Phys 101 **Homework 12** Name ________________________

All problems 3 points unless otherwise noted. Show enough work for FULL credit.

1) State the conditions for static equilibrium.

Diff: 1 Page Ref: Sec. 12–1

2) Several forces act on an object at rest. It is known that the sum of the forces acting on the object is zero. Which statement is necessarily true?

A) The object's center of mass will not move, but the object may begin to rotate.
B) The object's center of mass may accelerate and the object may begin to rotate.
C) The object's center of mass may accelerate, but the object will remain in the same orientation.
D) The object will remain stationary.
E) The object's center of mass may move in such a way that the object will roll without slipping.

Diff: 1 Page Ref: Sec. 12–1

3) Two identical ladders are 3.0 m long and weigh 600 N each. They are connected by a hinge at the top and are held together by a horizontal rope, 1.0 m above the smooth floor forming a symmetric "A" arrangement. The angle between the ladders is 60° and both ladders have their center of gravity at their midpoint. What is the tension in the rope?

Diff: 3 Page Ref: Sec. 12–2

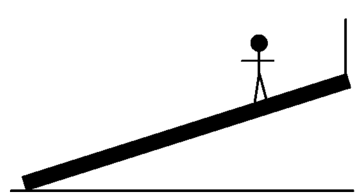
4) A 3.00–m long plank of negligible mass has a 30.0–kg mass at one end and a 40.0–kg mass at the other end. How far from the 30.0–kg mass should a fulcrum be placed so that the plank is balanced?

Diff: 1 Page Ref: Sec. 12–2

5) Two people are lifting a 2.0–m wide, 80–kg, office desk by the ends. One side is heavier than the other, and it is found that the person exerting the larger force is exerting a vertical force of 500 N. How far from that person is the center of mass of the desk?

Diff: 1 Page Ref: Sec. 12–2

FIGURE 12–5

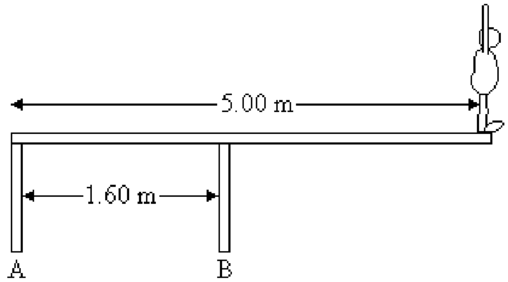


6) A 20.0–kg uniform plank is supported by the floor at one end and by a vertical rope at the other as shown in Fig. 12–5. A 50.0–kg mass person stands on the plank a distance three–fourths of the length plank from the end on the floor.

(a) What is the tension in the rope?
(b) What is the magnitude of the force of floor on the plank?

Diff: 2 Page Ref: Sec. 12–2

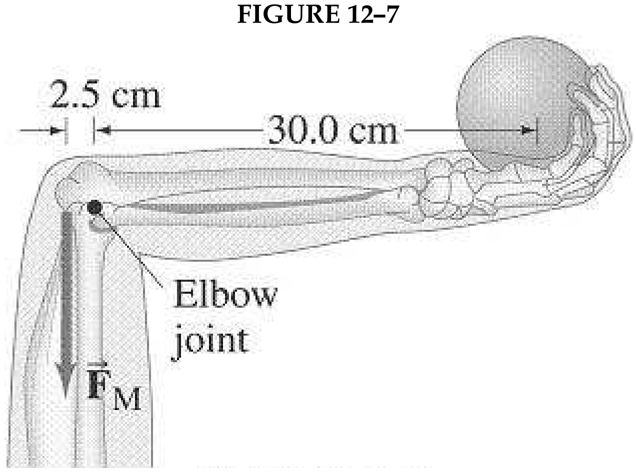
FIGURE 12–3



7) An 82.0 kg–diver stands at the edge of a light 5.00–m diving board, which is supported by two pillars 1.60 m apart, as shown in Fig. 12–3.
(a) Find the force exerted by pillar A.
(b) Find the force exerted by pillar B.
Diff: 1 Page Ref: Sec. 12–2

