TUTORIAL ANSWERS DYNAMICS 1

1.) $a = F / (m + 2m) = F / 3m$

Force X on Y, $F_{xy} = (2m)(F / 3m) = 2F / 3$

Force Y on X will be same in magnitude as force X on Y based on Newton's 3rd Law

= **2F / 3 (D)**

2.) Change in momentum is = Area under the graph

= **20 kgms^{-1} (C)**

3.) Use conservation of momentum and conservation of kinetic energy to solve.

$mu = mv_1 + mv_2$

$u = v_1 + v_2$; $v_1 = u - v_2$ ---------- (1)

$\frac{1}{2} mu^2 = \frac{1}{2} mv_1^2 + \frac{1}{2} mv_2^2$

$u^2 = v_1^2 + v_2^2$ ---------------(2)

Substitute (1) into (2):

$u^2 = (u - v_2)^2 + v_2^2$

$u^2 = (u^2 - 2uv_2 + v_2^2) + v_2^2$

$2uv_2 = 2v_2^2$; $\mathbf{v_2 = u}$ and thus $\mathbf{v_1 = 0}$.

Hence P becomes stationary and Q moves to the right with the same speed u. When Q collides with R the same outcome occurs as for the collision between P and Q. Therefore, Q becomes stationary while R moves to the right with the same speed u. (D)

4.) For an inelastic collision, there is loss in kinetic energy during the collision and hence there is reduction in speed after the puck rebounds. **So (A) is the answer.**

5.) Use conservation of momentum and conservation of kinetic energy to solve.

Let m_n = mass of neutron & m_N = mass of nitrogen

$m_n u = m_n v_n + m_N v_N$ ($m_N = 14m_n$)

$u = v_n + 14v_N$; $v_n = u - 14v_N$ ---------- (1)

$\frac{1}{2} m_n u^2 = \frac{1}{2} m_n v_n^2 + \frac{1}{2} m_N v_N^2$ ($m_N = 14m_n$)

$u^2 = v_n^2 + 14v_N^2$ ---------------(2)

Substitute (1) into (2):

$u^2 = (u - 14v_N)^2 + 14v_N^2$

$u^2 = (u^2 - 28uv_N + 196v_N^2) + 14v_N^2$

$28uv_N = 210v_N^2$; $\mathbf{v_N = 2u / 15}$ & $\mathbf{v_n = -13u / 15}$.

So answer is **(A)**

6.) When a mass accelerates uniformly, its velocity v increases uniformly with time. Therefore its acceleration, a is a constant. **So answer is B.**

7.) Since linear momentum is conserved,

20 -12 = -2 + momentum of Y

Thus, momentum of Y = 10 Ns. (C)

8.) Using F = ma,

acceleration, $a = F / 4m$

Considering block Y, $F_{xy} = (3m)(F / 4m) =$ **3F / 4 (D)**

9.) A body accelerated by a constant force will have a constant acceleration. Its velocity will therefore increases linearly with time. Hence its momentum also increases linearly with time. **Answer is A.**

TUTORIAL ANSWERS DYNAMICS 2

1.)

a.)**The mass of a body is a measure of the inertia of the body. S.I unit is kg.**
The weight of a body is the gravitational force exerted on that body. S.I unit is Newton (N)

b.) (i) $p = mv =$ **1.6×10^7 Ns**

(ii) $s = \frac{1}{2}(v + u)t$
$1200 = \frac{1}{2}(8000 + 0)\,t$
$t =$ **0.3 s**

(iii) $F = \Delta p / \Delta t = 1.6 \times 10^7 / 0.3 =$ **5.33×10^7 N**

(iv) $a = F / m = 5.33 \times 10^7 / 2000 =$ **26650 ms^{-2}**

c.) **The enormous force that is required to produce the high acceleration will kill any astronaut in the space vehicle.**

2.) $F = ma$
$(F_{thrust} - mg) = ma$; $a = 2s / t^2 = 1.2\ ms^{-2}$
$F_{thrust} = (5.0)(1.2) + (5.0)(9.81) =$ **55.1 N**

3.) Use conservation of momentum and conservation of kinetic energy to solve.

