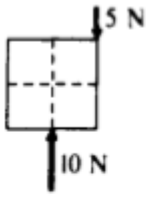
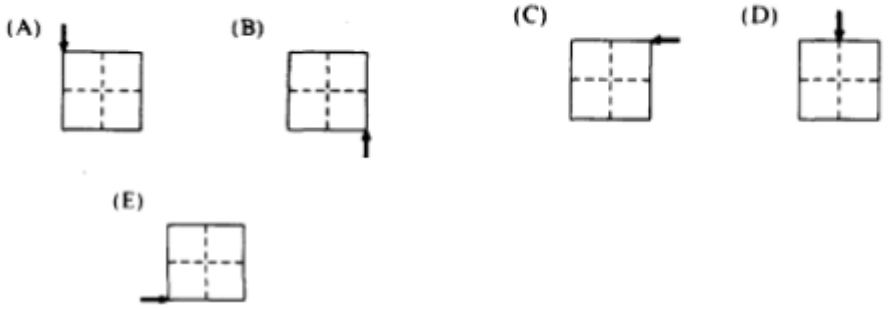
EQUILIBRIUM, TORQUE EQUILIBRIUM, AND CENTER OF MASS PRACTICE MULTIPLE CHOICE

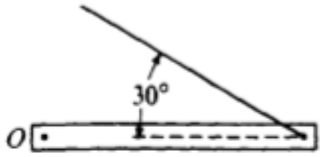
1984:

1. Torque is the rotational analogue of
(A) kinetic energy (B) linear momentum (C) acceleration (D) force (E) mass

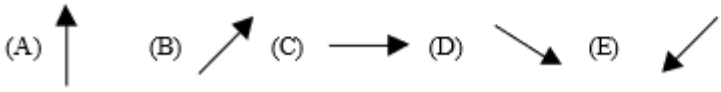


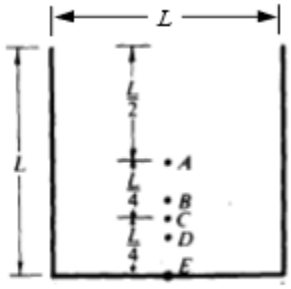
16. A square piece of plywood on a horizontal tabletop is subjected to the two horizontal forces shown above right. Where should a third force of magnitude 5 newtons be applied to put the piece of plywood into equilibrium?



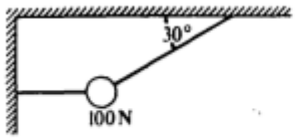


22. A uniform rigid bar of weight W is supported in a horizontal orientation as shown above by a rope that makes a 30° angle with the horizontal. The force exerted on the bar at point O, where it is pivoted, is best represented by a vector whose direction is which of the following?



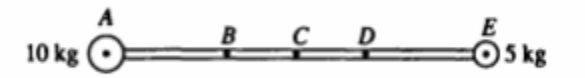


29. The center of mass of a uniform wire, bent in the shape shown above, is located closest to point
(A) A (B) B (C) C (D) D (E) E



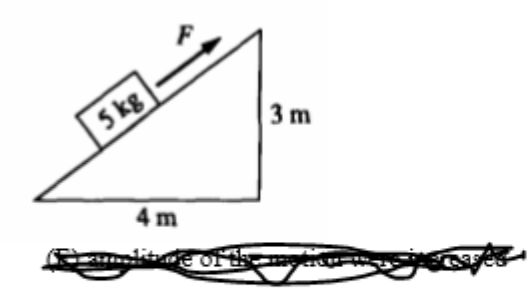
32. A 100-newton weight is suspended by two cords as shown in the figure above. The tension in t slanted cord is
(A) 50 N (B) 100 N (C) 150 N (D) 200 N (E) 250 N

1993:



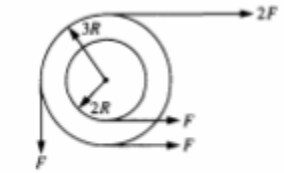
A 5-kilogram sphere is connected to a 10-kilogram sphere by a rigid rod of negligible mass, as shown above.

29. Which of the five lettered points represents the center of mass of the sphere-rod combination?
(A) A (B) B (C) C (D) D (E) E

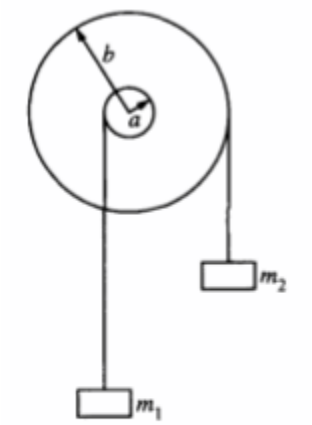


34. A block of mass 5 kilograms lies on an inclined plane, as shown above. The horizontal and vertical supports for the plane have lengths of 4 meters and 3 meters, respectively. The coefficient of friction between the plane and the block is 0.3. The magnitude of the force F necessary to pull the block up the plane with constant speed is most nearly (A) 30 N (B) 42 N (C) 49 N (D) 50 N (E) 58 N

