Exercise

(1) A car moves from rest with an acceleration of $0.2\ m/s^2$. Find its velocity when it has moved a distance of 50m.

Ans 4.47 m/s

(2) A car has a uniform velocity of 108 km/h. How far does it travel in $\frac{1}{2}$ min?

Ans 900m

(3) A train slows from 108 km/h with a uniform retardation of $5\ m/s^2$. How long will it take to reach 18 km/h and what is the distance covered?

Ans 87.5m, t = 5 sec.

(4) A car starts from rest and accelerates uniformly until it reaches a velocity of 30 m/s after 5s. It travels with uniform velocity for 15s and is then brought to rest in 10s, with a uniform retardation. Determine (a) the acc. of the car (b) the retardation (c) the distance covered after 5s (d) the total distance covered

$v = 0 + axs,\ a = 30/5 = 6\ m/s^2$

$0 = u + (-10a) / a = 30/10 = 3\ m/s^2$

$s = 0 + \frac{1}{2} \times 6 \times 5^2 = 75m$

$s = 0 + \frac{1}{2} \times 6 \times 15^2 = 675m$

Ans (a) $6\ m/s^2$ (b) $3\ m/s^2$ (c) 75m (d) 675m

(5) A ball is released from a height of 20m. Calculate (a) the time it takes to fall (b) the velocity with which it hits the ground.

$V = u + gt,\ 20 = 0 + 10t,\ t = 2sec$

$V^2 = u^2 + 2gs$
$= 0^2 + 2 \times 10 \times 20$
$= 400$
$V = \sqrt{400} = 20 m/s.$

$H = \frac{v^2}{2g}$
$v^2 = 2gH$

Ans (a) t = 2 sec (b) V = 20 m/s

(6) A ball is thrown up vertically with a velocity of 40 m/s. Calculate (a) the maximum height reached (b) the time to reach the maximum height, (c) the time to reach the ground again

$H = \frac{u^2}{2g} = \frac{40^2}{20} = 80m$ / $V^2 = u^2 + 2gs$

$s = \frac{u^2}{2g} = \frac{40^2}{20} = 80m$

$t = \frac{u}{g} = \frac{40}{10} = 4s$ / $v = u + gt$

$t = \frac{v}{g} = \frac{40}{10}$ as

$T = \frac{2u}{g} = \frac{80}{10} = 8s$

Ans (a) s = 80 m (b) t = 4s (c) t = 8s

(7) A body is projected horizontally from the top of vertical cliff 40m high, with a velocity of 20 m/s. Calculate.
(a) the time taken for the body to fall to the ground
(b) the vertical component of the velocity when the body hits the ground
(c) the distance from the cliff when it strikes the ground

Ans (a) t = 2.828 (b) V = 28.28 m/s (c) s = 56.57 m.

(8) A cannon ball is projected so as to attain a maximum range. Find the maximum height attained if the initial velocity is

Ans $H = u^2/4g$.

9. A tennis ball is hit with a velocity of 3 m/s at angle of 60° to the horizontal, Calculate.
(a) the time of flight $T = \frac{2u\sin\theta}{g}$
(b) the maximum height $H = \frac{u^2\sin^2\theta}{2g}$
(c) the range $R = \frac{u^2\sin 2\theta}{g}$

Ans (a) $T = 0.52$ sec (b) $H = 33.75$ cm (c) $R = 78$ cm

10. A ball is thrown into the air with initial velocity of 50 m/s at 37° to the horizontal. find the total time the ball is in the air and the total horizontal distance it travels, taking $g = 10$ m/s².

Ans $t = 6$ s $s = 240$ m. $T = \frac{2u\sin\theta}{g}$, $R = \frac{u^2\sin 2\theta}{g}$

11. A projectile is fired at an angle of 60° with the horizontal with the initial velocity 80 m/s. Calculate
(a) the time of flight
(b) the maximum height attained and the time taken to attain it
(c) the range attained
(d) the velocity of projection 2 sec. after being fired ($g = 10$ m/s²)

Ans (a) ~~$T = 13.8$ sec~~ $T = 13.86$ sec $T = \frac{2u\sin\theta}{g}$ (b) $t = 6.9$ sec, $t = \frac{u\sin\theta}{g}$, $H = 240$ m $H = \frac{(u\sin\theta)^2}{2g}$ (c) $R = 554$ m $R = \frac{u^2\sin 2\theta}{g}$, (d) $V = 63.5$ m/s $s = ut + \frac{1}{2}gt^2$, $v^2 = u^2 - 2gs$

