300 PHYSICS FORMULAS

Measurements

1. $\theta = s/r$
2. 2π rad $= 360^0$
3. $360^0 = 1$ revolution
4. 1 radian $= 57.3^0$
5. 1 degree = 60 minute
6. 1 minute = 60 seconds
7. Angle at circle is 2π radian.
8. Angle at sphere is 4π steradian.
9. Volume of slid cylinder $= \pi r^2 l$
10. Area of sphere $= 4\pi r^2$
11. Volume of sphere $= 4/3\ \pi r^3$

Vectors and equilibrium

12. Commutative property of vector= A+B = B+A
13. $F_x = F\cos\theta$
14. $F_y = F\sin\theta$
15. $F = \sqrt{Fx^2 - Fy^2}$
16. $A.B = AB\cos\theta$
17. $A \times B = AB\sin\theta$
18. Scalar product; work and power
19. Vector product; torque
20. $\tau = r \times F$
21. First condition of equilibrium; $\sum F = 0$
22. Second condition of equilibrium; $\sum \tau = 0$

Motion and Force

23. $v = s/t$

24. $a = v/t$
25. $v_f = v_i + at$
26. $s = v_i t + \frac{1}{2} at^2$
27. $2as = v_f^2 - v_i^2$
28. $S = v_{ave} \times t$
29. $V_{ave} = (v_i + v_f)/2$
30. $g = 9.8\ ms^{-2} = 32\ ft^{-2}$
31. $F = ma$
32. $a = v/t$
33. $P = mv$
34. $P = F t$
35. Impulse; $J = F \times t = \Delta P$
36. $J = \Delta P$
37. Law of conservation of momentum; $\Delta p = 0$
38. Elastic collision in one dimension; $[v_1 + v_2] = [v_1' + v_2']$
39. Magnitude of projectile velocity; $V_f = \sqrt{v_{fx}^2 + v_{fy}^2}$
40. Height of projectile; $H = v_i^2 \sin^2\theta/2g$
41. Time of flight; $T = 2\ v_i \sin\theta/g$
42. Time of summit or time to reach to highest point; $T = v_i \sin\theta/g$
43. Range; $R = v_i^2 \sin 2\theta/g$
44. $R_{max} = v_i^2/g$
45. $R = R_{max}$ at 45^0

Work and Energy

46. $W = Fd \cos\theta$
47. Power; $p=W/t$ or $p = Fv$
48. $1\ watt = Js^{-1}$
49. $1\ hp = 746\ watts$
50. $K.E = \frac{1}{2} mv^2$
51. $P.E = mgh$
52. Efficiency = output/input = W x D/P x d

53. Absolute potential energy =Fr = - GmM_e/R_e (- because work is done against gravity)
54. Gravitational potential = E/m = GM_e/R_e
55. For escape velocity compare K.E with Absolute potential energy; $v_{esc} = \sqrt{\frac{2GM_e}{r_e}} \rightarrow v_{esc} = \sqrt{2gr_e}$
56. $G = 6.67 \times 10^{-11}\ Nm^2kg^{-2}$
57. $R_e = 6.4 \times 10^6$ m
58. $M_e = 6 \times 10^{24}$ kg
59. $V_{esc} = 11.2 \times 10^3\ ms^{-1}$
60. Wh = K.E + fh → (Wh = loss in potential energy)
61. Loss in P.E = Gain inn K.E + work done against friction

62. $E = mc^2 \rightarrow (c = 3 \times 10^8\ ms^{-1})$
63. Rotational and circular motion
64. Angular velocity; $\omega = \Delta\theta/\Delta t$
65. Angular acceleration; $\alpha = \Delta\omega/\Delta t \rightarrow a = \alpha \times r$
66. $v = r\omega$

