Materials – A2 Physics P1

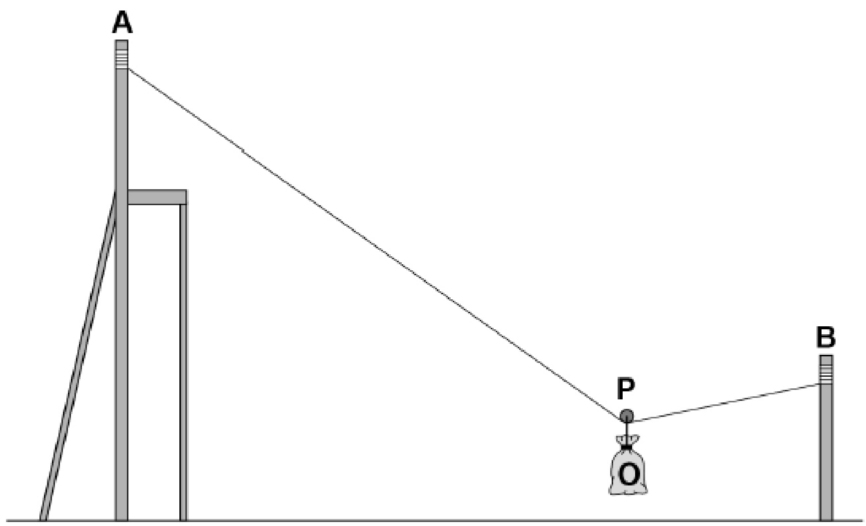
1. June/2024/Paper_7408/1/No.5

0 5 A cable system is to be used to transfer supplies across a river. A model of the proposed system is built in order to test its performance.

The model consists of a cable attached to two vertical posts **A** and **B**, as shown in **Figure 3**.
A pulley **P** of negligible mass is attached to the cable.

In this question the length of the cable does not change and the weight of the cable can be ignored.

Figure 3



An object **O** is attached to **P**. In one test, **O** and **P** are at rest in the position shown in **Figure 3**.
The weight of **O** is 350 N.

0 5 . 1 **Figure 4** is a force diagram drawn to scale. It represents the magnitudes and directions of the tensions T_1 and T_2 in the cable when **O** is at rest in the position shown in **Figure 3**. At this position, resistive forces are zero.

Complete the force diagram.
Go on to determine, using your diagram, the magnitudes of T_1 and T_2.

[4 marks]

