FIRST YEAR HSE MARCH 2020

PHYSICS

1. (c) strong nuclear force
2. (a) 70m, +15m. $(S = x_2 - x_1)$
3. (c) Inertia
4. (d) Torque
5. (b) less than steel

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6. (a) ~~MLT~~ $[F] = [MLT^{-2}]$

   (b) $\frac{\Delta F}{F} \times 100\% = \left(\frac{\Delta M}{M} + 2\frac{\Delta V}{V} + \frac{\Delta r}{r}\right) \times 100\%$

7. statement (OR) If $F = 0$, $P = $ constant

8. (a) +ve (b) −ve (c) +ve (d) −ve

9. $\tau = I\alpha = RF\sin\theta$ | $\theta = 90$

$$\frac{MR^2}{2} \times \alpha = RF$$

$$\alpha = \frac{2RF}{MR^2}$$

$$= \frac{2 \times 25}{20 \times 0.2}$$

$$= 12.5 \text{ rad/s}^2$$

10. (a) Definition.

    (b) $V_e = \sqrt{\frac{2GM}{R}}$ independent of mass of object

11. Such I shaped beam provides large load bearing surface and high depth prevent bending. This shape also reduces weight of the beam without reducing the strength

12. $\frac{F_{car}}{F} = \frac{A_2}{A_1}$

$$\frac{M_{car}}{M} = \frac{A_2}{A_1} = \left(\frac{\pi r_2}{\pi r_1}\right)^2$$

$$= \left(\frac{15}{5}\right)^2$$

$$= 9$$

$$M = \frac{M_{car}}{9} = \frac{1350}{9}$$

$$= 150\text{ kg}$$

$$F = Mg = 150 \times 9.8$$

$$= 1470\text{ N}$$

13. * rising of liquid level inside a tube of small radius when diped in a liquid.
    * Surface tension

14. $y = \sin\omega t - \cos\omega t$

$$y = \sqrt{2}\left[\sin\omega t \cos\pi/4 - \cos\omega t \sin\pi/4\right]$$

$$y = \sqrt{2}\sin\left[\omega t - \pi/4\right]$$

is similar to the solution of SHM $y = A\sin(\omega t \pm \phi)$

15. $L = 12\text{ m}$

$m = 2.10\text{ kg}$

linear mass density

$$\mu = \frac{M}{L} = \frac{2.10}{12} = 0.175\text{ kg/m}$$

$$V = \sqrt{\frac{T}{\mu}} \Rightarrow T = \mu V^2$$

$$= 0.175 \times 343^2$$

$$= 20588.6\text{ N}$$

(16) $V = KA^2ut$

(a) principle of homogenity in dimension

(b) $[V] = [M^0L^3T^0]$

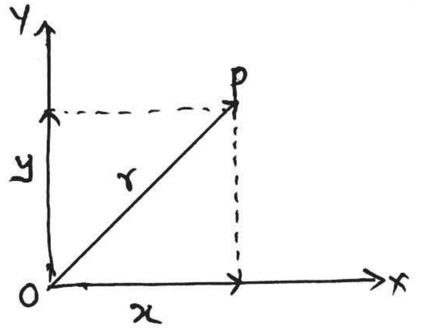
$[KA^2ut] = [L^2]^2[LT^{-1}][T]$

$= [L^5]$

$= [M^0L^5T^0]$

Equation is ~~dimensionally correct~~ wrong

(17) (a)



(b) $\vec{r} = x\hat{i} + y\hat{j}$

(c) $R = \sqrt{A^2+B^2+2AB\cos\theta}$

~~(18) (a) KE — A Total~~

(18) (a) PE — B

KE — C

Total Energy — A

(b) Derivation $PE = \frac{1}{2}kx^2$

~~Applied Force F =~~

Restoring force $F = -kx$

Applied force $F = +kx$

work done for displacement dx

$dw = F\,dx$

$= kx\,dx$

Total workdone

$w = \int_0^x kx\,dx$

$= k\left(\frac{x^2}{2}\right)_0^x$

$= \frac{1}{2}kx^2 = PE$

(19) (a) Heat engine

(b) (i) Isothermal expansion

(ii) Adiabatic "

(iii) Isothermal Compression

(iv) Adiabatic "

