KNOWLEDGE AREA: MECHANICS

Answers

Multiple-choice questions

1.	B	2.	B	3.	D	4.	C	5.	A
6.	D	7.	B	8.	D	9.	A	10.	A
11.	C	12.	C	13.	B	14.	D	15.	C
16.	A	17.	B	18.	C	19.	D	20.	A
21.	D	22.	D	23.	A	24.	D	25.	C
26.	B	27.	A	28.	A	29.	C	30.	B

Momentum

Contextual questions

1.1 $p = mv$
$= 6,8 \times 7,4$
$= 50,32$ kg·m·s^{-1} north-east

1.2 Impulse $= \Delta p$
$= mv_f - mv_i$
$= 0 - 50,32$
$= -50,32$
$= 50,32$ kg·m·s^{-1} southwest

1.3 $F_{netto} = \frac{\Delta p}{\Delta t}$

$= \frac{50,32}{0,4}$

$= 125,8$ N southwest

2. $F_{net}\Delta t = mv_f - mv_i$
$(9,6)(0,24) = (0,13)v_f - 0$
$v_f = 17,723$ m·s^{-1} south

3. $\Sigma p_i = \Sigma p_f$ Choose direction of m_1 as positive.
$m_1v_{1i} + m_2v_{2i} = m_{(1+2)}v_f$
$(34)(5,4) + (14,6)(-8,4) = (48,6)v_f$
$v_f = 1,25$ m·s^{-1} in the direction of A

4. $\Sigma p_i = \Sigma p_f$ Choose direction of waitress as positive.
$m_{(1+2)}v_i = m_1v_{1f} + m_2v_{2f}$
$(59,8)(2,4) = (55)v_{1f} + (4,8)(0)$
$v_{1f} = 2,61\ m{\cdot}s^{-1}$ in the original direction

5. $\Sigma p_i = \Sigma p_f$ Choose east as positive.
$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$
$(58)(2,3) + (41,5)(1,9) = (58)(-1,3) + (41,5)(v_{2f})$
$v_{2f} = 6,93\ m{\cdot}s^{-1}$ east

6. $F_{net}\,\Delta t = \Delta p$
$\Delta p = (65)(15)$
$\Delta p = 975\ kg{\cdot}m{\cdot}s^{-1}$ right

7. $P_{train} = mv$
$= (6 \times 10^6)(15)$
$= 9 \times 10^7\ kg{\cdot}m{\cdot}s^{-1}$ north
$v_{motor} = \frac{p}{m}$
$= \frac{(9 \times 10^7)}{2\ 200}$
$= 4,09 \times 10^4\ m{\cdot}s^{-1}$ north

8.1 $\Delta p = mv_f - mv_i$
$\Delta p = (8)(8,5) - (8)(2,5)$
$\Delta p = 48\ kg{\cdot}m{\cdot}s^{-1}$ left

8.2 impulse = Δp
impulse = $48\ kg{\cdot}m{\cdot}s^{-1}$ left or 48 N·s left

8.3 $F_{net} = \frac{\Delta p}{\Delta t}$
$F_{net} = \frac{48}{7}$
$F_{net} = 6,86$ N left

9.1 $\Delta p = mv_f - mv_i$
$\Delta p = (2,3 \times 10^3)(28) - (2,3 \times 10^3)(12)$
$\Delta p = 3,68 \times 10^4\ kg{\cdot}m{\cdot}s^{-1}$ north

9.2 impulse = Δp
impulse = $3,68 \times 10^4\ kg{\cdot}m{\cdot}s^{-1}$ north or $3,68 \times 10^4$ N·s north

9.3 $F_{net} = \frac{\Delta p}{\Delta t}$

$F_{net} = \frac{(3{,}68 \times 10^4)}{15}$

$F_{net} = 2\,453{,}33$ N north

10. $F_{netto}\Delta t = m(v_f - v_i)$

$(45)\Delta t = (420)(11{,}6 - 8{,}4)$

$\Delta t = 29{,}87$ s

11.1 $F_{net} = \frac{(m(v_f - v_i))}{\Delta t}$

$F_{net} = \frac{68(0 - 5{,}2)}{9{,}6}$

$F_{net} = -36{,}83$ N

$F_{net} = 36{,}83$ N north

Choose south as positive.