Right Hand = Left Hand

$T_2 \cos 12 = T_1 \cos 34$

$T_2 = T_1 \dfrac{\cos 34}{\cos 12}$

$T_2 = 0.844 T_1$

Vertical ~~Up~~ = vertical down

$T_1 \sin 34 + T_1 \sin 12 = W$

$T_1 \sin 34 + T_2 \sin 12 = 350$

$0.560 T_1 + \sin 12° T_2 = 350$

$0.560 T_1 + (\sin 12° \times 0.844 T_1) = 350$

$0.560 T_1 + 0.175 T_1 = 350$

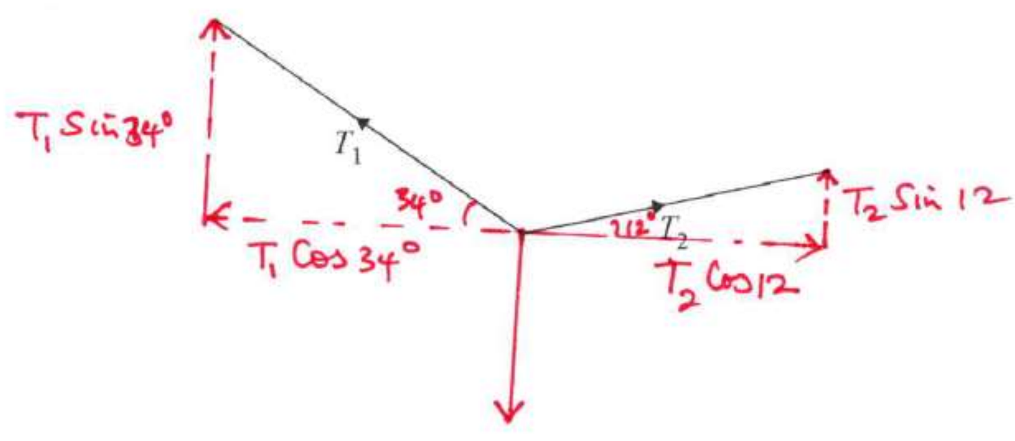
So $T_1 = 476$ N

So

$T_2 = 476 \times 0.844$

$T_2 = 401$ N

Figure 4



$T_1 =$ 476 N N

$T_2 =$ 401 N N

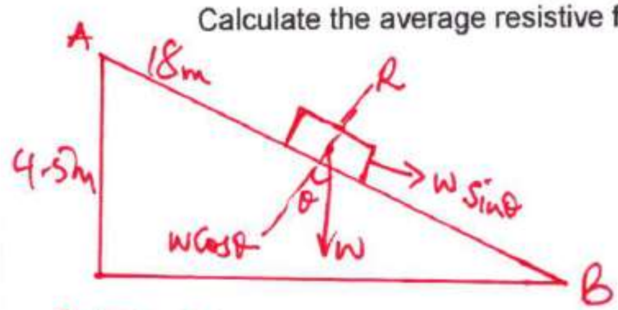
0 5 . 2 In a second test, pulley **P** with **O** attached is released from **A**.
P and **O** move along the cable to **B**.

The change in height of the centre of mass of **O** between **A** and **B** is 4.5 m.
The distance travelled along the cable is 18 m.

The speed of **O** when it reaches **B** is 6.5 m s^{-1}.

Calculate the average resistive force on **O** and **P** as they move from **A** to **B**.

[5 marks]



GPE = KE

$Mgh = \left(\frac{350}{9.8}\right)\text{kg} \times 9.8 \times 4.5$

$= 1575\text{ J}$

$KE = \frac{1}{2}mv^2$

$= \frac{1}{2} \times \frac{350}{9.8} \times 18^2$

$= 754\text{ J}$

How much is lost by friction

$= 1575 - 754$

$= 801\text{ J}$

W = Friction force × d

$W = F \times d$

$F = \frac{W}{d} = \frac{801}{18} = 45.6$

average resistive force = 45.6 N

0 5 . 3 O contains a fragile item packed in suitable material.

Explain how the material can prevent damage to the fragile item when **O** stops suddenly at **B**.

[3 marks]

with $F = ma \Rightarrow F = \left(\frac{v-u}{t}\right)m = F = \frac{mv - mu}{t}$

then $Ft = \Delta p$ or $F = \Delta p / \Delta t$ with Δt being stopping time and if Δt increases then Force decreases and the impact on the fragile object becomes smaller. Since $\Delta F \propto \frac{1}{\Delta t}$

2. June/2024/Paper_7408/1/No.25

A uniform wire is stretched by a load F.
The elastic strain energy stored in the wire is E.

The load is increased from F to $2F$.
The wire obeys Hooke's law.

What is the increase in the elastic strain energy stored in the wire?

[1 mark]

$E = \frac{1}{2}Fx$ and $x = \frac{F}{k}$ so $E = \frac{F^2}{2k}$

$E_1 = \frac{F^2}{2k}$, $E_2 = \frac{(2F)^2}{2k} = \frac{4F^2}{2k}$ or $4E_1$

$\Delta E = 4E_1 - E_1 = 3E_1$ or $3E$

A E ☐

B $2E$ ☐

C $3E$ ☒

D $4E$ ☐

3. June/2024/Paper_7408/1/No.26

A spring is compressed by a force F. The spring has stiffness k and its length changes by ΔL during the compression. When the force is removed the spring returns to its original length in time t.

What is the average power developed by the spring as it returns to its original length?

[1 mark]

$P = \frac{W}{t}$ and $E = \frac{1}{2}kx^2$

so $E = \frac{1}{2}k(\Delta L)^2$

then $P = \frac{\frac{1}{2}k(\Delta L)^2}{t} = \frac{k(\Delta L)^2}{2t}$

A $\frac{k\Delta L}{2t}$ ☐

B $\frac{k\Delta L}{t}$ ☐

C $\frac{k(\Delta L)^2}{2t}$ ☒

D $\frac{k(\Delta L)^2}{t}$ ☐