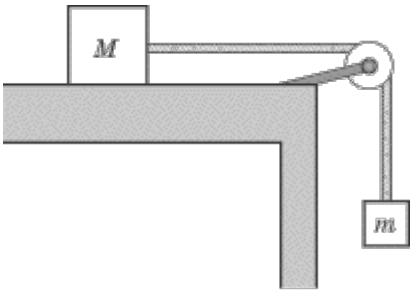
Compound Machines Test

1. We have masses *m* and *M* in the following arrangement:



   What is the minimum coefficient of static friction that will keep this system, initially still, from sliding? Let *g* be the acceleration due to gravity.

2. What are the SI base units? List them.

3. Ideal mechanical advantage in hydraulic cylinders is determined by:

   a. Relative lengths of the cylinders

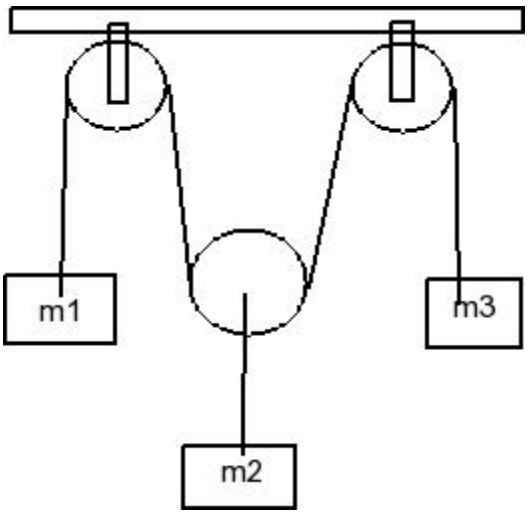
   b. Relative areas of the piston heads

   c. Relative volumes of the cylinders

   d. Relative volumes of fluid in the cylinders

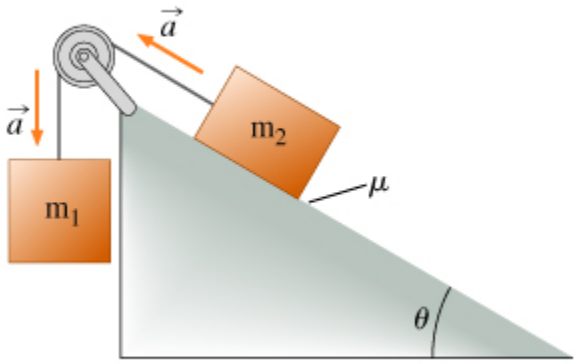
   e. Force applied

4. Consider the following system:



   Determine the accelerations of the three masses, positive down. Let *g* be the acceleration due to gravity.

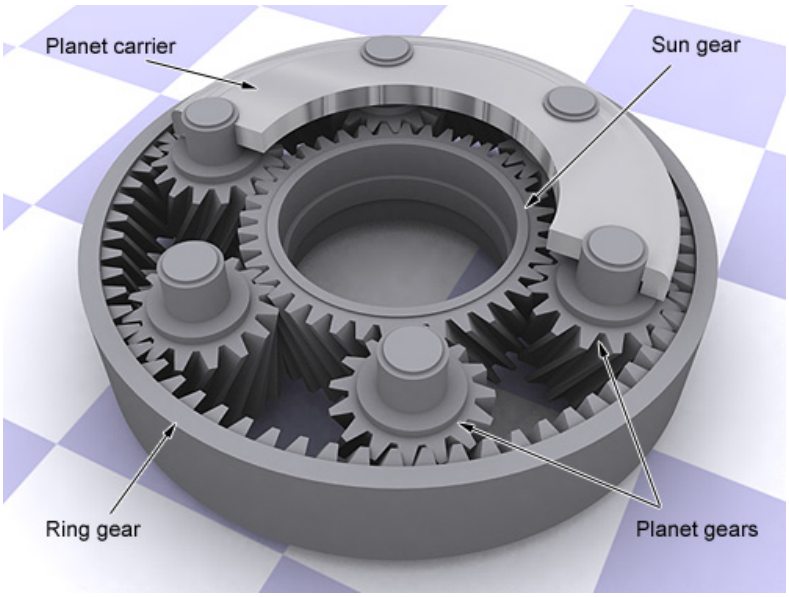
5. In the previous problem, what's the tension in the rope?
6. True or false: All rotations of a sphere take the form of a planar rotation about an axis.
7. Find m_1/m_2 in terms of other quantities here:



Let *g* be the acceleration due to gravity.