12. A body moving with a constant velocity along a straight line PQR takes 30 s to go from P to Q and 10 s to go from Q to R. If PR = 4 m, find PQ $v = \frac{s}{t} = \frac{4}{30+10} = 0.1$ m/s

$d_1 = PQ = vt_1 = \frac{0.1}{1} \times 30 = 3$ m
$d_2 = QR = vt_2 = 0.1 \times 10 = 1$ m
4 m

Ans PQ = 3 m

13. An object moves in a straight line starting from rest. There are two stages in the journey.
(a) it gains speed uniformly for 2.0 s and attains a speed of 8.0 m/s
(b) it continues at this speed for a further 1.5 sec. find,
(a) the acc. in stage (a) $v = u + at$ $\{u = 0, t = 2, v = 8$ m/s$\}$
(b) the acc in stage (b)
(c) the total distance moved during stages (a) & (b)

Ans (i) 4 m/s² (ii) 0 (iii) 20 m $s_1 = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times 4 \times 2^2 = 8$ m, $s_2 = ut + \frac{1}{2}at^2 = 8 \times 1.5 + 0 = 12$ m, 20 m

14. A train starts from rest from a station and travel with uniform acc. 0.5 m/s² for 20 s. if travels with uniform velocity for another 30 sec, the brakes are then applied so that a uniform retardation is obtained and the train came to rest in a further 10 sec. Calculate
(a) The total distance travelled by the train?

Ans $s = 50$ m

15. A ball thrown vertically upwards from ground level hits the ground after 4 sec. Calculate the maximum height it reached during its journey ($g = 10$ m/s²)

Ans $H = 20$ m. $T = \frac{2u}{g}$, $u = \frac{4g}{2} = 2g = 20$ m/s
$H = \frac{u^2}{2g} = \frac{20^2}{20} = 20$ m

A body is dragged from rest at a height of 80m. How long does it take to reach the ground? ($g = 10 m/s^2$)

Ans $t = 4s$. $s = ut + \frac{1}{2}gt^2 \;/\; 80 = 0 + \frac{1}{2} \times 10 \times t^2$, $t = \sqrt{16} = 4s$

(17) A stone is thrown vertically upwards with an initial speed u. If g is the acc due to gravity, at what time will the stone return to the starting point.

Ans $t = \frac{2u}{g}$ (3)

(18) A motor car is uniformly retarded and brought to rest from a velocity 36 km/h in 5 sec. find it retardation and the distance covered during this period.

Ans $a = 2 m/s^2$, $s = 25m$. $V = 0$, $u = 36 km/h = 10 m/s$, $t = 5s$. $V = u - at$, $a = \frac{u}{t} = \frac{10}{5} = 2 m/s^2$ $s = ut - \frac{1}{2}at^2 = 10 \times 5 - \frac{1}{2} \times 2 \times 5^2 = 25m$

(19) A body travels from rest with acc. $8 m/s^2$. find its velocity when it has covered a distance of 100m.

Ans 40 m/s. $\{u = 0, a = 8 m/s^2, s = 100\}$ / $V^2 = u^2 + 2as = 0^2 + 2 \times 8 \times 100 = 1600$, $V = 40 m/s$.

(20) An object falls from a height of 20m. what is it velocity just before hitting the ground? ($g = 10 m/s^2$)

Ans 20 m/s $v^2 = u^2 + 2gs = 0^2 + 2 \times 10 \times 20 = 400$ / $v = \sqrt{400} = 20 m/s$.

(21) A particle moving in straight line with uniform deceleration has a velocity of 40 m/s at a point P, 20 m/s at a point Q and comes to rest at a point R, when QR = 50 m. Calculate the

(i) distance PQ — $\{u = 20 m/s, v = 0\}$ $v^2 = u^2 - 2as$, $a = \frac{u^2}{2s} = \frac{20^2}{2 \times 50} = \frac{400}{100} = 4 m/s^2$

(ii) time taken to cover PQ — $\{u = 40 m/s, v = 20 m/s, a = 4 m/s^2\}$ $v^2 = u^2 - 2as$, $s = \frac{u^2 - v^2}{2a} = \frac{40^2 - 20^2}{8} = 150m$

(iii) time taken to cover PR — $\{u = 40 m/s, v = 20 m/s, a = 4 m/s^2\}$ $v = u - at$, $t = \frac{u - v}{a} = \frac{40 - 20}{4} = 5 sec$.

