Laws of Motion Important Questions

Here are the solutions (keys) to the numerical problems I shared earlier:

Problem 1:

A car of mass 1000 kg is moving with a speed of 72 km/h. It is brought to rest by applying brakes in 5 seconds. Calculate the force applied by the brakes.

- **Given:**
  - Mass of car, $m = 1000\,\text{kg}$
  - Initial velocity, $u = 72\,\text{km/h} = 72 \times \frac{5}{18} = 20\,\text{m/s}$
  - Final velocity, $v = 0\,\text{m/s}$
  - Time, $t = 5\,\text{seconds}$
- **Using the first equation of motion:**

$$v = u + at$$

$$0 = 20 + a \times 5$$

$$a = \frac{-20}{5} = -4\,\text{m/s}^2$$

  (The negative sign indicates deceleration.)
- **Force applied by the brakes:**

$$F = m \times a = 1000 \times (-4) = -4000\,\text{N}$$

  The negative sign indicates that the force is applied in the opposite direction to the motion.
- **Answer:** $F = 4000\,\text{N}$ (Force applied by the brakes)

Problem 2:

Two blocks of masses 5 kg and 7 kg are connected by a light string passing over a frictionless pulley. The 5 kg block lies on a smooth table, and the 7 kg block hangs vertically. Find the acceleration of the system and the tension in the string.

- **Given:**
  - Mass of the first block, $m_1 = 5\,\text{kg}$
  - Mass of the second block, $m_2 = 7\,\text{kg}$
  - Gravitational acceleration, $g = 9.8\,\text{m/s}^2$
- **For the 7 kg block:**

$$T - m_2 g = m_2 a$$

$$T - 7 \times 9.8 = 7a$$

$$T = 7a + 68.6$$

- **For the 5 kg block:**

$$T = m_1 a$$

$$T = 5a$$

- **Solving for T from both equations:**

$$5a = 7a + 68.6$$

$$2a = -68.6$$

$$a = 4.9\,\mathrm{m/s^2}$$

- **Now, find the tension:**

$$T = 5a = 5 \times 4.9 = 24.5\,\mathrm{N}$$

- **Answer:**
  - Acceleration of the system: $a = 4.9\,\mathrm{m/s^2}$
  - Tension in the string: $T = 24.5\,\mathrm{N}$

Problem 3:

A force of 20 N is applied to a block of mass 4 kg resting on a horizontal surface with a coefficient of kinetic friction 0.3. Find the acceleration of the block.

- **Given:**
  - Force applied, $F = 20\,\mathrm{N}$
  - Mass of block, $m = 4\,\mathrm{kg}$
  - Coefficient of kinetic friction, $\mu_k = 0.3$
  - Gravitational acceleration, $g = 9.8\,\mathrm{m/s^2}$
- **Force of friction:**

$$F_{\text{friction}} = \mu_k \times N = \mu_k \times mg$$

$$F_{\text{friction}} = 0.3 \times 4 \times 9.8 = 11.76\,\mathrm{N}$$

- **Net force:**

$$F_{\text{net}} = F - F_{\text{friction}} = 20 - 11.76 = 8.24\,\mathrm{N}$$

- **Acceleration:**

$$a = \frac{F_{\text{net}}}{m} = \frac{8.24}{4} = 2.06\,\mathrm{m/s^2}$$

- **Answer:** $a = 2.06\,\mathrm{m/s^2}$

These are the solutions for the problems provided. Let me know if you need further clarification!