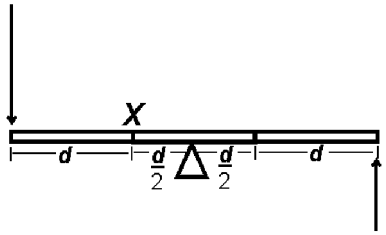
1. A bar of length 3*d* is pivoted in the center as shown. At each of its ends a force of magnitude *F* is applied in the directions indicated by the arrows.



What force must be applied at point *X* to keep the rod in rotational equilibrium?

1) 6*F* upwards

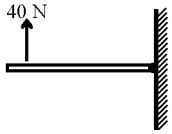
2) 2*F* upwards

3) 0

4) 2*F* downwards

5) 6*F* downwards

Base your answers to questions **2** and **3** on the picture below, which represents a rigid uniform rod with a mass of 6kg and a length of 1.0 m is pivoted on the right end. It is held in equilibrium by an upward force of 40 N.



2. How far from the left end of the rod should the force be placed to maintain equilibrium?

   1) 10 cm

   2) 20 cm

   3) 25 cm

   4) 40 cm

   5) 50 cm

3. What force is applied to the rod by the pivot?

   1) 10 N

   2) 20 N

   3) 40 N

   4) 60 N

   5) 100 N

---

4. The newton•meter is a measure of

   1) force

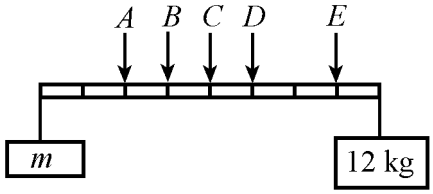
   2) torque

   3) power

   4) momentum

   5) velocity

Base your answers to questions **5** and **6** on the picture below, which represents two objects, one of mass 12 kg and one of mass *m*, hung from the ends of a stick with negligible mass, that is 80 centimeters long and has marks every 10 centimeters as shown below.



5. If the stick remains horizontal when pivoted at point *B*, what is the mass of block *m*?

   1) 7.2 kg

   2) 7.5 kg

   3) 12 kg

   4) 20 kg

   5) 24 kg

6. If *m* = 7.2 kg, at what point should the rod be pivoted to remain horizontal?

   1) *A*

   2) *B*

   3) *C*

   4) *D*

   5) *E*

---

7. Which of the following is not a scalar quantity?

   1) work

   2) energy

   3) speed

   4) torque

   5) distance

8. When an object is experiencing a net torque

   1) it is in dynamic equilibrium.

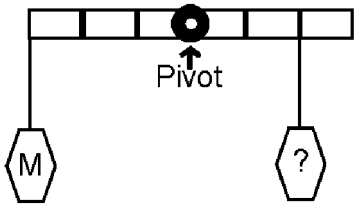
   2) it is in static equilibrium.

   3) it is rotating.

   4) it is translating.

   5) its mechanical energy is negative.

9. A uniform wooden board of mass 10 *M* is held up by a nail hammered into a wall. A block of mass *M* rests $\frac{L}{2}$ away from the pivot. Another block of a certain mass is hung a distance $\frac{L}{3}$. The system is in static equilibrium.



What is the measure of the mass labeled "**?**" ?

   1) $\frac{M}{2}$

   2) $\frac{M}{3}$

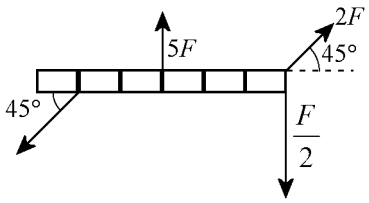
   3) M

   4) $\frac{3M}{2}$

   5) $2M$

Base your answers to questions **10** and **11** on the following information.

A uniform rod of length *L* is placed into outer space with the following forces acting on it:
- $5F$ upwards from its center of mass.
- F 45 degrees downwards $\frac{L}{3}$ from its center of mass.
- $2F$ 45 degrees upwards $\frac{L}{2}$ from its center of mass.
- $\frac{F}{2}$ downwards $\frac{L}{2}$ from its center of mass.



10. If this object is to rotate, which way would it be?

    1) It will rotate Clockwise.

    2) It will rotate Counter-Clockwise.