Ans (i) 150 m (ii) 5 sec (iii) 10 sec — $\{u = 40 m/s, v = 0, a = 4 m/s^2\}$ / $v = u - at$, $t = \frac{u}{a} = \frac{40}{4} = 10$

(22) An arrow is shot into the air with an initial velocity of 100 m/s at an elevation of 60°. find

(a) the time of flight → $T = \frac{2u \sin\theta}{g}$

(b) the maximum height attained → $H = \frac{(u \sin\theta)^2}{2g}$

(c) the range. → $R = \frac{u^2 \sin 2\theta}{g}$

Ans (a) 17.32 sec (b) 374.98 m (c) 866 m.

(23) A ball thrown with a speed of 100 m/s attained a height of 150 m. calculate

(a) the time of flight → $T = \frac{2u \sin\theta}{g} = \frac{2 \times 100 \sin 33.2}{10}$

(b) the angle of projection — $H = \frac{u^2 \sin^2\theta}{2g}$, $\sin^2\theta = \frac{150 \times 20}{100^2}$, $\theta = 33.2°$

(c) the range → $R = \frac{u^2 \sin 2\theta}{g}$

Ans (a) 5.48 sec (b) 33.21° (c) 916.5 m.

(24) An anti-aircraft gun fires at an elevation of 60° at an enemy aircraft at 10,000 m above the ground. At what speed must the cannon be shot to hit the plane at that height

Ans 516.4 m/s $H = \frac{u^2 \sin^2\theta}{2g}$, $10,000 = \frac{u^2 (\sin 60)^2}{20}$, $u^2 = \frac{200,000}{(\sin 60)^2}$

A ball is thrown horizontally from the top of a cliff 20 m high. If the initial horizontal velocity is 8.0 m/s. Find
(a) how long it takes to reach the horizontal plane at the foot of the cliff.
(b) how far from the foot of the cliff it strike the ground
(c) the speed with which it strikes the ground ($g = 9.8$ m/s²) (4)

Ans (a) 2.02 sec (b) 16.2 m (c) 19.8 m/s.

(28) A rocket is fired at 60° to the horizontal with an initial speed of 200 m/s. Calculate its time of flight and its range on a horizontal plane. $T = \frac{2u\sin\theta}{g}$, $R = \frac{u^2 \sin 2\theta}{g}$.

Ans 34.6 sec, 3,464 m.

Phy 113 [redacted] Questions

Work, Energy & power

(1) A body is pulled along a horizontal plane by a constant force of 10N applied parallel to the plane. (1)
(a) Calculate the work done in moving the body a distance of 20m
(b) What work has been done if the same force is used on the body for the same distance but applied in a direction making an angle 60° to the horizontal.

(a) $W = 200\,J$, $W = f \times s = 10 \times 20$
(b) $W = F\cos 60° \times 20 = 100\,J$

(2) A man of mass 80kg carries a load of bricks of mass 20kg up a vertical ladder of length 6m. What work has he done? ($g = 10 m/s^2$)
$W = (80+20) \times 10 \times 6$ ($W = mgh$) $= 6000\,J = 6kJ$

(3) A stone of mass 10kg falls from a height of 2m. Calculate the work done.
$W = mgh = 10 \times 10 \times 2 = 200\,J$

(4) A body of mass 100kg is released from a height of 200m. With what energy does the body strike the ground? ($g = 10m/s$)
$E_p = mgh = 100 \times 10 \times 200 = 200{,}000\,J = 200\,kJ$.

(5) A boy of mass 30kg is running with a speed of $4ms^{-1}$. What is his kinetic energy?
$K.E = \frac{1}{2}mv^2 = \frac{1}{2} \times 30 \times 4^2 = 240\,J$

(6) A bullet of mass 40g is moving with a speed of $216 km h^{-1}$. Calculate its kinetic Energy
$40g = 0.04kg$; $216 km/h = 60 m/s$; $K.E = \frac{1}{2}mv^2 = \frac{1}{2} \times 0.04 \times 60 = 72\,J$

(7) A stone of mass 0.5kg is thrown vertically upwards with a velocity of $10ms^{-1}$. find
(a) the P.E at the greatest height h and the value of h
(b) the K.E on reaching the ground again ($g = 10ms^2$).