1998:

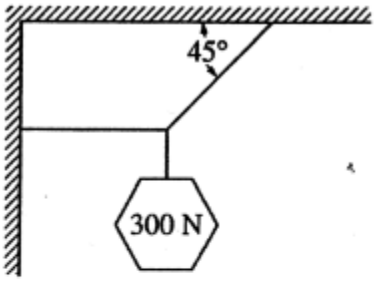


5. A system of two wheels fixed to each other is free to rotate about a frictionless axis through the common center of the wheels and perpendicular to the page. Four forces are exerted tangentially to the rims of the wheels, as shown above. The magnitude of the net torque on the system about the axis is
(A) zero (B) FR (C) 2FR (D) 5FR (E) 14FR



30. For the wheel-and-axle system shown above, which of the following expresses the condition required for the system to be in static equilibrium?
(A) $m_1 = m_2$ (B) $am_1 = bm_2$ (C) $am_2 = bm_1$
(D) $a^2m_1 = b^2m^2$ (E) $b^2m_1 = a^2m_2$

2004:



9. **An object weighing 300 N is suspended by means of two cords, as shown above. The tension in the horizontal cord is**

(A) 0 N
(B) 150 N
(C) 210 N
(D) 300 N
(E) 400 N

Questions 10-12

A small box is on a ramp tilted at an angle θ above the horizontal. The box may be subject to the following forces: frictional (f), gravitational (mg), pulling or pushing (F_p) and normal (N). In the following free-body diagrams for the box, the lengths of the vectors are proportional to the magnitudes of the forces.

Figure A

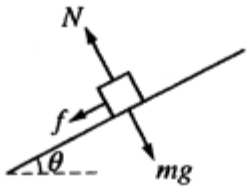


Figure B

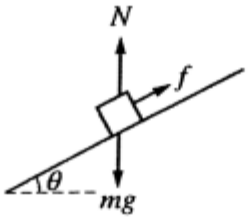


Figure C

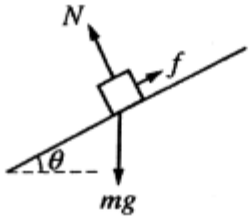


Figure D

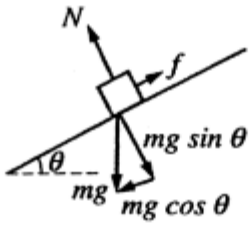
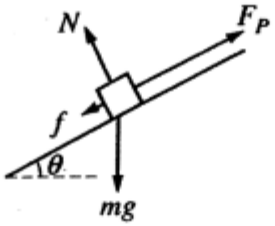


Figure E

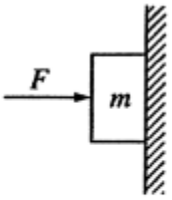


11. Which figure best represents the free-body diagram for the box if it is at rest on the ramp?

(A) Figure A
(B) Figure B
(C) Figure C
(D) Figure D
(E) Figure E

12. Which figure best represents the free-body diagram for the box if it is sliding down the ramp at constant speed?

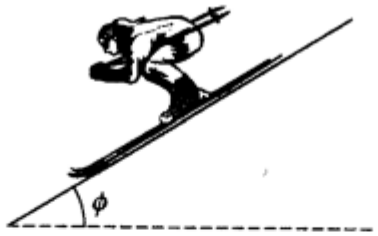
(A) Figure A
(B) Figure B
(C) Figure C
(D) Figure D
(E) Figure E



28. A horizontal force F pushes a block of mass m against a vertical wall. The coefficient of friction between the block and the wall is μ. What value of F is necessary to keep the block from slipping down the wall?

(A) mg
(B) μmg
(C) $\frac{mg}{\mu}$
(D) $mg(1-\mu)$
(E) $mg(1+\mu)$

2009:



19. A skier slides at constant speed down a slope inclined at an angle ϕ to the horizontal, as shown above. If air resistance is negligible, the coefficient of friction μ between the skis and the snow is equal to

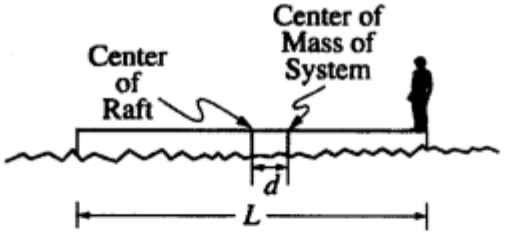
(A) $\frac{1}{\tan\phi}$

(B) $\frac{1}{\cos\phi}$

(C) $\sin\phi$

(D) $\cos\phi$

(E) $\tan\phi$



21. A person is standing at one end of a uniform raft of length L that is floating motionless on water, as shown above. The center of mass of the person-raft system is a distance d from the center of the raft. The person then walks to the other end of the raft. If friction between the raft and the water is negligible, how far does the raft move relative to the water?

(A) $\frac{L}{2}$

(B) L

(C) $\frac{d}{2}$

(D) d

(E) $2d$