

Question 1: Mathematical Routines (MR)**10 points**

- A (i)** For drawing only one arrow for the momentum of Block 2 before the collision that points leftward and is 6 units long **Point A1**

For drawing only identical arrows for the momentum of the two-block system before and after the collision that are equal to the sum of the momentums drawn for blocks 1 and 2 before the collision **Point A2**

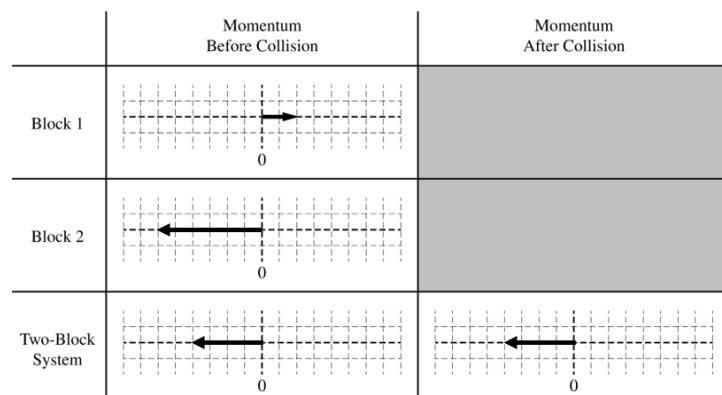
Example Response

Figure 2

- (ii)** For a multistep derivation that includes the integral form of impulse or the differential form of Newton's second law **Point A3**

For indicating **one** of the following: **Point A4**

- The final speed of Block 1 or Block 2 is $\frac{4}{7}v_0$.
- The change in the momentum of Block 2 is $+\frac{18}{7}mv_0$.
- The change in the momentum of Block 1 is $-\frac{18}{7}mv_0$.
- The change in the velocity of Block 2 is $+\frac{3}{7}v_0$.
- The change in the velocity of Block 1 is $-\frac{18}{7}v_0$.

For substituting the given expression for $F(t)$ into an expression for the impulse exerted on either block or the differential form of Newton's second law **Point A5**

For an integral with appropriate limits or a constant of integration **Point A6**

For a correct expression for $F_{\max}$ in terms of given quantities **Point A7**

Example Responses

$$\vec{J} = \int_{t_1}^{t_2} \vec{F}_{\text{net}}(t) dt = \Delta \vec{p} \quad \text{OR} \quad \vec{F}_{\text{net}} = \frac{d\vec{p}}{dt} \\ \int \vec{F}_{\text{net}} dt = \Delta \vec{p}$$

$$\sum \vec{p}_0 = \sum \vec{p}_f \\ (m)(2v_0) + (6m)(-v_0) = (m + 6m)(v_f) \\ v_f = -\frac{4}{7}v_0$$

$$\Delta p_{\text{Block 2}} = -\Delta p_{\text{Block 1}} = 6m\left(-\frac{4}{7}v_0 - (-v_0)\right)$$

$$\Delta p_{\text{Block 2}} = \int_0^{t_c} F_{\max} \sin(At) dt$$

$$\frac{18}{7}mv_0 = \frac{F_{\max}}{A}[-\cos(At)] \Big|_0^{t_c}$$

$$\frac{18}{7}mv_0 = \frac{F_{\max}}{A}[1 - \cos(At_c)]$$

$$F_{\max} = \frac{18}{7} \left(\frac{Amv_0}{1 - \cos(At_c)} \right)$$

- B** For a multistep derivation that includes conservation of momentum **Point B1**

For indicating that the magnitude of the final momentum of the two-block system is $7mv_0$ **Point B2**

For a correct expression for v_1 in terms of v_0 **Point B3**

Example Response

$$\sum \vec{p}_0 = \sum \vec{p}_f$$

$$mv_1 + 6m(-v_0) = 7m(v_0)$$

$$mv_1 = 13mv_0$$

$$v_1 = 13v_0$$