(a) $P.E = mgh = \frac{1}{2}mv^2 = \frac{1}{2} \times 0.5 \times 10^2 = 25\,J$
$h = \frac{v^2}{2g} = \frac{10^2}{2 \times 10} = 5m$.
(b) $K.E = P.E = 25\,J$

(8) A body of mass 2kg falls from rest through a height of 20m and comes to rest having penetrated a distance of 0.5m into sandy ground. Calculate the average force exerted by the sand in bringing the body to rest. ($g = 10ms^{-2}$)
$\frac{1}{2}mu^2 = W = mgh = 2 \times 10 \times 20 = 400\,J$; $400 = F \times 0.5$, $F = \frac{400}{0.5} = 800\,N$

(9) A ball of mass 2kg falls from rest from a height of 200m. Calculate its K.E after falling a distance of 150m. ($g = 10m/s^2$)
Total E/P $= mgh = 2 \times 10 \times 200 = 4000\,J$
E_p at 200m $= mgh = 2 \times 10 \times 150 = 3000\,J$
E_p at 150m $= mgh = 1000\,J = 1kJ$
K.E $= 4000 - 3000\,J$

(10) Calculate the power of a pump which lift 500kg of water through a vertical height of 4m in 5sec. ($g = 10m/s^2$).
$\text{power} = \frac{WD}{t} = \frac{F \times s}{t} = \frac{500 \times 10 \times 4}{5} = 4000W = 4KW$

(11) A car travelling at a constant speed of $20ms^{-1}$ overcomes a constant frictional resistance of 300N. What is the horse power of the engine? ($1 h.p = \frac{3}{4} KW$)
$\text{Engine power} = \frac{WD}{t} = F \times \frac{s}{t} = F \times V = 300 \times 20 = 6000W = 6KW$
$1 h.p = \frac{3}{4} KW$, $6 \times \frac{4}{3} h.p = 8\,h.p$.

Solution by
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A boy of mass 60kg runs up a set of steps of total height 3m, work done in joules is
$W = mgh = 60 \times 10 \times 3 = 1800\,J$ (2)

~~The speed of a bullet of mass 40g is 216 km/h. What is the K.E in joules?~~
~~Ans = 72 J~~

(19) What is the engine power of a car with retarding force 500N moving at constant speed 20ms
$P = F \times V = 500 \times 20 = 10000\,W = 10\,kW$

(20) A 2kg body is allowed to roll down an inclined plane 4m long with angle of inclination 30°. Calculate the work done. ($g = 10 ms^{-2}$).
$\sin 30° = \frac{h}{4}$, $h = 4 \sin 30°$
$W = F \cos 30° \times s = 2 \times 10 \times \sin 30° \times 4 = 40\,J$

(21) A bullet of mass 0.05kg has a speed of 400 ms^{-1}. What is its K.E? If it hits a wall of which the average resistive force is 10000N. Calculate the distance penetrated by the bullet.
$K.E = 4000\,J$, $s = 0.4m$. $K.E = \frac{1}{2}mu^2 = \frac{1}{2} \times 0.05 \times 400^2 = 4000\,J$, $s = \frac{4000}{10000} = 0.4$
$F \times s = K.E$

(22) A ball of mass 8kg falls from rest from a height of 100m. Calculate its K.E after falling a distance of 30m. ($g = 10 ms^{-2}$).
Total E $\Rightarrow$ Ep at 100m $= mgh = 8 \times 10 \times 100 = 8000\,J$
Ep at 30m $= mgh = 8 \times 10 \times 30 = 2400\,J$, $K.E = 8000 - 2400 = 5600\,J = 5.6\,kJ$

(23) A boy whose mass is 40kg runs up a flight of 30 steps, each 150mm high, in 6 sec. Find the average power developed. ($g = 10 ms^{-2}$).
$h = 30 \times \frac{150}{1000} = 4.5m$; av. power $= \frac{W.D}{t} = \frac{mgh}{t} = \frac{40 \times 10 \times 4.5}{6} = 300\,W$

(24) A man strikes a nail into a wooden block, with an average force of 200N. If he continues to strikes the nail with that force, estimate how much heat energy will be generated by the time the nail penetrates a depth of 0.05m.
$E = W.D = F \times s = 200 \times 0.05 = 10\,J$