67. $F_c = mv^2/r$
68. $a_c = -(v^2/r)$
69. Centrifugal force= mv^2/r
70. $F \sin\theta = mv^2/r$
71. $F \cos\theta = mg$
72. $\text{Tan}\ \theta = v^2/gr$
73. Torque = $r\ F = rma = rm\ (r\alpha) = (r^2m)\alpha = I\ \alpha$
74. Moment of inertia; $I = mr^2$
75. Ring or thin walled cylinder inertia(I) = MR^2
76. Disc or solid cylinder inertia = $\frac{1}{2}\ MR^2$
77. Disc inertia = $\frac{1}{2}\ M\ (R_2^2 + R_1^2)$
78. Solid sphere inertia = $2/5\ MR^2$
79. Solid rod or meter stick inertia = $1/12\ Ml^2$
80. Rectangular plate inertia = $1/12\ M\ (a^2+b^2)$
81. Angular momentum = L = r x p = r mv = $rmr\omega = r^2m\omega = I\omega$
82. $L = rmv \rightarrow L/t = rmv/t = rma = rF = \tau$
83. $L/t = \tau$
84. Linear kinetic energy = $\frac{1}{2}\ mv^2$
85. Rotational kinetic energy = $\frac{1}{2}\ I\omega^2$
86. Velocity of hoop = $v = \sqrt{gh}$
87. Velocity of disc = $v = \sqrt{\frac{4}{3}gh}$
88. Critical velocity = $v = 7.9\ km^2$
89. The orbital velocity = $v = \sqrt{\frac{GM_e}{r}}$
90. Lift at rest $\rightarrow$ T =w
91. Lift moving downward $\rightarrow$ T = w – ma
92. Lift moving upward $\rightarrow$ T = w + ma
93. Lift falling freely = T mg-ma = 0
94. Frequency for artificial satellite $\rightarrow$ $f = \frac{1}{2\pi}\sqrt{\frac{g}{r}}$

Fluid dynamics

95. Drag force → $F_d = 6\pi\eta r v$

96. Terminal velocity → $v_t = \frac{2\rho g r^2}{9\eta}$

97. Continuity equation → $A_1 v_1 = A_2 v_2$

98. $Av = \Delta V/\Delta t$ = constant

99. $\Delta m/\Delta t = \rho \Delta V/\Delta t$

100. Bernoulli's Equation = $P + \frac{1}{2}\rho v^2 + \rho gh$ = constant

101. Torricelli's Theorem → $v = \sqrt{2gh}$

102. Flow meter or the venture meter → $v_1 = \sqrt{\frac{2gh}{\frac{A_1^2}{A_2^2} - 1}}$

Oscillation

103. Frequency → $f = 1/T$

104. Angular frequency → $\omega = 2\pi f$

105. Time period → $T = 2\pi/\omega$

106. Velocity of projection → $v_y = \omega\sqrt{r^2 - x^2}$

107. Simple pendulum time period → $T = 2\pi\sqrt{\frac{L}{g}}$

108. Simple pendulum potential energy = $\frac{1}{2} kx^2$

109. Simple pendulum kinetic energy = $\frac{1}{2} kx_0^2 - \frac{1}{2} kx^2$

110. Total energy of simple pendulum = $\frac{1}{2} kx_0^2$

111. Resonance frequency = $F_n = nf_1$

112. Phase → $\theta = \omega t$

113. Waves

114. Transverse wave speed → $v = \frac{\sqrt{T \times L}}{M}$ or $v = \frac{\sqrt{T}}{m}$

115. Longitudinal waves speed → $v = \frac{\sqrt{E}}{\rho}$

116. Phase change → $2\pi = \lambda$

117. Phase difference → $\delta = 2\pi/\lambda$

118. Speed of sound by newton → $v = \sqrt{\frac{\rho_m gh}{\rho}} = 281\ ms^{-1}$

119. Laplace correction → $v = \sqrt{\frac{\gamma\rho_m gh}{\rho}} = 332\ ms^{-1}$

120. $1\ e = 1.602 \times 10^{-19}\ C$

121. $Q = ne$

122. Coulomb's Law; $F = k\frac{q1\ q2}{r2}$

123. $K = \frac{1}{4\pi\varepsilon o}$

124. $K = 9.0 \times 10^{9}\ N\ m^2\ C^{-2}$

125. $\varepsilon_o = 8.85 \times 10^{-12} C^2\ N^{-1}\ m^{-2}$

126. $\varepsilon_r = \frac{\varepsilon}{\varepsilon 0}$

127. $F_{med} = \frac{F\ vac}{\varepsilon r}$

128. $E = \frac{F}{q} = \frac{V}{d} = K\frac{q}{r2}$

129. $\Phi = E\ A \cos\theta = N\ m^2\ C^{-1}$

130. $\Phi = \frac{Q}{\varepsilon 0}$

131. E due to sheet of charge; $E = \frac{\sigma}{2\varepsilon}$

132. E due to charge palates; $E = \frac{\sigma}{\varepsilon}$

133. $V = \frac{W}{Q} = \frac{U}{Q}$ Volt = Joule / Coulomb

134. Electric potential energy; $U = K\frac{Qq}{r}$

135. Electric potential; $V = \frac{W}{Q} = \frac{Fr}{Q} = K\frac{Q}{r}$

136. Potential Gradient = $E = -\frac{\Delta V}{\Delta r}$

137. $1\ eV = 1.602 \times 10^{-19}\ C \times 1V \rightarrow (1\ eV = 1.602 \times 10^{-19}\ J)$