    3) It will rotate in dynamic equilibrium.

    4) It will not rotate, it will only move upwards.

    5) It will not rotate it will only move downwards.

11. What is the magnitude of the force needed to bring this object into translational equilibrium?

    1) X: $\frac{F\sqrt{2}}{2}$
       Y: $F(9 + \sqrt{2})$

    2) X: $\frac{F}{2}$
       Y: $F(9 - \sqrt{2})$

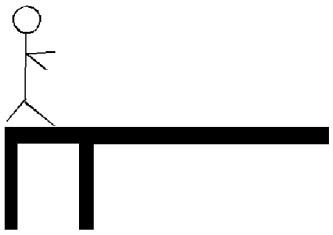
    3) X: $(\frac{F}{2})^2$
       Y: $7F$

    4) X: $F(9 - \sqrt{2})$
       Y: $\frac{F\sqrt{2}}{2}$

    5) X: $F(9 - \sqrt{2})$
       Y: $\frac{F\sqrt{2}}{2}$

---

12. A person of mass 60 kg is walking down a 10 m, 100 kg beam supported by two pillars, one at the head of the beam and one 3 m away from the center of the beam.



How far down the beam can the person walk before the beam begins to tip? (Consider the origin to be the left end of the beam.)

    1) 0 m

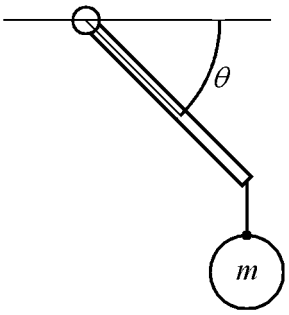
    2) 2 m

    3) $2\frac{1}{3}$ m

    4) $6\frac{2}{3}$ m

    5) To the end of the beam

13.



In the diagram above a mass *m* is attached by a massless string to a stationary arm at an angle θ from the horizontal. If the net torque of the mass on the arm is τ, find the length of the lever arm.

1) $\frac{\tau}{mg\sin\theta}$

2) $\frac{\tau}{mg\cos\theta}$

3) $\frac{mg\cos\theta}{\tau}$

4) $\frac{mg\sin\theta}{\tau}$

5) $\frac{\tau}{mg\sin\theta\cos\theta}$

14.

In the diagram above, two masses, one with mass *m*, the other with mass $M = 2m$ are resting on a uniform plank of length *L* that pivots at its midpoint. If the mass *m* is at the far end of the plank, how far away from the pivot should the mass *M* be to balance the plank in a horizontal position shown?

1) $\frac{L}{2}$

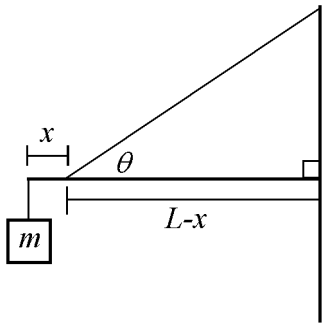
2) $\frac{L}{3}$

3) $\frac{L}{4}$

4) $\frac{L}{6}$

5) $2L$

15.



The diagram above shows a massless pole of length *L* that supports a mass *m* being held horizontally against a tower by a wire that makes an angle θ with the horizontal pole. The wire is connected to the pole at a distance *x* from the free end of the pole. The mass is attached by a massless string at the free end of the pole. For the pole to remain horizontal, the tension in the wire must be

1) $\frac{mgL}{2x\cos\theta}$

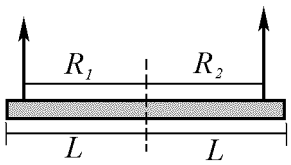
2) $\frac{mgx}{2L\sin\theta}$

3) $\frac{mgx}{2(L-x)\sin\theta}$

4) $\frac{mgL}{(1-x)\sin\theta}$

5) $\frac{mgL}{2(L-x)\cos\theta}$

16.



The diagram above shows a stick of uniform density with length $2L$ and mass m supported near each end by upward forces. Find the magnitude of the force a distance R_1 away from the center of the stick if the stick is balanced in a horizontal position.