8. Which of the following is not a form of dry friction?
    a. Skin Friction
    b. Kinetic Friction
    c. Belt Friction
    d. Rolling Resistance
    e. Stiction
9. What is power divided by angular velocity?
10. Which of the following is not dimensionless?
    a. Efficiency
    b. Lead (axial)
    c. Solid Angle
    d. Reynolds Number
    e. Coefficient of Kinetic Friction
11. True or false: The double pendulum system is chaotic.
12. True or false: The gravitational field is conservative.

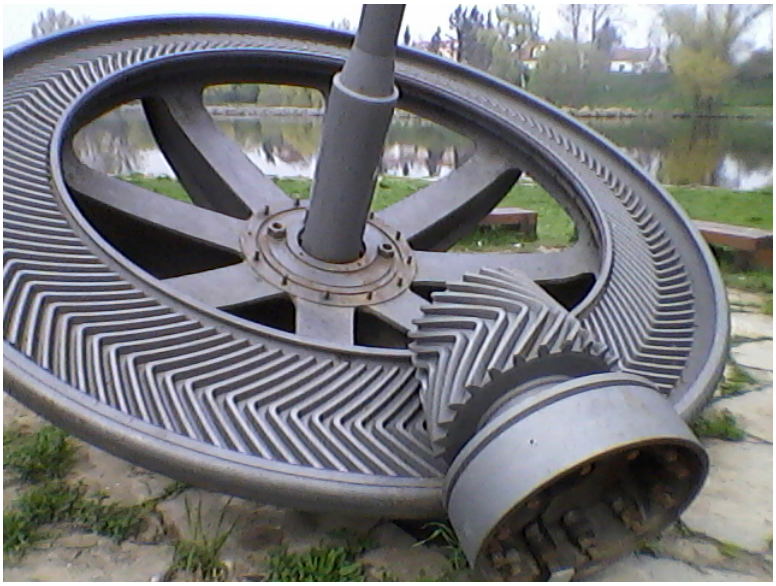
13. Consider the following planetary gear system:



Calculate the ratio N_s/N_r of the number of teeth in the sun gear to the that of the ring gear in terms of ω_s, ω_p, ω_c, and ω_r, the angular velocities of the sun gear, planet gears, planet carrier, and ring gear respectively, positive clockwise.

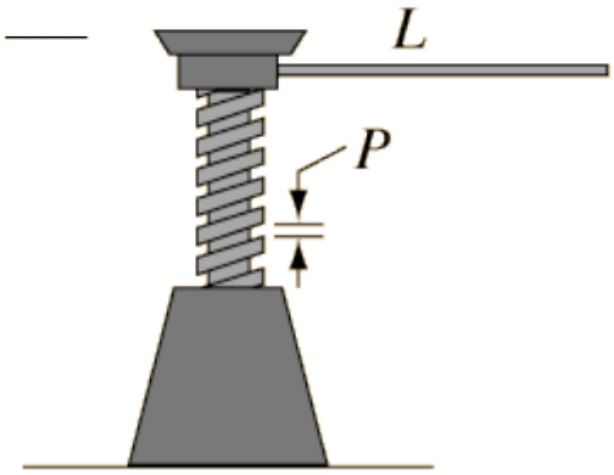
14. What is the problem with open differentials that limited-slip differentials address?