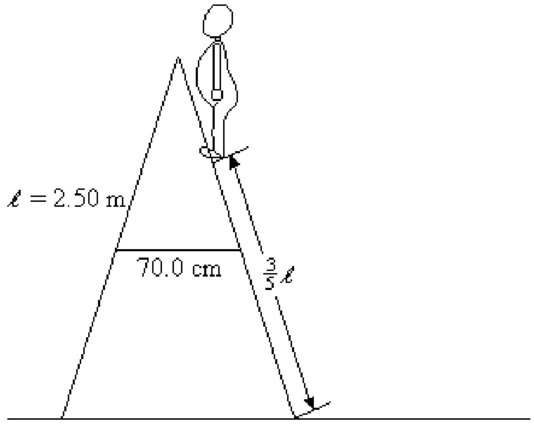
8) A heavy boy and a lightweight girl are balanced on a massless seesaw. If they both move forward so that they are one–half their original distance from the pivot point, what will happen to the seesaw?
A) It is impossible to say without knowing the distances.
B) It is impossible to say without knowing the masses.
C) Nothing, the seesaw will still be balanced.
D) The side the girl is sitting on will tilt downward.
E) The side the boy is sitting on will tilt downward.
Diff: 2 Page Ref: Sec. 12–2

FIGURE 12–7



9) Assuming the lower arm has a mass of 2.8 kg and its CG is 12 cm from the elbow–joint pivot, how much force must the extensor muscle in the upper arm exert on the lower arm to hold a 7.5 kg shot put (Fig. 12–7)?
Diff: 2 Page Ref: Sec. 12–2

FIGURE 12–8



10) A stepladder consists of two halves, hinged at the top, and connected by a tie rod which keeps the two halves from spreading apart. In this particular instance, the two halves are 2.50 m long, the tie rod is connected to the center of each half and is 70.0 cm long. An 800–N person stands 3/5 of the way up the stepladder, as shown in Figure 12–8. Neglecting the weight of the ladder, and assuming that the ladder is resting on a smooth floor, what is the tension in the tie rod? Note: to solve this problem you must "cut" the ladder in half and consider the equilibrium of forces and torques acting on each half of the ladder.

Diff: 3 Page Ref: Sec. 12–2

11) A cone balanced on its small end is in
   A) neutral equilibrium.
   B) stable equilibrium.
   C) positive equilibrium.
   D) negative equilibrium.
   E) unstable equilibrium.

Diff: 1 Page Ref: Sec. 12–3

12) A 120–kg refrigerator, 2.00 m tall and 85.0 cm wide has its center of mass at its geometrical center. You are attempting to slide it along the floor by pushing horizontally on the side of the refrigerator. The coefficient of static friction between the floor and the refrigerator is 0.300. Depending on where you push, the refrigerator may start to tip over before it starts to slide along the floor. What is the highest distance above the floor that you can push the refrigerator so that it won't tip before it begins to slide?

Diff: 2 Page Ref: Sec. 12–3

13) An object in static equilibrium, if left undisturbed, will undergo no translational or rotational acceleration. However, if the object is displaced slightly, three outcomes are possible. List and explain each of these outcomes.

Diff: 2 Page Ref: Sec. 12–3

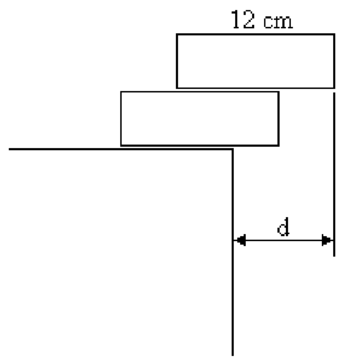
14) If you stand with your back towards a wall and your heels touching the wall, you cannot lean over to touch your toes. Why?

Diff: 2 Page Ref: Sec. 12–3

15) The wheelbase on a truck is 2.4 m wide and the truck's center of mass is located along the vertical centerline of the truck and 2.0 m above the bottom of the tires. The truck is going around a banked turn, when it is forced to stop. What is the maximum slope that the bank can have such that the truck will not tip over?

Diff: 2 Page Ref: Sec. 12–3

FIGURE 12–9



16) A child is trying to stack two uniform wooden blocks, 12 cm in length, so they will protrude as much as possible over the edge of a table, without tipping over, as shown in Fig. 12–9. What is the maximum possible overhang distance?