(20) $\alpha = \frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_2}$

$= \frac{T_2}{T_1 - T_2}$

$= \frac{282}{309 - 282}$

$= \frac{282}{27} = 10.44$

$T_2 = 9^\circ C$

$= 282$

$T_1 = 36^\circ$

$= 309$

(21) Pressure of gas,

$P = \frac{1}{3} n m \bar{v}^2$

$PV = \frac{1}{3} nV m\bar{v}^2$

$= \frac{1}{3} N m\bar{v}^2$

$= \frac{2}{3} N \times \frac{1}{2} m\bar{v}^2$

$= \frac{2}{3} KE$

Total Kinetic energy

$KE = N \times \frac{1}{2} m\bar{v}^2$

But $PV = \mu RT$

$\mu RT = \frac{2}{3} KE$

$KE = \frac{3}{2} \mu RT$

Av. Kinetic energy of single molecule

$\frac{KE}{N} = \frac{3}{2} \frac{\mu RT}{N} = \frac{3}{2} N_A RT$

$= 3$

$\overline{KE}_{molecule} = \frac{3}{2} K_B T$

KE molecule $\propto$ T

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	Vel	Acc^n	Force
a	0	-ve	-ve
b	-ve	0	0
c	-ve	+ve	+ve

(Hint) we can take $y = A\cos\omega t$

23 $y = 3.0\sin(36t + 0.018x + \pi/4)$ cm

$y = A\sin(\omega t + kx + \phi)$

(a) Travelling

(b) $A = 3.0$ cm

$\nu = \frac{\omega}{2\pi} = \frac{36}{2\pi} = 5.73$ Hz

(c) $\phi = +\pi/4$

(d) Least distance b/w successive crest is wavelength λ.

$k = \frac{2\pi}{\lambda} = 0.018\ cm^{-1}$

$\lambda = \frac{2\pi}{k} = \frac{2\pi}{0.018}$ cm

$= 348.9$ cm.

24 (a) 100 m/s.

(b) Distance $= \frac{1}{2}b_1h_1 + \frac{1}{2}b_2h_2$

$= \frac{1}{2}(10-0)\times 100 + \frac{1}{2}(20-10)\times 100$

$= 500 + 500$

$= 1000$ m

(c) a = slope

$= \frac{0-100}{10-0} = -10\ m/s^2$

25 (a) Derivation $H_{max} = \frac{u^2\sin^2\theta}{2g}$

(b) Range = Horizontal velocity × Time

$H = \frac{(u\sin\theta)^2}{2g}$ is same

$R = u_x \times T$

$= u\cos\theta \times \frac{2u\sin\theta}{g}$

$\Rightarrow R \propto u\cos\theta$

Range is max for 3

$\rightarrow u_x = u\cos\theta$ is max. for 3.

26 (a) Statement

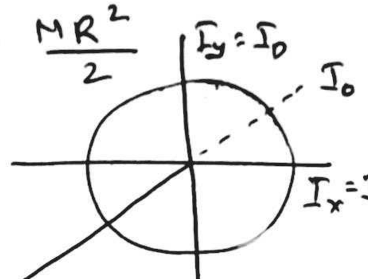
OR

figure, equation

for Disc, $I_z = I_x + I_y$

MI about its own axis,

$I_0 = \frac{MR^2}{2}$



Using ⊥r axis theorem,

$I_z = I_x + I_y$

$\frac{MR^2}{2} = I_D + I_D$

$= 2I_D$

$I_D = \frac{MR^2}{4}$

27 $F = 98.6°C$

$\frac{C}{100} = \frac{F-32}{180}$

$C = \frac{(98.6-32)\times 100}{180}$

$= 37°C$

(27) b Definition of latent heat or $Q = mL$

(c) Brass is a good conductor of heat and wood is a bad conductor

(28) (a) A $\rightarrow$ R, Normal reaction

B $\rightarrow$ weight of car

C $\rightarrow$ Centripetal force

D $\rightarrow f_s$ frictional force

(b) $R\cos\theta = mg + f_s\sin\theta$

$F_c = R\sin\theta + f_s\cos\theta$

$\frac{mv^2}{R} = R\sin\theta + f_s\cos\theta$

(c) Statement OR

$f_s^{max} \propto R$

$f_s^{max} = \mu_s R$

(29) (a) (I) g decreases with altitude

(II) g decreases with depth

(III) $TE = -\frac{GMm}{2r}$

$= -KE$

(IV) North-South direction

(b) Statement

OR

$T^2 \propto a^3$

(30) (a) Statement.

(b) Derivation,

$P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$

$P_1 + \frac{1}{2}\rho v_1^2 + \rho gh_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho gh_2$

(c) $F = 6\pi r\eta v$

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