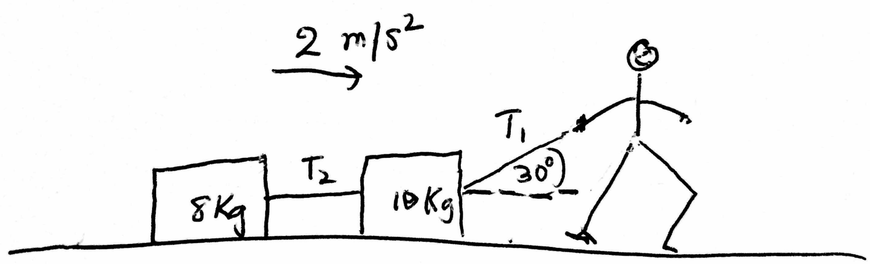
Exam PHYS 4A WINTER 2015 QUIZ 2 VERSION A

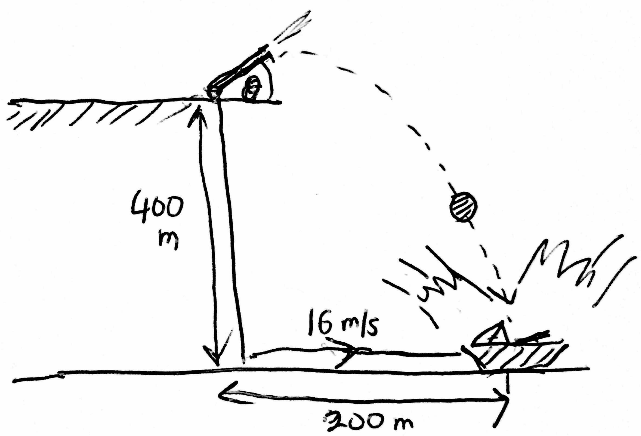
1 hour =60 mins; 1 min = 60 secs. g= 9.8 m s^{-2}

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.



1. A person is walking on a horizontal surface, pulling 2 blocks of mass 10 Kg and 8 Kg connected by ropes. He is pulling on the first block with a rope making 30º to the horizontal, while the rope between the 2 blocks is horizontal as shown in the figure. The blocks are accelerating at 2 m/s^2 and there is no slack in the ropes. The tensions in the ropes are T1 and T2 as indicated. Neglecting the friction between the blocks and the ground, the difference in the tension between the ropes (T1 –T2) is closest to:

(A) 16.0 N (B) 25.6 N (C) -1.52 N (D) 36.0 N



2. An enemy ship starts sailing directly outwards from the base of a cliff 400 m high at a constant speed of 16 m/s. At the same instant a projectile is fired from the top of the cliff and hits the ship when it is 200 m away from the base of the cliff. Neglect air resistance. Closest to which angle to the horizontal was the projectile fired from the top of the cliff?

(A) 83.2º (B) 75.3º (C) – 63.4º (D) 61.3º

3. A man in a space suit with total mass 80 Kg steps outside his space ship to push away a block of debris of mass 600 Kg which is stationary with respect to the spaceship. Assuming he pushes it with a constant force of 100 N for 1 sec, how far apart will he and the block be 10 secs after he started pushing, if he does not use his thrust rocket?

(A) 12.8 m (B) 16.6 m (C) 13.5 m (D) 14.1 m

4. An astronaut who weighs 725 N on earth goes to planet X, which has no atmosphere. She observes that when she drops a 2.35 Kg stone from rest on planet X, it takes 1.12s to fall a distance of 3.82 m. The astronaut's weight on planet X is closest to:

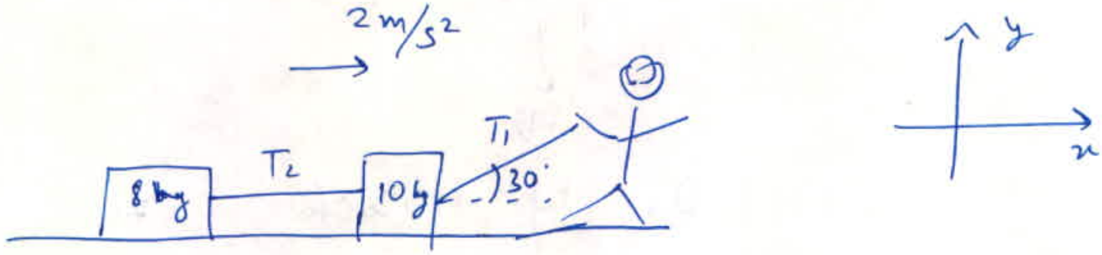
(A) 225 N (B) 1167 N (C) 505 N (D) 451 N

As PER VERSION A.

