2018年大学物理阶段二答案

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选择题

1. C

相对论情境下对于任何参考系都有动量守恒成立,但请注意牛顿第三定理可能会失效。

2.B

长度收缩只会发生在运动方向上,而不会发生在垂直于运动方向的方向上。 实际角度为:

$$\arctan\sqrt{\frac{3}{1-\beta^2}} > \frac{\pi}{3}$$

3. C

$$au=\sqrt{1-eta^2}t \ t=5 \quad year; au=3 \quad year \ eta=0.8$$

4. A

$$M=rac{2m_0}{\sqrt{1-eta^2}}$$
 $m_0=rac{M}{2}\cdot\sqrt{1-eta^2}$ $=rac{\mu}{2}\cdotrac{3}{5}=0.3m_0$

5. B

$$egin{aligned} 5. \ W &= \Delta E = \left[rac{m_0}{\sqrt{1-eta^2}} - m_0
ight]c^2 \ &= 0.25 \mathrm{m}_0 c^2 \end{aligned}$$

7. D

$$egin{align} arphi_M &= \int_M^P rac{q\hat{r}}{4\piarepsilon_0 r^2} dr \ &= rac{q}{4\piarepsilon_0 r}igg|_a^{2a} \ &= -rac{1}{4\piarepsilon_0 2a} \end{split}$$

8. A

9. B

$$C=C_1+C_2$$
 $C_1=arepsilon_rC_2$ $q_1=arepsilon_rq_2$ $q_2=rac{1}{1+arepsilon_r}Q<rac{1}{2}Q$ σ 刻 $<\sigma$ 表 E 表 η

10. D

填空题

1. *c*

 $2.8.89 \times 10^{-8} \mathrm{\ s}$

$$\Delta \tau = \sqrt{1 - \beta^2 \Delta t} = \sqrt{1 - \beta^2} \frac{20 \text{ m}}{0.6c} = \frac{4}{5} \times \frac{20 \text{ m}}{0.6c}$$

$$=\frac{80 \text{ m}}{3c} \approx 8.89 \times 10^{-8} \text{ s}$$

1.
$$(n-1)M_0C^2$$

$$egin{aligned} rac{ au}{t} &= \sqrt{1-eta^2} = rac{1}{n} \ E_k &= mc^2 - M_0c^2 \ &= rac{1-\sqrt{1-eta^2}}{\sqrt{1-eta^2}} \cdot rac{1}{m_0c^2} = \ &= (n-1)M_0C^2 \end{aligned}$$

4. $7.5 \times 10^{-9} \text{ s}$

$$t = \frac{3m}{0.8c} \quad \beta = \frac{0.8c}{c} = 0.8$$

$$au = \sqrt{1 - \beta^2} \cdot \frac{3M}{0.8C}$$

$$= \frac{9 \text{ m}}{4c} = 7.5 \times 10^{-9} \text{ s}$$

5. $\frac{\sqrt{3}}{2}c$

$$mV = 2m_0 V \quad rac{m_0}{\sqrt{1-eta^2}} = 2m_0 \quad eta^2 = rac{3}{4} \quad eta = rac{\sqrt{3}}{2} \quad V = rac{\sqrt{3}}{2} c$$

6.4 V

$$U_{OA} = \int_0^A ec{E} \cdot dx = \int_0^2 2x dx = 4 ext{ V}$$

7.

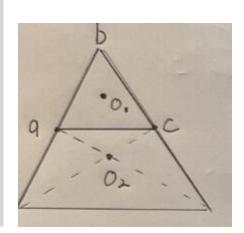
$$rac{q}{4\piarepsilon_0 r^2}; \quad arphi_A = arphi_B = rac{q}{4\piarepsilon_0 r_C}$$

8.

$$\frac{2}{3}u_1;u_2-\frac{1}{3}u_1$$

考虑如图所示对称性:

$$egin{aligned} arphi_1, arphi_2; arphi_1 &= 2arphi_2 \ u_1 &= 3arphi_1 \ u_2 &= arphi_1 + 2arphi_2 \ u_1' &= 2arphi_1 &= rac{2}{3}u_1 \ u_2' &= 2arphi_2 &= u_2 - rac{1}{3}u_1 \end{aligned}$$



9. $\varepsilon_r; \varepsilon_r$

(1).

$$c' = arepsilon_r c \ rac{c'}{c} = arepsilon_r$$

(2.1)

$$rac{arepsilon_0}{2}\int DE d au = arepsilon_r rac{arepsilon_0}{2}\int E^2 d au$$

(2.2):

$$\frac{1}{2}c'u^2 = \varepsilon_r \frac{1}{2}cu^2$$

10.
$$ec{D}=arepsilon_0arepsilon_rec{E}$$

解答题

1.

$$(m-m_0) c^2 = qV$$

$$m=m_0+rac{q~ ext{V}}{c^2}=\ pprox 2.69 imes 10^{-30}~ ext{kg}$$

$$m=rac{m_0}{\sqrt{1-eta^2}}$$
 $1-eta^2=\left(rac{m_0}{m}
ight)^2$ $eta=\sqrt{1-\left(rac{m_0}{m}
ight)^2}$

$$V = 0.94 {\rm c} = 2.82 \times 10^8 \; {\rm m/s}$$

2. (1).

$$au = rac{L_0\sqrt{1-eta^2}}{V_0} = rac{rac{3}{5} imes 90~ ext{m}}{0.8 ext{C}} = rac{45~ ext{m}}{2 ext{C}}rac{135~ ext{m}}{2 ext{c}} = 2.25 imes 10^{-7}~ ext{S}$$
 $= 0.225\mu ext{s}$

(2).

$$t = rac{ au}{\sqrt{1-eta^2}} = rac{5}{3} au = 3.75 imes 10^{-7}~{
m S} = 0.375 \mu{
m S}$$

或

$$t = rac{L_0}{V_0} = rac{90 ext{ m}}{0.80} pprox 3.75 imes 10^{-7} ext{ s}$$

3. (1)

$$D \cdot 2\pi r \cdot L = \lambda \cdot L$$

$$D = \frac{\lambda}{2\pi r}$$

$$E = rac{D}{arepsilon_0 arepsilon_r} = rac{\lambda}{2\pi arepsilon_0 arepsilon_r r}$$

(2).

$$C = \frac{Q}{U}$$

$$Q = \lambda L$$

$$U = \int_{R_1}^{R_2} E \cdot dr = rac{\lambda}{2\piarepsilon_0 arepsilon r} \ln rac{R_2}{R_1}$$

$$C = rac{\lambda L_2 \pi arepsilon_0 arepsilon_r}{\lambda \ln rac{R_2}{R_1}} = rac{2\pi arepsilon_0 arepsilon_r L}{\ln rac{R_2}{R_1}}$$

4.(1).

$$E = \left\{ egin{array}{ll} 0 & r < R \ & \ & \ rac{q\hat{r}}{4\piarepsilon_0 r^2} & r > R \end{array}
ight.$$

(2).

$$F=\int_{r_0}^{r_0+L}rac{q\cdot(\lambda dr)}{4\piarepsilon_0r^{-2}}\hat{r}dr$$

$$=rac{q\lambda}{4\piarepsilon_0}\left(rac{1}{r_0}-rac{1}{r_0+L}
ight)\hat{r}$$

$$U=\int_{r_0}^{r_0+L}rac{q(\lambda dr)}{4\piarepsilon_0 r}dr$$

$$=rac{q\lambda}{4\piarepsilon_0}\lnrac{r_0+L}{r_0}$$