(25) An engine raise 100kg of water through a height of 60m in 20s. What is the power of the engine? ($g = 10 ms^{-2}$).
$\text{power} = \frac{W.D}{t} = \frac{mgh}{t} = \frac{100 \times 10 \times 60}{20} = 3000\,W = 3\,kW$

(26) A body of mass 10kg and initially at rest is subjected to a force of 20N for a distance of 10m. Calculate the change in K.E of the body.
$K.E = W.D = F \times s = 20 \times 10 = 200\,J$

(27) A certain coil spring with an unstretched length of 1m requires a force of 5N to stretch it 0.1cm. What work is done in stretching it by 1cm if the elastic limit is still not exceeded.
Ans 0.25 J

(28) An engine pumps water from a river 10m below its own level and discharges it through a nozzle of diameter 10cm with a speed of 50 ms^{-1}. Find the power required assuming (a) no losses (b) 70% efficiency (Water weighs $10^3\,kg\,m^{-3}$, $g = 10\,m/s^2$).

(a) 39.5 kW (b) 27.65 kW.

Momentum, Impulse & collision

A body of mass 2kg undergoes a constant horizontal acc. of $5ms^{-2}$. Calculate the resultant horizontal force acting on the body. What will be the resultant force on the body when it moves with uniform velocity of $10 ms^{-1}$?

$F = ma = 2 \times 5 = 10\ N$; at uniform vel, $a = 0$, $F = 0$. (3)

(2) A car of mass 600kg, moving with a forward acc. of $5ms^{-2}$ is acted upon by a constant resistive force of 1000N. Calculate the force exerted from the engine to maintain this forward acc.

$R_f = F - 1000$; $F - 1000 = ma$; $F = ma + 1000 = (600 \times 5) + 1000 = 4000N = 4kN$

(3) A force of 10N acts for 20s. What is the change in momentum of the body?

$P = \text{Impulse} = Ft = 10 \times 20 = 200\ Ns$

(4) A body of mass 5kg moving with a speed of $30ms^{-1}$ is suddenly hit by another body moving in the same direction, thereby changing the speed of the former body to 60 m/s. What is the impulse received by the first body?

$\text{Impulse} = \Delta p = mv - mu = m(v-u) = 5(60-30) = 150\ Ns$

(5) A body of mass 5kg is to be given an acc. of 20m/s. Calculate the force required when the acc. is vertically upwards. ($g = 10m/s^2$).

$R_f = F - mg$ [weight act downwards]. $ma = 5 \times 20 = 100N$; $mg = 5 \times 10 = 50N$

$F - mg = ma$; $F = ma + mg = 100 + 50 = 150N$.

(6) A body of mass 4kg moving with a velocity of 10m/s collides with a stationary body of mass 6kg. If the bodies move together after the collision, Calculate their common velocity.

$m_1u_1 + m_2u_2 = (m_1+m_2)V$; $4 \times 10 + 0 = (4+6)V$; $V = \frac{40}{10} = 4\ m/s$

(7) Object A of mass 20kg moving with a velocity of 3m/s makes a head-on collision with object B, mass 10kg moving with a velocity of 2m/s in the opposite direction. If A and B stick together after collision, Calculate their common velocity V in the direction of A.

$m_Au_A + m_Bv_B = (m_A+m_B)V$; $20 \times 3 + 10(-2) = (20+10)V$; $V = \frac{40}{30} = \frac{4}{3}\ m/s$

Exercise

(8) A resultant force of 15.0N acts on a body for 4s mass 4 kg. Calculate the change in momentum of the body within this period.

$\Delta p = \text{Impulse} = Ft = 15 \times 4 = 60\ Ns$

(9) A ball of mass 100g falls from a height of 5m onto a floor and rebounds to a height of 3m. What energy is lost as a result of the impact on the floor?

$\text{Energy loss} = mgh - mgh_1 = (0.1 \times 10 \times 5) - (0.1 \times 10 \times 3) = 5\bar{j} - 3\bar{j} = 2\bar{j}$.

Ans $2\bar{j}$

(10) A body of mass 10kg, moving with velocity of 10m/s, hit a stationary body and had its direction reversed and velocity changed to 17.5 m/s in 5 sec. Calculate the force of impact.