138. $C = \frac{Q}{V} = C\ V^{-1} = farad$

139. Charge density; $\sigma = \frac{Q}{A}$

140. $C_{vac} = \frac{Q}{V} = \frac{\varepsilon 0\ A}{d} = \frac{\varepsilon 0\ \varepsilon r\ A}{d}$

141. $\varepsilon_r = C_{med} / V_{vac}$

143. Capacitors In Series;

144. $Q = Q1 = Q2 = Q3$

145. $V = V1 + V2 + V3$

146. $1/Ce = 1/C1 + 1/C2 + 1/C3$

147. Capacitors In Parallel;

148. $Q = Q1 = Q2 = Q3$

149. $V = V1 + V2 + V3,$

150. $Ce = C1 + C2 + C3$

151. Electric dipole; $P = q\ d$

152. Energy = $U = \frac{UV}{2} = \frac{CV2}{2} = \frac{1}{2}\frac{A\ \varepsilon 0\ \varepsilon r}{d}(Ed)^2$

153. Energy density; $\mu = \frac{U}{Ad} = \frac{1}{2}\varepsilon o\ \varepsilon r\ E^2$

154. Maximum charge on capacitor = C x e.m.f

155. $q/q_0 = 63.2\ \%$ →for charging

156. $q/q_0 = 36.7\ \%$ →for discharging

157. $q = q_0\ (1-e^{-t/RC})$ →for charging

158. $q = q_0\ e^{-t/RC}$ →for discharging

CURRENT ELECTRICITY

159. Current, $I = Q/t \rightarrow C\ s^{-1} = A$

160. Drift velocity order = 10^{-5} m/s.

161. $V = IR$

162. $Tan\ \theta = I/V = 1/R$

163. Resistance, $R = V/I \rightarrow 1\Omega = 1V/1A$
164. $R = \rho\, L/A \rightarrow \Omega.m$
165. Conductance, $G = 1/R \rightarrow$ Siemen(S) or mho
166. Conductivity, $\sigma = 1/\rho = L/RA \rightarrow$ mho/m or S/m
167. Pure metals R inc with T inc.
168. Electrolytes and insulators, R dec with T inc.
169. $\Delta R = \alpha R_0 T \rightarrow R_T = R_0(1+\alpha T)$
170. Temperature co-efficient of Resistance, $\alpha = R_T - R_0/R_0T \rightarrow K^{-1}$
171. Resistivity, $\rho_T = \rho_0(1+\alpha T)$ OR $\alpha = \rho_T - \rho_0/\rho_0 T \rightarrow K^{-1}$
172. Electromotive Force, $\varepsilon = W/q \rightarrow 1$ volt = 1 joule/coulomb
173. Open circuit, $I = 0$ so $V = \varepsilon$
174. Terminal Voltage, $V_t = \varepsilon - Ir$
175. Power, $P = W/t = VI$
176. $\rightarrow$ 1 Watt = 1V x 1A
177. 1 kWh = 1 unit of electrical energy
178. 1 J = 1W x 1s
179. Maximum output power, $(P_{out})_{max} = \varepsilon^2/4r = \varepsilon^2/4R$
180. Thermo emf, $\varepsilon = \alpha T + \frac{1}{2}\beta T^2$
181. KCL, $\Sigma I = 0$
182. KVL, $\Sigma\varepsilon = \Sigma V = \Sigma IR$
183. KCL based on L.O.C.O.CHARGE
184. KVL based on L.O.C.O.ENERGY
185. Wheatstone Bridge, $X = PQ/R$
186. Potentiometer, $\varepsilon_2/\varepsilon_1 = I_2/I_1$
187. $\tan\theta = I/V = 1/R$

