ISP209 30min. Exam-1**A**   February 6, 2001

11. Of the following phenomena, which is **NOT** due primarily to a weak nuclear force?
    a) emission of neutrinos from Strontium 90.
    b) decay of the W-boson to an electron and a neutrino.
    c) beta decay of Carbon 14.
    d) decay of a pi-meson to a muon and a neutrino.
    * e) none of the above.

12. Of the following phenomena, which is **NOT** due primarily to a strong nuclear force:
    a) fusion of Deuterium and Tritium nuclei releasing energetic neutrons.
    b) absorption of neutrons by a Boron nucleus.
    c) emission of a helium nucleus from an Americium nucleus.
    d) fission of Plutonium nuclei.
    * e) none of the above.

13. Consider the validity of the following statements:
T I. Two forces that balance can't be an action - reaction pair of forces.
F II. Three forces that balance must have equal magnitudes and opposite directions.
T III. Fundamental forces are generated in action-reaction pairs.

Are the statements true or false?
    a) I, II and III are true.
    * b) I and III are true, but II is false.
    c) I and II are true, but III is false.
    d) II is true, but I and III are false.
    e) I, II, and III are false.

14. Force vectors, $\mathbf{F}_1 = -2A$, and $\mathbf{F}_2 = -7A$, act on an object. To balance these forces, how many of the force vectors, $\mathbf{F}_3 = +3A$, must also act on the object?

a) 1
b) 2
* c) 3
d) 4
e) none of the above

$$\begin{aligned} \mathbf{F}_1 + \mathbf{F}_2 + n\mathbf{F}_3 &= 0 \\ (-2A) + (-7A) + n(3A) &= 0 \\ +3nA &= +9A \\ n &= 3 \end{aligned}$$

15. From its natural length, an ideal spring stretches 2.0×10^{-2} m when a force of 20 N is applied. From its natural length, the same spring stretches 1.0×10^{-1} m under what applied force?

*a) 100 N b) 600 N c) 1000 N d) 4000 N e) 2 N

$$k = \frac{F}{x} = \frac{20\ \text{N}}{2.0 \times 10^{-2}\ \text{m}} = 1.0 \times 10^{3}\ \frac{\text{N}}{\text{m}}$$

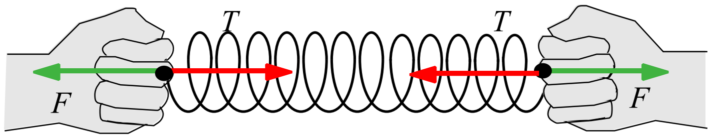
$$F' = kx' = \left(1.0 \times 10^{3}\ \frac{\text{N}}{\text{m}}\right)\left(1.0 \times 10^{-1}\ \text{m}\right)$$

$$= 1.0 \times 10^{2}\ \text{N}$$

16. What is your weight expressed in newton units?
(choose the closest answer)

a) 40 N b) 100 N c) 6×10^2 N d) 1600 N e) 4×10^3 N

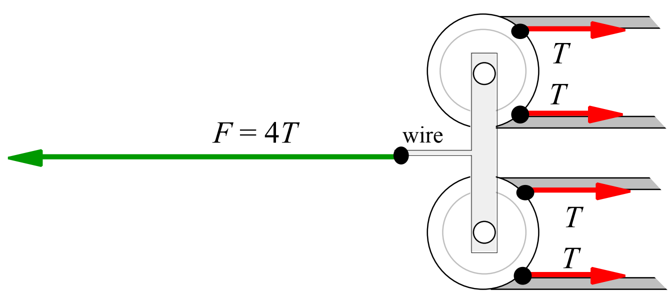
$$W = 100\ \text{lb} \quad (= 200\ \text{lb})$$
$$= 100\ \text{lb}\left(\frac{1\ \text{N}}{\frac{1}{4}\ \text{lb}}\right) = 400\ \text{N} \quad (= 800\ \text{N})$$



The two hand forces, *F*, act on the same object (spring)

17. In the figure above, an ideal spring is stretched by forces, F, generating tension forces, T. Which force pair is **not** an action-reaction pair?

* a) Two forces, F, of the hands acting on the spring.
b) Two tension forces, T, of the spring acting on the hands.
c) Tension, T, and hand force, F, on the left side of the spring.
d) Tension, T, and hand force, F, on the right side of the spring.
e) Every pair of forces is an action-reaction pair.



18. Two ropes each with tension, T, pass over a frictionless and massless pulley wheels held together by a vertical bar as shown above. What **magnitude** of force must be applied to the wire to hold the pulley wheels in place?

a) $2T$ * b) $4T$ c) $-4T$ d) $-T$ e) $-2T$

19. You observe an object for a short time. What action of the object tells you that the forces acting on the object were **not** balanced? The object

a) moves with a constant speed and direction.
b) is at rest.
c) moves.
d) starts moving.
e) none of the above.

Balanced forces do not change the motion of an object. Also, unbalanced forces change the motion of an object.

