Formulas A-level physics

Gravitational Fields

1. $F = \frac{GMm}{r^2}$

$T^2 = \frac{4\pi^2 r^3}{GM}$

$\frac{1}{2} m v_x^2 = \frac{1}{2} m v_y^2 - mgh$

2. $F_{centripital} = \frac{mv^2}{r} = mr\omega^2$

3. $acceleration_{centripital} = r\omega^2 = \frac{v^2}{r}$

4. angular velocity $(\omega) = \frac{\Delta\theta}{\Delta t} = \frac{2\pi}{T} = 2\pi f$ | if radios given $\boxed{\frac{2\pi r}{T}}$

5. gravitational field strength $= g = \frac{-GM}{r^2}$

6. Speed of object moving around planet

$$F_g = F_c$$

$$\frac{GMm}{r^{\cancel{2}}} = \frac{mv^2}{\cancel{r}}$$

$$\frac{GM}{r} = v^2$$

$$v = \sqrt{\frac{GM}{r}}$$

7. Gravitational potential Energy $= E_g = -\frac{GMm}{R}$

8. Gravitational potential $= \phi = \frac{-GM}{r}$ (J/kg)

9. Work done $= F \times dx \cos\theta$

10. $W = mg$

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⇒ Oscillations

1. frequency $= \frac{1}{T}$

2. $a = -\omega^2 x$

3. $x = x_0 \sin(\omega t)$

4. $v_0 = x_0 \omega$

5. $v_0 = \pm \omega \sqrt{x_0^2 - x^2}$

6. $F_{restoring} = -m\omega^2 x$

7. Potential Energy $= E_p = \frac{1}{2} m\omega^2 x^2$ | Kinetic Energy $E_k = \frac{1}{2} m\omega^2 (x_0^2 - x^2)$

8. $E_{tot} = E_k + E_p = \frac{1}{2} m\omega^2 x_0^2$

9. ϕ (phase difference) $= \frac{2\pi \Delta t}{T}$

⇒ Electric Fields

→ if graph below x axis it shows attractive force and vice versa.

1. Electric field strength $= \frac{F}{Q}$

2. $F = QE$

3. $E = \frac{V}{d}$ → parallel plates $\boxed{E = \frac{F}{q}}$

4. speed $(v) = \sqrt{\frac{2Vq}{m}}$

$W = \Delta V \times q$ | $W = F \times d$

6. $E_{isolated\ point} = \frac{Q}{4\pi \varepsilon_0 r^2}$

7. $V = \frac{Q}{4\pi \varepsilon_0 r}$ Electric Potential

8. $F = \frac{Q_1 Q_2}{4\pi \varepsilon_0 r^2}$

9. $E_{Potential} = \frac{Qq}{4\pi \varepsilon_0 r}$ = Energy

⇒ Temperature, Thermodynamics, Ideal Gases

Q

V

1. $Q = mc\Delta\theta$
2. $Q = ml$ (l_v or l_f)
3. $\Delta U = q + w$ (internal energy = thermal energy + work done)

$P\uparrow \quad \Delta U\uparrow \quad w\uparrow$

$V\downarrow \quad \Delta U\uparrow \quad w\uparrow$

$P\downarrow \quad \Delta U\downarrow \quad w\downarrow$

$V\uparrow \quad \Delta U\downarrow \quad w\downarrow$

4. avogadro's constant = 6.02×10^{23} mol
5. $P_1V_1 = P_2V_2$
6. $\dfrac{V_1}{T_1} = \dfrac{V_2}{T_2}$
7. $\dfrac{P_1}{T_1} = \dfrac{P_2}{T_2}$
8. $PV = nRT$ ($R = 8.3$)

Used when temp changes

$V = \text{og}V \times \dfrac{(\text{New temp})}{(\text{old temp})}$

$w = P\Delta V$ → dependent

$p = E \times T$

9. $n = \dfrac{N}{N_a}$, $pV = \dfrac{N}{N_a} \times R \times T$, $\dfrac{R}{N_a} = k$

$pV = NkT$ | $k = 1.38 \times 10^{-23}$

10. distance = $2L$

speed = c_x

time = $\dfrac{2L}{c_x}$

$mv - mu = mc_x - (-mc_x)$

$= 2mc_x$

$F = \dfrac{mv - mu}{t} = \dfrac{2mc_x}{2L/c_x} = \dfrac{2mc_x^2}{2L}$

$\boxed{F = \dfrac{mc_x^2}{L}}$

$P = \dfrac{F}{A} = \dfrac{mc_x^2}{L \times L^2} = \dfrac{mc_x^2}{L^3}$

$P = \dfrac{mc_x^2}{V}$ for one particle, $p = \dfrac{Nmc_x^2}{L}$ for N particles

→

$$C^2 = C_x^2 + C_y^2 + C_z^2$$

$$\langle C^2 \rangle = 3\langle C_x^2 \rangle$$

$$\frac{\langle C^2 \rangle}{3} = \langle C_x^2 \rangle$$

$$p = \frac{N m C_x^2}{V}$$

$$p = \frac{Nm}{V} \times \frac{\langle C^2 \rangle}{3} \qquad \frac{Nm}{V} = \rho$$