ELECTROMAGNETISM

188. Force on current carrying wire, $F = BIL \sin\theta$.
189. Magnetic field or magnetic induction, $B = F/IL \rightarrow 1$ tesla $= 1\ NA^{-1}\ m^{-1} = 1\ Wb\ m^{-2}$
190. $1\ T = 10^4\ G$

191. Magnetic Flux, $\Phi = B\,A\cos\theta \rightarrow 1\ Wb = 1\ N\ m\ A^{-1}$.

192. Ampere's Law, $B \propto I/r = \mu_0 (I/2\pi r)$ OR $\Sigma B.\Delta L = \mu_0 I$

193. $B_{net} = B_1 + B_2$

194. Magnetic field due to current carrying solenoid, $B = \mu_0 n I \rightarrow n=N/L$

195. Motion of charge particle in uniform magnetic field, $F=q\,v\,B\sin\theta$

196. Centripetal Force = Magnetic force $\rightarrow mv^2/r = qvB$

197. Time period of charge particle in B, $T = 2\pi m/qB$

198. Frequency of charge particle in B, $f = qB/2\pi m$

199. Velocity selector, $F_E = F_M \rightarrow qE = qvB \rightarrow v = E/B$

200. Torque on current carrying coil, $\tau = NBIA\cos\theta$

201. Pestoring torque, $\tau = C\,\theta$

202. Galvanometer, $NBIA\cos\theta = C\,\theta \rightarrow I = C\theta/NAB \rightarrow I \propto \theta$

203. galvanometer into ammeter, small R connected in parallel

204. galvanometer into voltmeter, large R in series are connected

205.

206. Ammeter, $R_s = R_g I_g / (I - I_g)$ → Ideal ammeter → 0 R

207. Voltmeter, $R_h = (V/I_g) - R_g$ → Ideal voltmeter → infinite R

ELECTROMAGNETIC INDUCTION

208. Faraday's Law, $\varepsilon \propto N (\Delta\Phi/\Delta t)$ → $\varepsilon = N (\Delta\Phi/\Delta t)$

209. Lenz Law, $\varepsilon = -N (\Delta\Phi/\Delta t)$

210. Flux motional emf, $\varepsilon = Blv \sin\theta$

211. Rate of work done, $W = Bilv$

212. Rate of production of electrical energy, energy $= \varepsilon I$

213. W = energy → $Bilv = \varepsilon I$ → $\varepsilon = Blv$

214. Power, $P = F v$

215. $\varepsilon = L \Delta I/\Delta t$ or $\varepsilon = N \Delta\Phi/\Delta t$ → $LI = N\Phi$

216. Self-Inductance, $L = N\Phi / I$

217. $\varepsilon = M \Delta I/\Delta t$ or $\varepsilon = N \Delta\Phi/\Delta t$ → $MI = N\Phi$

218. Mutually inductance, $M = N\Phi / I$

219. $F = 1/T$

220. Induced emf, $\varepsilon = NAB \cos\omega t$ or $NAB\,\omega \sin\omega t$

221. $\varepsilon = \varepsilon_{max} \sin \omega t$

222. Back emf, $V = \varepsilon + IR$

223. $N_s / N_p = V_s / V_p = I_p / I_s$

PHYSICS OF SOLIDS

224. Elastic modulus $= \frac{Stress}{Strain}$

225. Tensile stress $= \frac{F}{A}$

226. Tensile strain $= \frac{\Delta L}{L}$

227. Young modulus $= \frac{\frac{F}{A}}{\frac{\Delta L}{L}} = Nm^{-2}$

228. Shear stress $= \frac{F}{A}$

229. Shear strain $= \frac{\Delta x}{y} = \tan\theta$

230. Shear modulus = rigidity modulus $= \frac{\frac{F}{A}}{\frac{\Delta x}{y}} = \frac{F}{A\theta}$

231. Bulk or volume stress $= \frac{F}{A}$

232. Bulk modulus (in fluids) $= \Delta p = \frac{F}{A}$

233. Volume strain $= -\frac{\Delta V}{V}$

234. Bulk modulus $= \frac{\frac{F}{A}}{-\frac{\Delta V}{V}} = \frac{\Delta p}{-\frac{\Delta V}{V}}$

235. Stress $\propto$ strain (Hook's law)

236. $A = \pi r^2$

237. $W = \frac{1}{2}Fe$ (work done on stretching wire).

