CheggSolutions - Thegdp

```html

## Advanced Physics - Statics

**Topic: Equilibrium of a Rigid Body**

## Step 1: Given Data and Introduction

**Given Data:**

- Mass: $m = 500 \, \text{kg}$
- Weight: $W = mg$
- Gravitational acceleration: $g = 9.81 \, \text{m/s}^2$
- Tensions in cables: $T_{BC}$ and $T_{BD}$

The problem involves determining the unit vectors for the cables $BC$ and $BD$, expressing the tensions in Cartesian vector format, drawing a free body diagram, writing the equations of equilibrium, and solving for unknown reactions and tensions.

## Step 2: Calculate the Weight

$$ W = mg $$ $$ W = 500 \, \text{kg} \times 9.81 \, \text{m/s}^2 $$ $$ W = 4905 \, \text{N} $$

**Explanation:** The weight of the sign is calculated using the formula $W = mg$, where $m = 500 \, \text{kg}$ and $g = 9.81 \, \text{m/s}^2$.

## Step 3: Calculate the Unit Vectors for Cables

For simplicity, use coordinates (assuming point B is at origin):

- Position vectors:
  - Point $C$ at $(0, y_C, z_C)$
  - Point $D$ at $(x_D, y_D, z_D)$
- Calculate the unit vectors:

$$
\vec{BC} = \frac{\vec{r_C}}{|\vec{r_C}|}
$$
$$
\vec{BD} = \frac{\vec{r_D}}{|\vec{r_D}|}
$$
$$
\vec{r_C} = \langle 0, y_C, z_C \rangle
$$
$$
\vec{r_D} = \langle x_D, y_D, z_D \rangle
$$

## Step 4: Express Tensions in Cartesian Vector Format

The tensions $T_{BC}$ and $T_{BD}$:
```

$$
\vec{T_{BC}} = T_{BC} \cdot \vec{u_{BC}}
$$
$$
\vec{T_{BD}} = T_{BD} \cdot \vec{u_{BD}}
$$

where $\vec{u_{BC}}$ and $\vec{u_{BD}}$ are unit vectors determined in Step 3.

Step 5: Draw and Label Free Body Diagram (FBD) of the Horizontal Pole

Include in the FBD:

- Weight W
- Reaction forces at the ball joint A: A_x, A_y, A_z
- Tensions T_{BC}, T_{BD}

Step 6: Writing the Equations of Equilibrium

$$
\Sigma F_x = 0
$$
$$
\Sigma F_y = 0
$$
$$
\Sigma F_z = 0
$$
$$
\Sigma M_A = 0
$$

Summing forces in each Cartesian coordinate:

$$
A_x + T_{BD_x} = 0
$$
$$
A_y + W + T_{BC_y} + T_{BD_y} = 0
$$
$$
A_z + T_{BC_z} + T_{BD_z} = 0
$$

Summing moments about A:

$$
\vec{r_{B}} \times \vec{T_{BC}} + \vec{r_{B}} \times \vec{T_{BD}} - \vec{r_{G}} \times W = 0
$$

Step 7: Solve for Unknown Reactions and Tensions

$$
\begin{cases}
A_x + T_{BD_x} = 0 \\
A_y + 4905 \, \text{N} + T_{BC_y} + T_{BD_y} = 0 \\
A_z + T_{BC_z} + T_{BD_z} = 0
\end{cases}
$$

Explanation: Use simultaneous equations to isolate and solve unknown variables. Ensure the correct values of T_{BC} and T_{BD} to satisfy equilibrium conditions.

Final Solution

Reactions at A: A_x, A_y, A_z

Tensions in cables: T_{BC}, T_{BD}

Explanation: The final step aggregates all the calculations and equilibrium conditions to find the unknown forces. The free body diagram aids in visually confirming each force's location and direction.

``` ```html ```
```