15. What kind of gear is this?

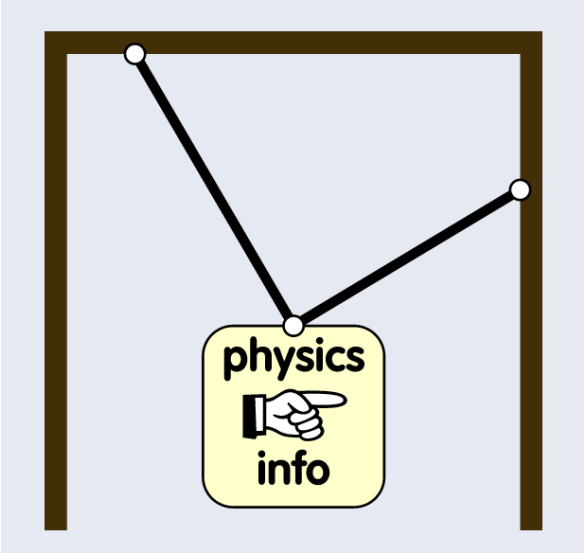


16. What is angular momentum divided by angular velocity?

17. What's the Ideal Mechanical Advantage, in terms of the length of the handle (L) and pitch (P)?

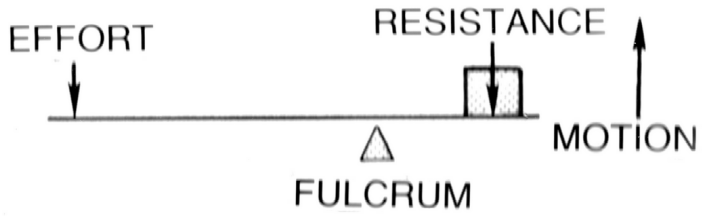


18. Consider the following sign, with mass *M*:



Let the left cable hang at an angle Θ_1 from the horizontal and the right cable at Θ_2. Calculate tensions T_1 and T_2, where *g* is the acceleration due to gravity.

19. Which class lever is this?



20. The magnitude of torque has the same dimensions as work. Explain the difference.

Name: _____

Compound Answer Sheet

1. μ=

2. _____ _____ _____

   _____ _____ _____

   _____

3. _____

4. a_1= a_2= a_3=

5. T=

6. _____

7. m_1/m_2=

8. _____

9. _____

10. _____

11. _____

12. _____

13. N_s/N_r=

14. _____

15. _____

16. _____

17. *IMA*=

18. T_1= T_2=

19. _____

20. _____

_____

Compound Answer Key

1. m/M (2 points)
2. meter, kilogram, second, ampere, kelvin, candela, mole (6 points for all 7 correct, 4 for 6, 2 for 5, 0 otherwise)
3. b (2 point)
4. $a_1 = g\frac{m_1m_2+4m_1m_3-3m_2m_3}{m_1m_2+4m_1m_3+m_2m_3}$ (10 points)
   $a_2 = g\frac{m_1m_2-4m_1m_3+m_2m_3}{m_1m_2+4m_1m_3+m_2m_3}$ (10 points)
   $a_3 = g\frac{-3m_1m_2+4m_1m_3+m_2m_3}{m_1m_2+4m_1m_3+m_2m_3}$ (10 points)
5. $T = 4g\frac{m_1m_2m_3}{m_1m_2+4m_1m_3+m_2m_3}$ (10 points)
6. False (1 point)
7. (a+gsin(θ)+μgcos(θ))/(g-a) (12 points)
8. a (2 point)
9. Torque (3 point)
10. b (2 point)
11. True (1 point)
12. True (1 point)
13. $(\omega_c - \omega_s)/(\omega_c - \omega_a)$ (18 points)
14. Loss of traction (3 point)
15. Herringbone bevel gear or double-helical bevel gear (4 points)
16. Moment of inertia (3 point)
17. 2πL/P (2 point)
18. $T_1=Mg/(\tan\Theta_2\cos\Theta_1+\sin\Theta_1)$ (14 points)
    $T_2=Mg/(\tan\Theta_1\cos\Theta_2+\sin\Theta_2)$ (14 points)
19. 1st (1 point)
20. Work is given by torque through an angle (angles are dimensionless). (2 points)