238. Strain energy $= \frac{1}{2} F e$

239. Strain energy per unit volume $= \frac{1}{2}\frac{F x e}{A x l} = \frac{1}{2}$ (stress) (strain)

DAWN OF MODERN PHYSICS

240. $E = m_0 c^2$

241. $L = L_0 \sqrt{\frac{1=v2}{c2}}$

242. $T = t_0 \sqrt{\frac{1=v2}{c2}}$

243. $M = m_0 \sqrt{\frac{1=v2}{c2}}$

244. $\lambda_{max} T = 0.2898 \times 10^{-2}$ m k (Wein's displacement law)

245. $E = \sigma T^4$ (Steffan-Bolts Law)

246. $\sigma = 5.67 \times 10^{-8} Wm^{-1} K^{-4}$

247. $E = n h f$

248. $K.E_{max} = e V_0$

249. $K.E_{max} = h f - \Phi$

250. $H f_0 = \Phi = \frac{hc}{\lambda}$

251. $K.E_{max} = hf - Hf_0$

252. $Hf = K.E + hf'$

253. $P = \frac{E}{c}$

254. $\Delta\lambda = \frac{E}{m0\ c} 1\text{-}\cos\theta$

255. $\frac{1}{f'} = \frac{1}{f} + \frac{E}{m0\ c} 1\text{-}\cos\theta$

256. $E_{photon} = E_{electron} + E_{positron}$

257. Photon rest mass energy $= 2m_0c^2 = 1.02$ MeV

258. $\frac{h}{fc} = mv_{e-} + mv_{e+}$

259. $\lambda = \frac{h}{p} = \frac{h}{mv}$

260. $\Delta p = \frac{h}{\lambda}$

261. $\Delta x = \lambda$

262. $(\Delta p)(\Delta x) = h$

263. $(\Delta E)(\Delta t) = h$

ATOMIC SPECTRA

264. $\frac{1}{\lambda} = R \left(\frac{1}{P2} - \frac{1}{n2} \right)$

265. $R = E_0 / hc = 1.097 \times 10^7 m^{-1}$.

266. $mvr = nh/2\pi$.

267. h = planks constant = 6.6256×10^{-34} j s.

268. $E = hf = E_n - E_p$

269. $r_n = \frac{n2\ h2}{4\ \pi\ k\ m\ e2}$

270. $E_n = -\frac{2\ \pi2\ \ 2\ k\ m\ e4}{n2\ h2}$

271. $E_n = -\frac{E0}{n2} = 2.17 \times 10^{-18}$ j/ $n^2 = +13.6$ ev/ n^2

272. $r_n = n^2 r_1 \rightarrow r_1 = 0.53\ ^0A$.

273. $1\ ^0A = 10^-$ m

274. $2\pi r = n\lambda$

275. $eV \rightarrow hf_{max} = hc/\lambda_{min}$

276. $\lambda_{min} = hc/eV$

277. excited state for 10^{-8} s.

278. metastable state for 10^{-3} s

NUCLEAR PHYSICS

279. Nuclear size is of the order of 10^{-14} m.

280. The mass of the nucleus is of the order of 10^{-27} kg.

281. $\frac{1}{2} mv^2 = Vq$
282. $Bqv = mv^2/r$
283. $Bqv = mv^2/r$
284. $m = Bqr/v$
285. $\frac{1}{2} mv^2 = Vq$
286. $v^2 = 2Vq/m$
287. So $m = qr^2B^2/2V$
288. $\Delta m = Zm_p + Nm_n - M_{(A,Z)}$
289. The binding energy in MeV is 931 x Δm.
290. The binding energy per nucleon = E_b/A.
291. ${}_0n^1 \rightarrow {}_1H^1 + {}_{-1}\beta^0$ + antineutrino 12 MIN
292. $\Delta N/\Delta t = -\lambda N$
293. $R = -\Delta N/\Delta t = \lambda N$
294. $N = N_0e^{-\lambda t}$
295. 1 Bq = 1 decay per second
296. 1 Ci = 3.70 x 10^{10} decay/s
297. $\lambda T \frac{1}{2} = 0.693$
298. The charge on u,t and c, in term of electron is +2/3e.
299. The charge on s,t and b in term of electron is -1/3e.
300. proton =2U→D.
301. neutron =U ←2D