$$p = \frac{\rho}{3} \times \frac{\langle c^2 \rangle}{3}$$

$$p = \frac{1}{3} \frac{Nm\langle c^2 \rangle}{V}$$

$$\boxed{pV = \frac{1}{3} Nm\langle c^2 \rangle}$$

11. $pV = \frac{2}{3} \times \frac{1}{2} Nm\langle c^2 \rangle$

$$pV = \frac{2}{3} \times N \times \frac{1}{2} m\langle c^2 \rangle$$

$$pV = \frac{2}{3} \times N \times k.e \quad , \quad pV = nRT$$

$$nRT = \frac{2}{3} \times N \times k.e$$

$$\frac{3nRT}{2N} = k.e$$

$$\frac{3}{2} \times \frac{\cancel{N}}{\cancel{N} \times N_a} \times R \times T = k.e$$

$$\frac{3}{2} \times \frac{R}{N_a} \times T = k.e \quad , \quad \frac{R}{N_a} = k$$

$$\frac{3}{2} k \times T = k.e$$

$$\therefore \boxed{K_e = \frac{3}{2} kTN}$$

$$K_e = \frac{3}{2} kT$$

$$\frac{1}{2} m\langle c^2 \rangle = \frac{3}{2} kT$$

$$\langle c^2 \rangle = \frac{3kT}{m}$$

$$\boxed{\sqrt{\langle c^2 \rangle} = \sqrt{\frac{3kT}{m}}}$$

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⟹ Capacitance

1. Capacitance (C) : $\frac{Q \text{ (charge)}}{V \text{ (Voltage)}}$

2. Capacitance in series : $\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \ldots$

3. Capacitance in parallel : $C_p = C_1 + C_2 + C_3 \ldots$

4. $E_p = \frac{1}{2}\left(\frac{Q^2}{C}\right) = \frac{1}{2}CV^2 = \frac{1}{2}QV$

5. $Q = Q_0 e^{-t/CR}$

6. $I = I_0 e^{-t/CR}$

7. $V = V_0 e^{-t/CR}$

dis Charging

8. $V_c = V_0(1 - e^{-t/CR})$

9. $Q_c = Q_0(1 - e^{-t/CR})$

10. Current decreases as capacitor charges.

⟹ Quantum Physics

1. $E = \frac{hc}{\lambda} = hf$

2. $p = \frac{E}{c}$ (p → momentum)

3. $E_p = q \times V_s$

4. $hf = \frac{1}{2} m_e V_{max}^2 + \phi$, $\phi = hf_0$, f_0 : frequency when energy = 0

5. $hf = \frac{1}{2} m_e V_{max}^2 + hf_0$

6. $\lambda = \frac{h}{p}$ = de broglie wavelength

$p = mv$

$\boxed{\frac{p}{m} = v}$

7. $hf = E_2 - E_1$ (electron levels)

8. $\lambda = \frac{hc}{\Delta E}$ (electrons)

9. P/hf = number per unit time.
P = Intensity × Area | P = Power

⇒ Nuclear Physics

1. $E = mc^2$

2. $-\lambda N = \frac{dN}{dt}$

3. $A = \lambda N$

4. $N = N_0 e^{-\lambda t}$

5. $A = A_0 e^{-\lambda t}$

$\cancel{6.\ t_{\frac{1}{2}} = \ln \left[\frac{2}{-\lambda}\right]}$

6. $t_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$

7. $P = P_0 e^{-\lambda t}$ | $M = M_0 e^{-\lambda t}$

⇒ Medical Physics

1. $I = I_0 e^{-\mu x}$

2. $Z = \rho c$

3. $\frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2} = \frac{I_r}{I_0}$

if $Z_2 = Z_1$ ∴ $\frac{I_r}{I_0} = 0$

if Z_2 and Z_1 far then $\frac{I_r}{I_0} =$ nearly 1

⇒ Astrophysics

1. $F = \frac{L}{4\pi d^2}$ (F → radiant flux intensity, L → luminosity)

$\lambda_{max} = \frac{b}{T}$ (T → kelvin)

wein's displacement

2. $L = 4\pi\sigma r^2 T^4$

age of universe $= \frac{1}{H_0}$

3. $v = H_0 d$

velocity = Hubble's constant × distance

2.3×10^{-18}

4. $z = \frac{\lambda - \lambda_0}{\lambda_0} = \frac{v}{c}$ (v → speed, c → speed of light) $\frac{\Delta\lambda}{\lambda} = \frac{\Delta f}{f}$

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⇒ Magnetic Fields

1. $F = BIL \sin\theta$

2. $B = \dfrac{F}{IL \sin\theta}$

3. $I = \dfrac{nq}{t}$

4. $F = Bnqv \sin\theta$

5. $V_H = \dfrac{BI}{ntq}$

6. $I = Anqv$

7. magnetic flux $(\phi) = BAN$ (B = magnetic flux density)

8. induced EMF $= -N \dfrac{\Delta d\phi}{dt}$

9. $Emf = \dfrac{\Delta B A N}{\Delta t}$

10. $r = \dfrac{mv}{BQ}$

11. if it is a coil
$F = NBIL \sin\theta$

⇒ Alternating Current

1. $P = I_0^2 R \sin^2(\omega t)$

2. $\langle P \rangle = \dfrac{I_0^2 R}{2}$

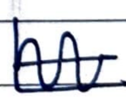
$\langle P \rangle = \dfrac{V_0^2}{2R}$

3. $I_{rms} = \sqrt{\langle I^2 \rangle}$
$= \dfrac{I_0}{\sqrt{2}} = 0.707 I_0$

4. $V_{rms} = \sqrt{\langle V^2 \rangle}$
$= \dfrac{V_0}{\sqrt{2}} = 0.707 V_0$

5. $V = V_0 \sin(\omega t)$

6. if graph is curved
$V_{rms} = \dfrac{V_0}{\sqrt{2}}$



if graph is square
$V_{rms} = V_0$