$\Delta p = Ft = m(v-u) = 10(27.5-10) = 175$; $F = \frac{175}{5} = 35.0N$

(11) A motor car of mass 800kg travelling at 20m/s is brought to rest by brakes in 100m. Calculate the average braking force required.

$v^2 = u^2 + 2as$, $20^2 = 0^2 + 2a \times 100$; $a = \frac{400}{200} = 2m/s^2$; $F = ma = 800 \times 2 = 1600N$

(12) If a force of 6.0N acts on a body for 5 sec, what is the change in momentum?

$\Delta p = \text{Impulse} = Ft = 6 \times 5 = 30\ Ns$

(13) A bullet of mass 0.045kg is fired from a gun of mass 9kg, the bullet moving with an initial velocity of 200 m/s. Find the initial backward velocity of the gun.

p of bullet $= -p$ of gun ; $MV = -mv$; $V = \frac{-mv}{M} = \frac{-0.045 \times 200}{9} = +1m/s = 1m/s$

(14) A body of mass 2kg moving with velocity of 6m/s collides with a stationary object of mass 0.5kg. If the two bodies move together after the impact, Calculate their common velocity.

$m_1u_1 + m_2u_2 = (m_1+m_2)V$; $2 \times 6 + 0 = (2+0.5)V$; $V = \frac{12}{2.5} = 4.8\ m/s$

Solution by
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15. Calculate the force required to impact an acc. of $5ms^{-2}$ to a mass of 10kg.

$F = ma = 10 \times 5 = 50N$

16. What force would be required to accelerate an electron (mass of $e^- = 9 \times 10^{-31}$ kg) from rest to a velocity of 104 m/s in 10 sec? (4)

$F = ma = m \times \frac{v}{t} = 9 \times 10^{-31} \times \frac{104}{10} = 9.36 \times 10^{-30} N$

17. A block of weight 7.0N rest on a level floor. The frictional force between the block and the floor is 1.0N. A horizontal force of 1.4N is used to pull the block for 4 sec. What is the velocity of the block after this time?

$R_f = 1.4 - 1.0 = ma$; $0.4 = 0.7a$, $a = \frac{0.4}{0.7} = 0.57 m/s^2$; $V = at = 0.57 \times 4 = 2.3 m/s$

18. A player hits a ball of mass 0.3kg which was moving eastwards with a velocity of 10 m/s, causing it now to move with velocity 15 m/s westwards. The force of the blow acts on the ball for 0.01s. Calculate the average force exerted on the ball by the player.

$F = \frac{m(V-u)}{t} = \frac{0.3(15-10)}{0.01} = \frac{0.3 \times 5}{0.01} = 150N$

19. A body of mass 10 kg is pulled along a horizontal floor by a horizontal force of 48N with an acc. of 3.0 m/s. Calculate the frictional force btw the body and the floor.

$R_f = 48 - F_f = ma$; $F_f = 48 - ma = 48 - 10(3) = 48 - 30 = 18N$

20. A ball of mass 200g, travelling with velocity of 100 m/s, collides with another ball of mass 800g, moving at 50 m/s in the same direction. If they stick together, what will be their common velocity? $m_1u_1 + m_2u_2 = (m_1+m_2)V$; $0.2 \times 100 + 0.8 \times 50 = (0.2+0.8)V$; $V = 60 m/s$

21. A steel block, S, is placed on a concrete platform, B. The weight of the block is 5N. A steadily increasing force is applied horizontally to the block so that it just begins to move. If the coefficient of friction is 0.2, Calculate the minimum force required to move the block.

$F = \mu R = 0.2 \times 5 = 1.0N$

22. A rocket expels gas at the rate of $0.4 kgs^{-1}$. If the average force of the gas is 120N, Calculate the velocity of the gas. (kgs^{-1})

$F = ma = m \cdot \frac{v}{t} = \frac{m}{t} \cdot V$; $120 = 0.4V$; $V = \frac{120}{0.4} = 300 m/s$

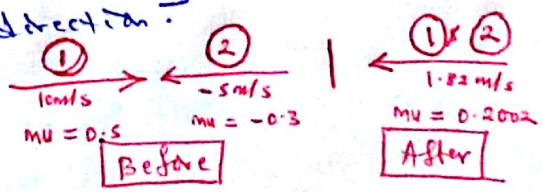
23. A player hits a ball of mass 0.24kg moving northwards with a velocity of 15 m/s, thereby causing it to move with a velocity of 20 m/s southwards. The force of the blow acts on the ball for 0.025s. Calculate the average force exerted on the ball by the player.

