML^2/12$
   B) $9ML^2/12$
   C) $13ML^2/12$
   D) **$19ML^2/12$**
   E) none of these

5. A certain wheel has a rotational inertia of 12 kg · m^2. As it turns through 5.0 rev its angular velocity increases from 5.0 rad/s to 6.0 rad/s. If the net torque is constant its value is:
   A) 0.016 N · m
   B) 0.18 N · m
   C) 0.57 N · m
   D) **2.1 N · m**
   E) 3.6 N · m

6. The rotational inertia of a rod of mass M and length L, about its center, is I = $ML^2/12$. What is its rotational inertia with respect to an axis a distance L/6 from one end?
   A) $3ML^2/4$
   B) $ML^2/6$
   C) $4ML^2/9$
   D) $7ML^2/12$
   E) **none of these (Answer: (7/36) ML^2**

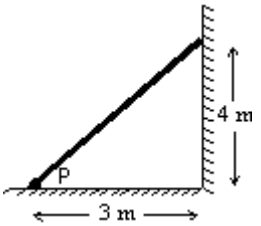
7. Planet X has a mass of 4.0 x 10^{24} kg, and a radius of 5.4 x 10^6 m. Near the surface of this planet a rocket reaches an upward speed of 2100 m/s. What maximum height will it reach, in meters?
   A) 2.85 x 10^6
   B) 1.65 x 10^6
   C) 2.09 x 10^6
   D) 4.32 x 10^7
   E) **none of these (Answer: 2.52 x 10^5 m)**

8. Two identical point-sized objects, each of mass m = 40 kg, are at opposite vertices of a square of side a = 5.0 meters. At one of the remaining vertices is a 70 kg point-sized object. What is the gravitational force on the 70-kg object, in newtons?
   A) 2.34 x 10^{-8}
   B) 4.56 x 10^{-8}
   C) **1.06 x 10^{-8}**
   D) 5.12 x 10^{-8}
   E) none of these

9. In an hypothetical alternate universe in which the Laws of Physics are not the same as they are in this universe, the gravitational force is F = kMm/r, where k is a the gravitational constant in that universe, M is the central attractor (i.e., a star, for example), and m is the mass of the attracted object (a planet, for example, in the solar system). Which of the following statements for planetary motion in that solar systems of that universe is *false*?

   A) The period of revolution does not depend on the mass of the planet.
   B) The orbital speeds of the planets is the same for all planets of a given solar system.
   C) **The period of revolution of planets is larger for planetary orbits of larger radii**
   D) The period of revolution depends on the mass of the star.
   E) None of the other answers in this list is false

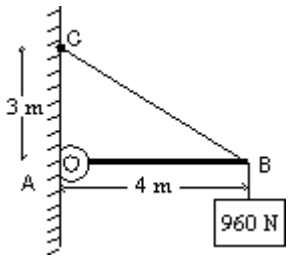
10. An 80-N uniform plank leans against a frictionless wall as shown. The base of the plank, in contact with the floor, is free to slide, if the frictional force is insufficient to prevent slipping. The minimum coefficient of static friction necessary to prevent the plank from slipping is



   A) **0.38**
   B) 0.22
   C) 0.31
   D) 0.15
   E) none of these

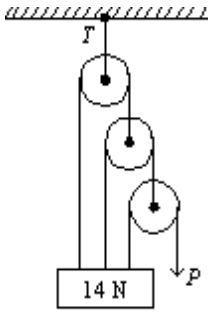
11. A 300-N weight is hung from two ropes attached to a ceiling. The rope on the left makes an angle of 30 degrees with respect to the ceiling, and the other makes an angle of 40 degrees. Connected to the ends of the ropes is the weight. The tension (in N) in the left rope is about:
   A) **245**
   B) 1302
   C) 1376
   D) 1496
   E) None of these

12. A 960-N block is suspended as shown. The beam AB is uniform and has a weight of 600 N and is hinged to the wall at A. The horizontal force (in N) exerted by the hinge on the beam is



A) 720 N
B) 1240 N
C) 1280 N
D) **1680 N**
E) none of these

13. The pull *P* is just sufficient to keep the 14-N block and the weightless pulleys in equilibrium as shown. The tension *T* in the longest cable (the one on the left) is:



A) **8N**
B) 28 N
C) 16 N
D) 12 N
E) none of these

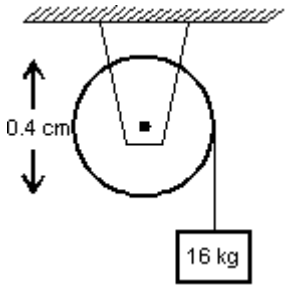
14. The position vector of a 0.25 kg object is r = <5, $4t^3$, 3>, where r is in meters, and t is in seconds. What is the torque on the object at time t = 0.50 s, in m-N?

A) <-12, 4, 11>
B) **<-9, 0, 15>**
C) <9, -12, 27>
D) <4, 8, -12>
E) none of these

15. The angular velocity of a rotating object, in rad/s, is $\omega = 3t^2 + 12$, where t is in seconds. The rotational inertia of the object about its axis of rotation is 20 kg-m^2. At what rate (in watts) is work being done on this object at time t = 2.5 s?
    A) 4255
    B) 1225
    C) 2415
    D) **9225**
    E) none of these

16. A solid sphere of radius 3.40 m consists of metal of uniform density 9000 kg/m^3. What would be the force on a 0.50 kg point-sized object placed 1.30 m from the sphere's center, in units of micro-newtons (1 micro-newton = 1.0 x 10^{-6} N)
    A) 2.34
    B) **1.63**
    C) 0.79
    D) 0.33
    E) none of these

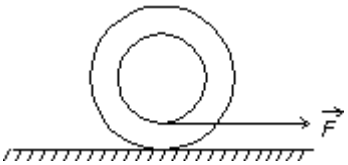
17. A 12 kg block is attached to a cord that is wrapped around the rim of a wheel of diameter 0.40 m (units are given incorrectly in figure below as "cm." The units are supposed to be in meters, not cm). The rotational inertia of the wheel is 2.0 kg $\cdot$ m^2. When the block is released and the cord unwinds, the acceleration of the block, in units of g (9.8 m/s^2) is:



    A) **0.24 *g***
    B) 0.56 *g*
    C) 0.84 *g*
    D) 1.3 g
    E) none of these

18. A hoop ($I = MR^2$) rolls with constant velocity and without sliding along level ground. Its rotational kinetic energy in relation to its translational kinetic energy is:
    A) half
    B) **the same**
    C) twice as much
    D) four times as much
    E) none of these

19. A yo-yo, arranged as shown, rests on a frictionless surface. When a force is applied to the string as shown, the yo-yo:



    A) moves to the left and rotates counterclockwise
    B) **moves to the right and rotates counterclockwise**
    C) moves to the left and rotates clockwise
    D) moves to the right and rotates clockwise
    E) moves to the right and does not rotate

20. A shearing force of 50 N is applied to an aluminum rod with a length of 10 m, a cross-sectional area of 1.0×10^{-5} m, and shear modulus of 2.5×10^{10} N/m$^{2.}$ As a result the rod is sheared through a distance of:
    A) zero
    B) **2.0 mm**
    C) 1.9 cm
    D) 19 cm
    E) none of these