QUIZ - 2 SOLUTIONS

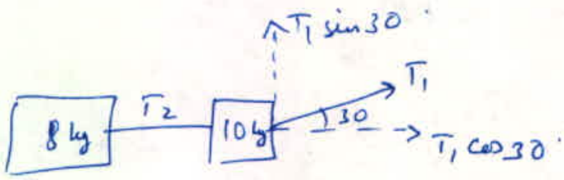
PHYS 4A

1.) B



Considering both the blocks as our system,

$$\vec{F}_{Total\ External} = T_1 \cos 30^\circ \,\hat{i} + T_1 \sin 30^\circ \,\hat{j}$$



and $\vec{a}$ in x-direction is $2\,m/s^2$

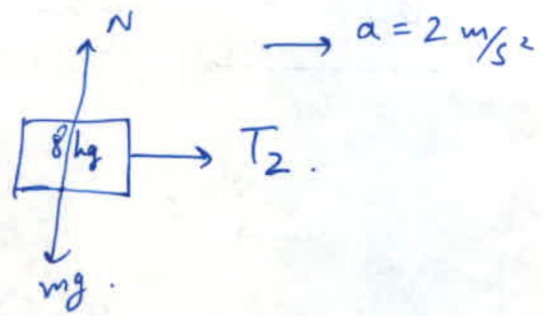
$\therefore$ $m_{Total}\, a = F_{total}$ (applying in x-direction)

$$\Rightarrow T_1 \cos 30^\circ = (10+8)\, 2$$

$$\Rightarrow T_1 = \frac{36}{\cos 30^\circ}\ N$$

$$\Rightarrow T_1 = \frac{72}{\sqrt{3}}\ N.$$

Now,



For the left block, T_2 is the only force acting in x-direction.

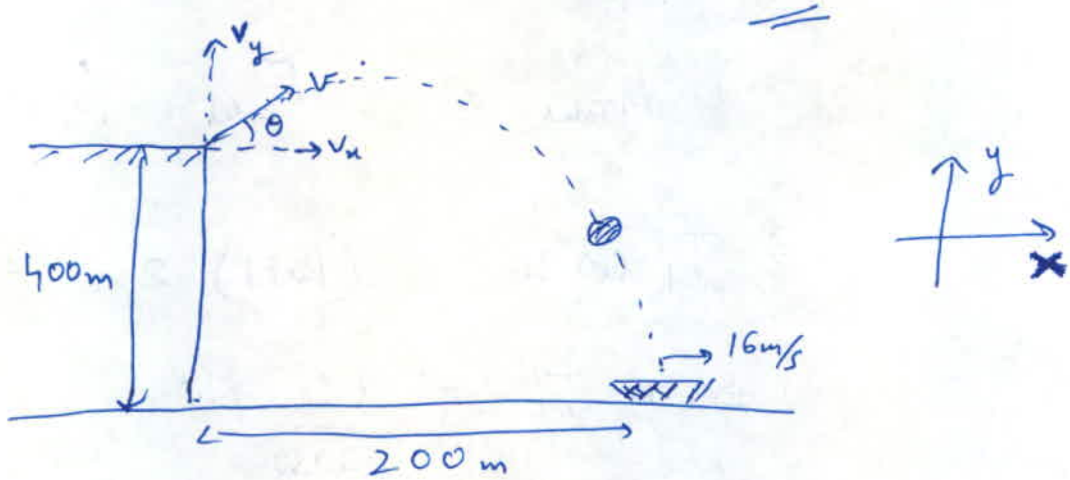
$$\therefore \quad T_2 = 8kg \times 2\ m/s^2$$

$$\Rightarrow T_2 = 16\ N$$

$$\therefore \quad T_1 - T_2 = \frac{72}{\sqrt{3}} - 16 = 25.56\ N$$

$$\text{or } T_1 - T_2 \simeq 25.6\ N$$

2.) C



Since ~~the~~ {projectile and enemy ship start off at same time,

$$v_x = \text{Speed of enemy ship} = 16\ m/s$$

(as there is no acceleration in x-direction for Projectile)

$$t = \frac{d}{v_x} = \frac{200}{16} \text{ s}$$

$$\Rightarrow t = 12.5 \text{ s}.$$

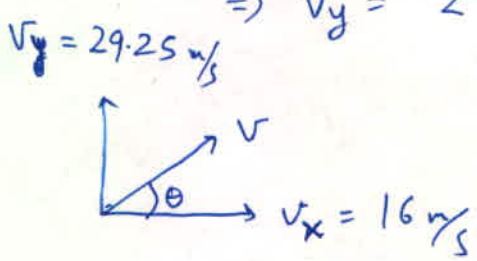
In this same time projectile covers a distance of 400 m in y-direction.

