Answer on Question #45515 – Physics – Other

If n balls hit elasticity and normally on the surface per unit time and all balls of mass m are moving with same velocity u, then force on surface is
(1) mun
(2) 2mun
(3) 1/2mu^2n
(4) mu^2n

Solution:
$\mathrm{n} - \text{number of balls;}$
$\Delta\mathrm{t} = 1 - \text{time of acting on a surface;}$
$\Delta\mathrm{p} - \text{change of the momentum of the surface}$
$\mathrm{m} - \text{mass of the ball;}$
$\mathrm{u} - \text{velocity of the ball;}$

If a force F is applied to a surface for a time interval Δt, the momentum of the surface changes by an amount

$$\Delta\mathrm{p} = \mathrm{F}\Delta\mathrm{t}$$

In differential form, this gives Newton's second law: the rate of change of the momentum of a surface is equal to the force F acting on it:

$$\mathrm{F} = \frac{\Delta\mathrm{p}}{\Delta\mathrm{t}} \qquad (1)$$

To find Δp we can use Momentum Conservation Principle: for a collision occurring between balls and sucrface in an isolated system, the total momentum of the two objects before the collision is equal to the total momentum of the two objects after the collision. That is, the momentum lost by balls is equal to the momentum gained by the surface.

$$\mathrm{M}_1 = \mathrm{M}_2 \qquad (2)$$

Initial momentum in isolated system (Initial momentum of the surface is zero):

$$\mathrm{M}_1 = \mathrm{M}_{\text{one ball}} \cdot \mathrm{n} = \mathrm{mu} \cdot \mathrm{n} \qquad (3)$$

Final momentum in isolated system: (balls hit elasticity and normally, thus there's derection changed to opposite, and we have minus sign before balls's momentum)

$$\mathrm{M}_1 = -\mathrm{M}_{\text{one ball}} \cdot \mathrm{n} + \Delta\mathrm{p} = -\mathrm{mu} \cdot \mathrm{n} + \Delta\mathrm{p} \qquad (4)$$

$$(4)\text{and}(3)\text{in}(2):$$

$$\mathrm{mu} \cdot \mathrm{n} = -\mathrm{mu} \cdot \mathrm{n} + \Delta\mathrm{p}$$

$$\Delta\mathrm{p} = 2\mathrm{mun} \qquad (5)$$

$$(5)\text{in}(1):$$

$$\mathrm{F} = \frac{\Delta\mathrm{p}}{\Delta\mathrm{t}} = \frac{2\mathrm{mun}}{1} = 2\mathrm{mun}$$

Answer: (2) 2mun