$F = \frac{m(v-u)}{t} = \frac{0.24(20-15)}{0.025} = \frac{0.24 \times 5}{0.025} = 48N$

24. A jet engine takes in 20 kg of air per second at 150 m. The air is compressed, heated and discharged at 500 m/s. What force is developed in the engine?

$Ft = mv$; $F \times 1 = 20 \times 500$; $F = 10,000N$

25. A ball of mass 50g travelling with a velocity of 10 m/s collides with another ball of mass 60g moving with 5 m/s in opposite direction. If they stick together, what will be their common velocity and in what direction.



$m_1u_1 + m_2u_2 = (m_1+m_2)V$

$0.05 \times 10 + 0.06(-5) = (0.05+0.06)V$

$0.5 - 0.3 = 0.11V$

$0.2 = 0.11$

$V = \frac{0.2}{0.11} = 1.82 m/s$ in the direction of the first ball

Some past Questions

~~What is the work done of a~~

1) A force of 100N acts for 20s. What is the change in momentum of the body

Δp = Impulse = ft = 100×20 = 2000 Ns

2) A gun fires a shell of mass 5kg in horizontal direction. The gun recoils at 0.4 m/s and it mass is 3 tons. Calculate the velocity of the shell.

p of shell = − p of gun ; $mv = -MV$; $5 \times v = 3000 \times 0.4$, $v = 240$ m/s

(shell) (gun)

3) A rifle bullet weighing 7g leaves the barrel of rifle with a velocity of 300m/s. If the rifle recoils with a velocity of 1m/s. find the mass of the rifle.

p of rifle = − p of bullet ; $MV = -mv$; $M \times 1 = 0.007 \times 300$, $M = 2.1$ kg

(rifle) (bullet)

4) A 1500 kg truck whose velocity is 60km/h overtakes a 4000kg truck moving in the same direction at 35km/h, Calculate their common velocity.

$m_1u_1 + m_2u_2 = (m_1+m_2)V$; $1500 \times 60 + 4000 \times 35 = (1500+4000)V$; $V = 42$ km/h

5) A 60g tennis ball moving at 8.0m/s hits a stationary trains racker perpendicularly and bounces off at 10 m/s. The impulse given to the racker is ?

(60m/s) (the) 3.12 Ns

Impulse = $ft = m(v-u) = 0.06(10-8) = 0.06 \times 2 = 0.12$ Ns

Phy 113 E-TEST Qns. solution by Dy'howner 2019

① What is the dimension for power

$$\text{Power} = \frac{\text{work done}}{\text{time}} = \frac{Fxs}{t} = \frac{kgms^{-2}\times m}{s} = kgm^2s^{-3} \Rightarrow ML^2T^{-3}$$ Ans ✓

② A force of 40N is applied to a 30kg load, what is the acceleration of the object

$F = 40N$, $m = 30kg$; $F = ma$, $a = \frac{F}{m} = \frac{40}{30} = \frac{4}{30} = 0.13\ m/s^2$ Ans ✓

③ A ball is thrown up vertically with a velocity of 40 m/s. Calculate the maximum height reached.

$$H = \frac{u^2}{2g} = \frac{40^2}{2\times10} = \frac{1600}{20} = 80m$$ Ans ✓

④ A ball thrown vertically upwards from ground level hit the ground after 4 sec. Calculate the maximum height it reached during its journey.

$$T = \frac{2u}{g}, \quad u = \frac{Tg}{2} = \frac{4\times10}{2} = 20\ m/s$$

$$H = \frac{u^2}{2g} = \frac{20^2}{2\times10} = \frac{400}{20} = 20m$$ Ans ✓

⑤ A projectile is fired at an angle of 60° with the horizontal with an initial velocity 80 m/s. Calculate the maximum height attained.

$$H = \frac{u^2\sin^2\theta}{2g} = \frac{80^2\sin^2 60}{2\times10} = \frac{6400\times0.866^2}{20} = 240m$$ Ans ✓

⑥ A body moving with a constant velocity along a straight line PQR takes 30s to go from P to Q and 10s to go from Q to R. If PR = 4m, find PQ.