$mu_1 = mv_1 + mv_2$
$u_1 = v_1 + v_2$; $v_1 = u_1 - v_2$ ---------- (1)

$\frac{1}{2} mu_1^2 = \frac{1}{2} mv_1^2 + \frac{1}{2}mv_2^2$
$u_1^2 = v_1^2 + v_2^2$ ---------------(2)

Substitute (1) into (2):
$u_1^2 = (u_1 - v_2)^2 + v_2^2$
$u_1^2 = (u_1^2 - 2u_1v_2 + v_2^2) + v_2^2$
$2u_1v_2 = 2v_2^2$ **$v_2 = u_1$** **$v_1 = 0$**

4.)

a.) Examine the change in momentum separately (horizontally & vertically)
Horizontally (take right as positive) : $mv_h - mu_h = (10)(5\cos 30°) - (10)(5\cos 30°) = 0$
Vertically (take downwards as positive) : $mv_v - mu_v = (10)(5\sin 30°) - (10)(-5\sin 30°) = 50$ Ns

Change in momentum = $\sqrt{50^2 + 0^2}$ =**50 Ns**

b.) $s = ut + \frac{1}{2} at^2$
$0 = (5\sin 30°)t + \frac{1}{2}(-9.81)t^2$
$t =$ **0.51 s**

c.) $F = \Delta p / \Delta t = 50 / 0.51$
$F =$ **98 N**

d.) $F = ma$
$a = F / m = 98 / 10 =$ **9.8 ms^{-2}**

5.) Let m_p = mass of proton & m_{He} = mass of helium nucleus.

Since the collision is elastic, we can use the two equations as below:

Relative speed of approach = Relative speed of separation

$u_p - u_{He} = v_{He} - v_p$

$3.60 \times 10^4 - 0 = v_{He} - v_p$

$v_p = v_{He} - 3.60 \times 10^4$ --- (1)

Conservation of momentum

$m_p u_p + m_{He} u_{He} = m_p v_p + m_{He} v_{He}$

$(1.01u)(3.60 \times 10^4) + (4.00u)(0) = (1.01u)v_p + (4.00u)v_{He}$ --- (2)

Substitute (1) into (2):

$(1.01u)(3.60 \times 10^4) = (1.01u)(v_{He} - 3.60 \times 10^4) + (4.00u)v_{He}$

$$V_{He} = \frac{2(1.01u)(3.60 \times 10^4)]}{5.01u} = \mathbf{1.45 \times 10^4\ ms^{-1}}$$

$V_p = 1.45 \times 10^4 - 3.60 \times 10^4 = \mathbf{-2.15 \times 10^4\ ms^{-1}}$

(The minus sign tells us that the proton reverse direction upon collision)

6.) Let m_h = mass of hydrogen & m_{ox} = mass of oxygen.

Since the collision is elastic, we can use the two equations as below:

Relative speed of approach = Relative speed of separation

$u_h - u_{ox} = v_{ox} - v_h$

$1880 - (-405) = v_{ox} - v_h$

$V_{ox} = v_h + 2285$ --- (1)

Conservation of momentum

$m_h u_h + m_{ox} u_{ox} = m_h v_h + m_{ox} v_{ox}$

$(2.00u)(1880) + (32.0u)(-405) = (2.00u)v_h + (32.0u)v_{ox}$ --- (2)

Substitute (1) into (2):

$(2.00u)(1880) + (32.0u)(-405) = (2.00u)v_h + (32.0u)(v_h + 2285)$

$(3760u) - (12960u) = (34.0u)v_h + (73120u)$

$(34.0u)v_h = -82320u$

$v_h = \mathbf{-2420\ ms^{-1}}$

$v_{ox} = (-2420) + 2285 = \mathbf{-136\ ms^{-1}}$