11.2 $F_{net} \propto {}^{1}/_{\Delta t}$; if the time decreases the net force will increase for the same change in momentum.

11.3 The impulse will not change.
Impulse is only dependent of the change in momentum and not of the time it takes.

12.1 $\Delta p = m(v_f - v_i)$

$\Delta p = (0{,}045)(28 - 0)$

$\Delta p = 1{,}26$ kg·m·s^{-1} north

Choose north as positive.

12.2 Impulse = Δp

Impulse = 1,26 kg·m·s^{-1} north or 1,26 N·s north

12.3 $F_{net} = \frac{\Delta p}{\Delta t}$

$F_{net} = \frac{1{,}26}{0{,}009}$

$F_{net} = 140$ N north

12.4 140 N south

13.1 $\Delta p = m(v_f - v_i)$

$\Delta p = 0{,}28(2{,}8 - (-4{,}3))$

$\Delta p = 1{,}988$ kg·m·s^{-1} east

Choose east as positive.

13.2 $F_{net} = \frac{\Delta p}{\Delta t}$

$F_{net} = \frac{1{,}988}{0{,}003}$

$F_{net} = 662{,}67$ N east

13.3 $F_{net} = 662{,}67$ N west
(according to Newton's third law)

14. Impulse = $\Delta p = m(v_f - v_i)$

Impulse = $(0{,}6)(16{,}5 - (-4{,}6))$

Impulse = 12,66 kg·m·s^{-1} outgoing or 12,66 N·s outgoing

Choose outgoing direction as positive.

15.1 $v_f^2 = v_i^2 + 2a\Delta y$

$v_f^2 = 0 + 2(9{,}8)(1)$

$v_f = 4{,}43$ m·s^{-1} downwards

Choose downwards as positive.

15.2 $p_{Adrie} = p_{Mbali} = mv$
$= 45(4,43)$
$= 199,22 \text{ kg·m·s}^{-1}$ downwards

15.3 Impulse $= \Delta p$
$= p_f - p_i$
$= 0 - 199,22$
$= -199,22 \text{ kg·m·s}^{-1}$
$= 199,22 \text{ kg·m·s}^{-1}$ upwards

15.4 Mbali; $F_{net} \propto {}^{1}/_{\Delta t}$ if the time decreases the net force will increase for the same change in momentum.

16.1 $\Sigma p_i = \Sigma p_f$ Choose direction of bullet as positive.
$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$
$0 + 0 = (2,8)v_{1f} + (0,012)(610)$
$v_{1f} = -2,614 \text{ m·s}^{-1}$
$v_{1f} = 2,614 \text{ m·s}^{-1}$ backward w.r.t. the bullet

16.2 $F_{net} = \dfrac{m(v_f - v_i)}{\Delta t}$
$F_{net} = \dfrac{0,012(610 - 0)}{0,03}$
$F_{net} = 244$ N forward w.r.t. the bullet

17.1 $\Sigma p_i = \Sigma p_f$ Choose west as positive.
$m_1v_{1i} + m_2v_{2i} = m_{(1+2)}v_f$
$(12,3)(25,4) + (36)(-36,4) = (48,3)v_f$
$v_f = -20,66 \text{ m·s}^{-1}$
$v_f = 20,66 \text{ m·s}^{-1}$ east

17.2 $\Delta p = m(v_f - v_i)$
$\Delta p = 12,3(-20,66 - (25,4))$
$\Delta p = -566,54 \text{ kg·m·s}^{-1}$
$\Delta p = 566,54 \text{ kg·m·s}^{-1}$ east

17.3 $\Delta p = m(v_f - v_i)$
$\Delta p = 36(-20,66 - (-36,4))$
$\Delta p = 566,64 \text{ kg·m·s}^{-1}$ west

17.4 $566,54 \text{ kg·m·s}^{-1}$ east, because impulse A = -impulse B, according to third law.

17.5 $F_{net} = \dfrac{\Delta p}{\Delta t}$
$F_{net} = \dfrac{-566,54}{0,1}$
$F_{net} = -5\,665,4$ N
$F_{net} = 5\,665,4$ N east

18. $\Sigma p_i = \Sigma p_f$ Choose south as positive.
$m_{1+2}v_i = m_1v_{1f} + p_2$
$(10)(7) = (2)(12,4) + p_2$
$p_2 = 45,2 \text{ kg·m·s}^{-1}$ south