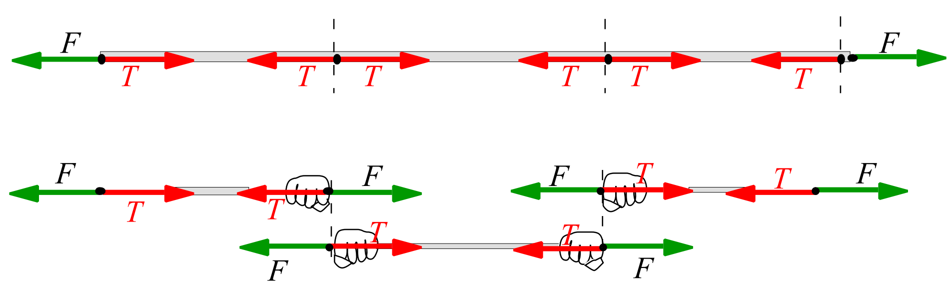
An object that starts to move has changed its motion from (at rest, not moving, stationary) to moving.

An object that turns around, has only one time where speed is zero. This object is NOT at rest, stationary. It MOVES.

20. The hands of two people lightly hold a string stretched by forces, F, as shown in the figure above. At the dashed lines between each person's hands, the string is cut into three equal length pieces. To keep the cut ends from pulling apart, what force magnitude must **each** hand apply to string?

*a) F b) $2F$ c) $\frac{2F}{3}$ d) $\frac{F}{4}$ e) $\frac{F}{2}$

Tension acting - reaction pairs exist at all points along the string. To maintain the tension, T, when cut, the string must be pulled with corresponding action forces, F.



21. In a rectangular solid with dimensions 1 cm wide, 2 cm high, and 3 cm long, atoms are spaced 1×10^{-8} cm apart. Assuming the atoms maintain that spacing throughout, how many atoms are in the cube?

a) 3×10^{8}

b) 6×10^{16}

c) 1×10^{25}

* d) 6×10^{24}

e) 1×10^{-24}

Along edges

1) $n_1 = \frac{\ell}{d} = \frac{1\ \text{cm}}{1\times10^{-8}\ \text{cm}} = 1\times10^{8}$

2) $n_2 = 2\times10^{8}$

3) $n_3 = 3\times10^{8}$

$N = n_1\ n_2\ n_3 = 6\times10^{24}$

22. The plot of the force applied versus the distance a spring is <u>compressed</u>, has a slope of 2×10^{7} N/cm. What is the spring constant of the same spring when it is <u>stretched</u>?

* a) 2×10^{7} N/cm

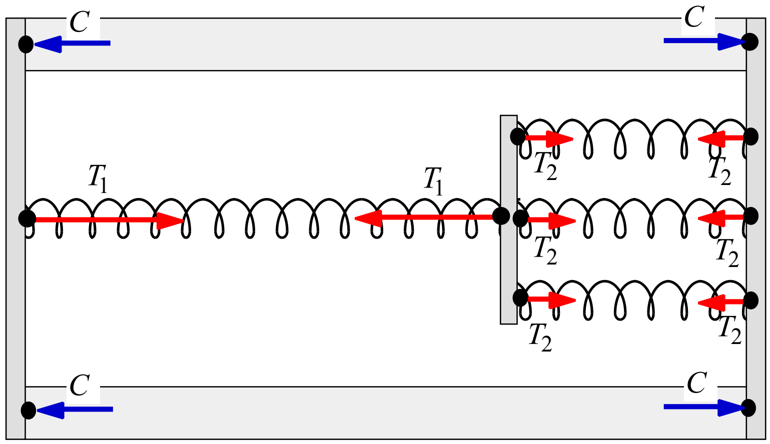
b) -2×10^{7} N/cm

c) zero

d) 1×10^{7} N/cm

e) none of the above

For a spring, the spring constant, k, is the same in stretching and compressing.



The stationary device, shown at the above, has stiff (can't bend) sides pulled together on the left by one spring with a tension, T_1, and on the right three identical springs with tension, T_2; the springs are connected at the middle by a bar. The sides are held apart by the compression forces, C, in the identical bars (shaded) on the top and bottom.

23. On the diagram, **draw and label** all compression force vectors (magnitude C) acting on the sides, with the proper direction, magnitude, and point of action (dot).

24. What is the relationship between T_1 and T_2? (**No credit without showing an application of the balance condition on force vectors** below)

*a) $T_2 = \frac{T_1}{3}$ b) $T_2 = 3T_1$ c) $T_1 = T_2$ d) $T_1 = \frac{T_2}{6}$ e) $T_1 = 6T_2$

$$\boxed{-T_1 + 3T_2 = 0; \qquad T_2 = \frac{T_1}{3}}$$

25. What is the magnitude, C, of the compression force in each bar? (**No credit without showing an application of the balance condition on force vectors** below)

a) $C = \frac{T_1 + 3T_2}{2}$ b) $C = \frac{T_2}{3}$ c) $C = \frac{3T_1}{2}$ d) $C = \frac{2T_2}{3}$ *e) $C = \frac{3T_2}{2}$

$$\boxed{+T_1 + 2(-C) = 0 \qquad C = \frac{T_1}{2} = \frac{3T_2}{2}}$$