1) $\frac{mgR_2}{R_1}$

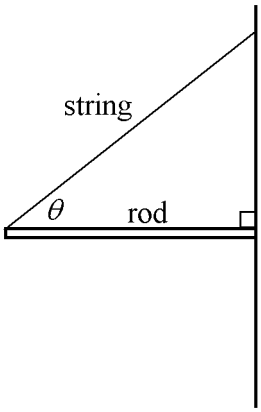
2) $\frac{mgR_1}{R_2}$

3) $\frac{mg(R_1+R_2)}{R_1}$

4) $\frac{mgR_2}{(R_1+R_2)}$

5) $\frac{mgR_1}{(R_1+R_2)}$

17.



If the rod in the figure above is uniform with mass m, what is the tension in the supporting string?

1) $mg\sin\theta$

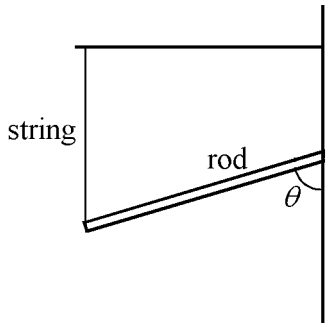
2) $\frac{mg\sin\theta}{2}$

3) $\frac{mg\cos\theta}{2}$

4) $\frac{mg}{2\cos\theta}$

5) $\frac{mg}{2\sin\theta}$

18.



The rod in the figure above is uniform, and the tension in the string is T. The mass of the rod is

1) $2T\text{g}$

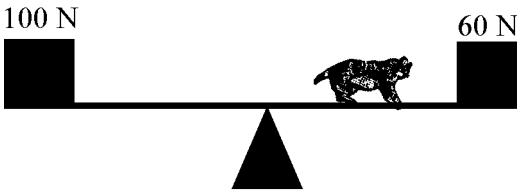
2) $\frac{2T}{\text{g}}$

3) $\frac{T}{\text{g}}$

4) $\frac{T}{2\text{g}}$

5) $\frac{2\text{g}}{T}$

19.



To measure the weight of the cat, a person places a 100 N box and a 60 N box from the ends of a uniform pole that is pivoted at its center. The system balances when the cat stands at a point $\frac{1}{4}$ of the rods length from the 60 N box. What is the approximate mass of the cat?

1) 3 kg

2) 4 kg

3) 6 kg

4) 8 kg

5) 12 kg

20. A rod of uniform material is balanced over a pivot with masses m and M positioned such that the system is in static equilibrium. If the mass M is a distance d from the pivot, and the mass m is a distance $\frac{d}{4}$ from the pivot, what is the ratio of M to m?

1) 4:1

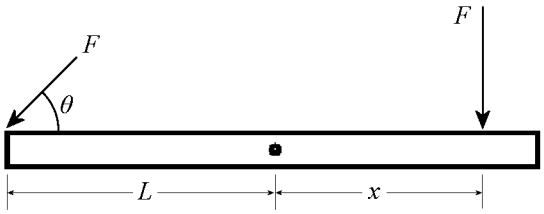
2) 2:1

3) 1:1

4) 1:2

5) 1:4

21.



A massless rod is positioned on a frictionless pivot as shown. A force with magnitude F is applied at an angle θ, a distance L from the pivot. At what distance x must the same force F be applied perpendicular to the rod such that the net torque on the rod is zero?

1) $L\sin\theta$

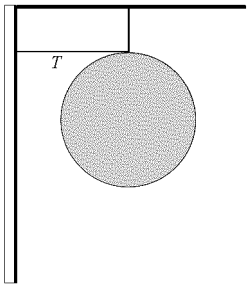
2) $L\cos\theta$

3) L

4) $L\tan\theta$

5) L ` 2

22. Base your answer to the following question on the diagram below which shows a uniform disc connected to a massless string of tension *T*.



What is *T* if the object is initially at rest?

1) 0

2) $Ig/2r^2$

3) Ig/r^2

4) $2Ig/r^2$

5) $2Ig/r$

Answer Key
[New Exam]

1. 1
2. 3
3. 2
4. 2
5. 4
6. 4
7. 4
8. 3
9. 4
10. 2
11. 1
12. 3
13. 2
14. 3
15. 4
16. 4
17. 5
18. 2
19. 4
20. 5
21. 1
22. 1

Name _____ Class _____ Date _____

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____