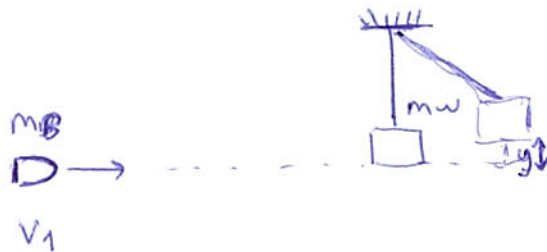**Closed book. No calculators are to be used for this quiz.**
Quiz duration: 10 minutes

Name: SOLUTION   Student ID: Signature:

A bullet with mass m_B is fired into a block of wood with mass m_W, suspended like a pendulum, and makes a completely inelastic collision with it. After the impact of the bullet, the block swings up to a maximum height y. Given the values of y, m_B, and m_W, what is the initial speed v_I of the bullet?

Completely inelastic means they stick and continue their movements together

m_B
$\square \rightarrow$
v_1

Let's call speed of block + bullet just after collision as V_2

Conservation of momentum

(I) , $m_B v_1 = (m_W + m_B) V_2$

, using info. max. height y;

$$\frac{1}{2}(m_W + m_B) v_2^2 = (m_W + m_B) \cdot g \cdot y$$

$$v_2 = \sqrt{2gy}, \quad (II)$$

insert (II) into (I) ;

yields $\Rightarrow$ $\boxed{v_1 = \dfrac{m_W + m_B}{m_B} \sqrt{2gy}} \quad (III)$

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: SOLUTION   Student ID: Signature:

Just before it is struck by a racket, a tennis ball weighing 0.56 N has a velocity of $20\frac{m}{s}\hat{\imath} - 4\frac{m}{s}\hat{\jmath}$. During the 3 ms that the racket and ball are in contact, the net force on the ball is constant and equal to $-380\ N\hat{\imath} + 110\ N\hat{\jmath}$. (a) What are the x and y components of the impulse of the net force applied to the ball? (b) What are the x and y components of the final velocity of the ball?

$$W_{ball} = 0.56\ N = m \cdot g \quad , \quad \boxed{m_{ball} = 0.057\ kg = 57\ g}$$

a) $\vec{J} = \vec{F} \cdot \Delta t = (-380\hat{\imath} + 110\hat{\jmath}) \times (3 \times 10^{-3}) = \boxed{-1.14\,\hat{\imath} + 0.33\,\hat{\jmath}\ (N \cdot s)}$ (I

b) $\vec{J} = \vec{P_2} - \vec{P_1} = 0.057\left[\vec{V_2} - (20\hat{\imath} - 4\hat{\jmath})\right] = -1.14\,\hat{\imath} + 0.33\,\hat{\jmath}$

$(\vec{V_2} - 20\hat{\imath} + 4\hat{\jmath}) = -20\hat{\imath} + 5.79\,\hat{\jmath}$

$$\boxed{\vec{V_2} = 1.79\,\hat{\jmath}} \qquad (\text{II})$$

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: SOLUTION   **Student ID:**   **Signature:**

Car A with mass 1200 kg is moving along a straight highway at 12 m/s. Car B with mass 1800 kg and speed 20 m/s has its center of mass 40 m ahead of the center of mass of car A. Find the speed of the center of mass of the system.j
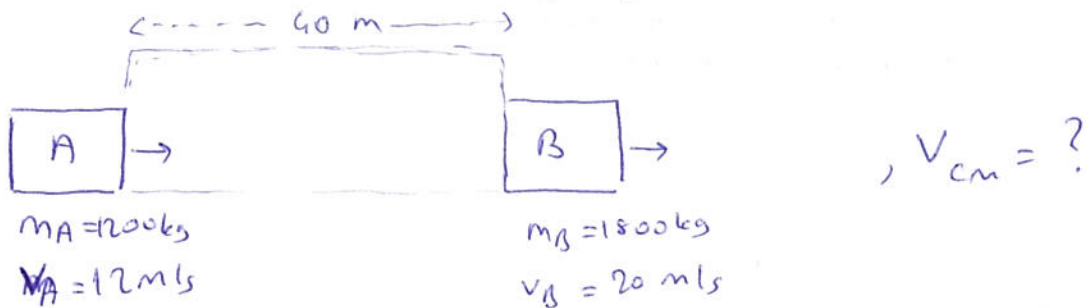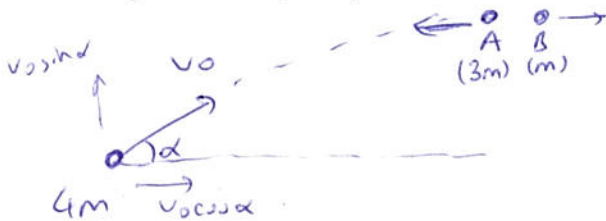

$$V_{cm} = \frac{m_A \cdot V_A + m_B V_B}{m_A + m_B} = \frac{2m \cdot 12 + 3m \cdot 20}{2m + 3m} = \frac{84}{5} = \boxed{16.8 \text{ m/s}}$$

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: $\mathcal{S}$OLUTION   Student ID: Signature:

A shell is launched at an angle α above the horizontal with an initial speed v_0. When it is at its highest point, the shell exploded into two fragments, one three times heavier than the other. The two fragments reach the ground at the same time. Assume that air resistance can be ignored. If the heavier fragment lands back at the same point from which the shell was launched, what are the velocities of the two fragments just after the explosion? Express your answer in terms of α and v_0.

at. max height

Conservation of momentum ; $4m \cdot (v_0 \cos \alpha) = 3m \cdot V_A + m \cdot V_B$ (I)

we also know that object A lands back @ the same point

$\therefore \boxed{V_A = -V_0 \cos \alpha}$ (II)

using (I) and (II)
we find $\Longrightarrow$ $\boxed{V_B = 7 V_0 \cos \alpha}$ (III)

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: SOLUTION   Student ID: Signature:

Blocks A (mass 2 kg) and B (mass 10 kg) move on a frictionless, horizontal surface. Initially, block B is at rest and block A is moving toward it at 2 m/s. The blocks are equipped with ideal spring bumpers that enable elastic collision. The elastic collision is head-on, so all motion before and after the collision is along a straight line. Find the velocity of each block after they have moved apart.

$$V_A \overset{= 2m/s}{\longrightarrow}$$

A B

elastic collusion

$$m_A = 2kg \qquad m_B = 10 kg$$
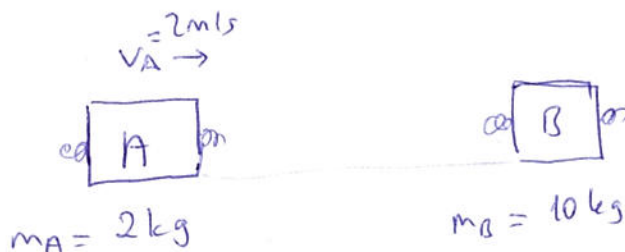
(I) , $\boxed{(m_A - m_B)V_{A1} = (m_A + m_B)V_{A2}}$ → velocity of A after collusion

↓

velocity of A before collusion

you can see the derivation from the book, eg. $(8.74, 8.25)$

(II) $\boxed{V_{B2} = V_{A1} + V_{A2}}$

↓

V of B after collusion

Using (I), $(2-10)\cdot 2 = (2+10)\cdot V_{A2}$, $\boxed{V_{A2} = -4/3 \; m/s}$

Using (II) , $V_{B2} = 2 - \dfrac{4}{3} = \boxed{\dfrac{2}{3}} \; m/s$