Diff: 2 Page Ref: Sec. 12–3

17) If an object is stretched beyond the elastic limit, it enters the _______ on an applied force versus elongation graph for a typical metal.

A) ultimate strength region
B) breaking region
C) elastic region
D) proportional region
E) plastic region

Diff: 1 Page Ref: Sec. 12–4

18) The Leaning Tower of Pisa is 55 m tall and about 7.0 m in diameter. The top is 4.5 m off center. How much farther can it lean before it becomes unstable?

Diff: 2 Page Ref: Sec. 12–3

19) Strain is

A) the applied force per cross–sectional area.
B) the ratio of the change in length to the original length.
C) the same as force.
D) the ratio of stress to elastic modulus.
E) the stress per unit area.

Diff: 1 Page Ref: Sec. 12–4

20) Stress is

A) applied force per cross–sectional area.
B) the ratio of elastic modulus to strain.
C) the same as force.
D) the strain per unit length.
E) the ratio of the change in length to the original length.

Diff: 1 Page Ref: Sec. 12–4

21) The maximum elongation of a typical metal is reached at the

A) elastic limit.
B) proportional limit.
C) ultimate strength.
D) breaking point.
E) inelastic limit.

Diff: 1 Page Ref: Sec. 12–4

22) What is the maximum length of steel cable that can hang vertically supported from one end of the cable? The Young's modulus of this steel is 2.10×10^{11} N/m^2, the tensile strength of this steel is 7.4×10^8 N/m^2, and the density of this steel is 7.6×10^3 kg/m^3.

Diff: 1 Page Ref: Sec. 12–4

23) A steel lift column in a service station is 4.0 m long and 0.20 m in diameter. Young's modulus for steel is 20×10^{10} N/m^2. By how much does the column shrink when a 5000–kg truck is on it?

Diff: 2 Page Ref: Sec. 12–4

24) A 55–cm steel rod has a diameter of 30 cm. The compressive strength of steel is 500×10^6 N/m^2. What is the compression force that would break the rod?

Diff: 1 Page Ref: Sec. 12–5

25) The tensile strength for a certain steel wire is 3000 MN/m^2. What is the maximum load that can be applied to a wire with a diameter of 3.0 mm made of this kind of steel?

Diff: 1 Page Ref: Sec. 12–5

26) A shear force of 400 N is applied to one face of an aluminum cube with sides of 30 cm. What is the resulting relative displacement? (The shear modulus for aluminum is 2.5×10^{10} N/m^2)

Diff: 2 Page Ref: Sec. 9.1

27) A steel sphere with a radius of 2.0 m falls off a ship and sinks to a depth where the pressure is 15 MN/m^2. The bulk modulus for steel is 1.6×10^{11} N/m^2. What is the change in the radius of the sphere?

Diff: 2 Page Ref: Sec. 12–4

28) At a depth of about 1030 m in the sea the pressure has increased by 100 atmospheres (to about 10^7 N/m^2). By how much has 1.0 m^3 of water been compressed by this pressure? The bulk modulus of water is 2.3×10^9 N/m^2.

Diff: 2 Page Ref: Sec. 12–4

1) (1) The net force acting on the object must be zero.
   (2) The net torque acting on the object must be zero.
2) A
3) 280 N
4) 1.71 m
5) 0.73 m
6) (a) 466 N
   (b) 220 N
7) (a) 1.71 kN downwards
   (b) 2.51 kN upwards
8) C
9) 1000 N
10) 140 N
11) E
12) 1.42 m
13) 1. Stable equilibrium: the object returns to its original position
    2. Unstable equilibrium: the object moves even farther from it original position
    3. Neutral equilibrium: the object remains in its new position
14) As you bend over your center of gravity moves forward and eventually is beyond the area of the floor in touch with your feet. This does not happen when you do it away from the wall because part of your body moves back and the center of mass remains over your feet.
15) 31°
16) 9 cm
17) E
18) 2.5 m
19) B
20) A
21) D
22) 9.93 km
23) 3.1×10^{-5} m
24) 3.5×10^{7} N
25) 21 kN
26) 5.3×10^{-8} m
27) 0.063 mm
28) 4.3×10^{-3} m^3