$\therefore$ Using,

$$y = v_y t + \frac{1}{2} a t^2$$

$$\Rightarrow -400 = v_y (12.5) + \frac{1}{2}(-9.8)(12.5)^2$$

$$\Rightarrow v_y = 29.25 \text{ m/s}$$



$$\therefore \tan\theta = \frac{v_y}{v_x}$$

$$\theta = \tan^{-1}\left(\frac{29.25}{16}\right)$$

$$\Rightarrow \theta = 61.3^\circ$$

3.) C

$t = 0$

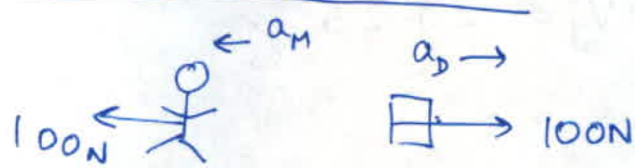
Both at rest. Man starts pushing the debris.

$t = 1\,s$

Looses contact with the debris

$t = 10\,s$

Between $t = 0$ & $t = 1\,s$



$$a_M = \frac{100\,N}{80\,kg} = \frac{5}{4}\,m/s^2$$

$$\therefore\ d_M = \frac{1}{2} a_M t^2 = \frac{1}{2}\,\frac{5}{4}\,(1)^2 = \frac{5}{8}\ m$$

$$a_D = \frac{100\,N}{600\,kg} = \frac{1}{6}\,m/s^2$$

$$\therefore\ d_D = \frac{1}{2} a_D t^2 = \frac{1}{2}\left(\frac{1}{6}\right) \times (1)^2 = \frac{1}{12}\ m$$

$v_M = u_M + a_M t$

$= 0 + \frac{5}{4} \times 1$

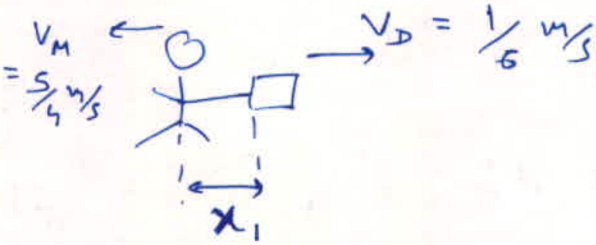
$= \frac{5}{4}$ m/s

$V_D = U_D + a_D t$

$= 0 + \frac{1}{6} \times 1$

$= \frac{1}{6}$ m/s

$\therefore$ At $t = 1$ s



$x_1 = d_M + d_D = \frac{5}{8} + \frac{1}{12}$

$= \frac{17}{24}$ m

After $t = 1$ s till $t = 10$ s, the force on man and debris is 0. $\therefore$ acceleration is 0 for both of them.

Then, distance travelled by man & debris between $t = 1$ s and $t = 10$ s is

$x_M = v_M t$

$= \frac{5}{4}(9)$

$= \frac{45}{4}$ m

$x_D = V_D t$

$= \frac{1}{6}(9)$

$= \frac{3}{2}$ m

$\therefore$ Total Separation after $t = 10$ s (d_{Total}) $= X_1 + (X_M + X_D)$

$= \frac{17}{24} + \frac{45}{4} + \frac{3}{2}$

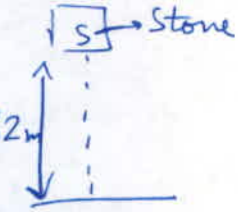
$= 13.46$

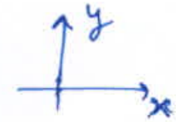
$\simeq 13.5$ m

4.) D

On Planet X,

$\therefore d = vt + \frac{1}{2} a_x t^2$





[illegible]

$\Rightarrow -3.82 = 0 + \frac{1}{2}(a_x)(1.12)^2$

$\Rightarrow a_x = -6.09$ m/s^2 ← acceleration due to gravity on Planet X.

{Negative because it is in downwards direction}.

Mass of astronaut (m_A) $= \frac{725\,N}{g} = \frac{725\,N}{9.8\,m/s^2}$

$= 73.98$ kg

$\therefore$ Weight of astronaut on Planet X $= m_A a_x$

$= 73.98 \times 6.09$

$= 450.54$

$\simeq 451$ N