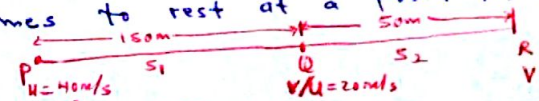
$$V = \frac{s}{t} = \frac{PR}{t_1+t_2} = \frac{4}{30+10} = \frac{4}{40} = 0.1\ m/s$$

$V = \frac{d_1}{t_1} \Rightarrow d_1 = PQ = Vt_1 = 0.1\times30 = 3m$ Ans ✓

⑦ An object moves in a straight line starting from rest. There are two stages in the journey, (a) it gains speed uniformly for 2.0s and attains a speed of 8.0 m/s. (b) it continues at this speed for a further 1.5 sec. Find the acc. in stage (b).

at constant speed / velocity, $a = 0$ Ans ✓

⑧ A particle moving in straight line with uniform deceleration has a velocity of 40 m/s at a point P, 20 m/s at a point Q and comes to rest at a point R, where QR = 50m. Calculate the distance PQ.



$u = 20m/s$, $V = 0$, $s_2 = 50$ [QR]

$\Rightarrow V^2 = u^2 - 2as_2$, $a = \frac{u^2-v^2}{2s_2} = \frac{20^2-0^2}{2\times50} = \frac{400}{100} = 4\ m/s^2$

$\Rightarrow V^2 = u^2 - 2as_1$, $s_1(PQ) = \frac{u^2-v^2}{2a} = \frac{40^2-20^2}{2\times4} = \frac{1600-400}{8} = \frac{1200}{8} = 150m$ Ans ✓

④ A motor car is uniformly retarded and brought to rest from a velocity 36 km/h in 5sec. Find its retardation.

$u = 36km/h = 10m/s$; $V = 0$, $t = 5s$

$V = u - at$, $a = \frac{u-v}{t} = \frac{10-0}{5} = 10/5 = 2\ m/s^2$ Ans ✓

⑩ A train slows from 108 km/h with a uniform retardation of 5 m/s² to 18 km/h. Calculate the distance covered.

$u = 108\ km/h = 30\ m/s$; $V = 18\ km/h = 5m/s$, $a = -5\ m/s$

$V^2 = u^2 + 2as$, $s = \frac{v^2-u^2}{2a} = \frac{5^2-30^2}{2\times-5} = \frac{+25-900}{-10} = \frac{-875}{-10} = 87.5m$ Ans ✓

⑪ A body moves with a velocity of 108 km/h in 6 sec. find its acceleration.

$t = 6s$; $V = 108\ km/h = 30\ m/s$; $a = \frac{v}{t} = \frac{30}{6} = 5\ m/s^2$ Ans ✓

⑫ An object of mass 0.4 kg moving with velocity 3000 m/s hit another object of mass 5 kg. What is the velocity of the second object.

$m_1u_1 = m_2u_2$; $0.4\times3000 = 5\times u$, $u = \frac{0.4\times3000}{5} = 240\ m/s$ Ans ✓

⑬ A car of mass 600kg moving with a forward acc. of 5 m/s² is acted upon by a constant resistive force of 1000N. Find the net force. Calculate the force exerted from the engine to maintain this forward acc.?

$F = ma = 600\times5 = 3000N$, $\Sigma F = F + f_r = 3000N + 1000N = 4KN$ Ans ✓

$F_r = 1000N$,

⑭ A car travels 20.0km due North and then 35.0km in direction 60° West of North. find the magnitude of the car's resultant displacement.

$R^2 = 20^2 + 35^2 + 2\times20\times35\cos60° = 2325$; $R = \sqrt{2325} = 48.2KM$ Ans ✓

⑮ An object of mass 50kg is moving with a uniform velocity of 10m/s. find the force on the object at uniform / constant velocity, $a = 0$; $F = ma = 50\times0 = 0$ Ans ✓

⑯ An object of mass 30kg is moving with a uniform velocity of 5 m/s. find the force on the object at uniform vel., $a = 0$, $f = 0$ Ans ✓

⑰ A car start from rest and travel to a distance 8m, with a speed of 2m/s. How long will the car move to reach 8m. $t = \frac{d}{s} = \frac{d_2-d_1}{s} = \frac{8-0}{2} = 4\ sec$ Ans ✓ (18) & (19) theory