2019-2020 学年夏 春季 学期《大学物理甲 1》期末考试试卷参考答案 A

一、填空题：（每题 4 分，2 个空格的题每个空格给 2 分，共 48 分）

1. $\int_{v_0}^{v} \mathrm{d}v = \int_0^t a\mathrm{d}t = \int_0^t (A + Bt^2)\mathrm{d}t$， $v = v_0 + At + \frac{1}{3}Bt^3$，

$\int_{x_0}^{x} \mathrm{d}x = \int_0^t v\mathrm{d}t = \int_0^t (v_0 + At + \frac{1}{3}Bt^3)\mathrm{d}t$， $x = x_0 + v_0 t + \frac{1}{2}At^2 + \frac{1}{12}Bt^4$

2. $\int_0^t F\mathrm{d}t = \int_0^5 5m(5-2t)\mathrm{d}t = mv - 0$， $v = \int_0^5 (25-10t)\mathrm{d}t = 25t - 5\times t^2 \Big|_0^5 = 0\ (\mathrm{m/s})$

3. $\Delta E_p = -G\frac{mM}{R_2} - (-G\frac{mM}{R_1}) = GmM\frac{(R_2 - R_1)}{R_2 R_1}$， $\Delta E_k = -\Delta E_p = GMm\frac{(R_1 - R_2)}{R_1 R_2}$

4. $mvr - m(v_0 - v)r = 0$， $v = \frac{v_0}{2}$

5. $\Delta t' = \frac{\Delta t}{\sqrt{1-u^2/c^2}}$， $u = c\sqrt{1-(\frac{\Delta t}{\Delta t'})^2} = \frac{\sqrt{3}}{2}c$， $\Delta x' = \frac{\Delta x - u\Delta t}{\sqrt{1-u^2/c^2}} = -\sqrt{3}c$

6. $E = mc^2 = \frac{m_0}{\sqrt{1-u^2/c^2}}c^2 = Km_0c^2$， $u = \frac{c}{K}\sqrt{K^2-1}$

7. $x_2 = 2\times 10^{-2}\cos(5t - \frac{\pi}{2})$ (SI)，$\Delta\varphi = \pi$，$A = A_1 - A_2 = 4\times 10^{-2}$ m， 由于 $A_1 > A_2$， $\varphi = \varphi_1 = \frac{\pi}{2}$

8. $x = 0.04\cos(\frac{2\pi}{T}t + \varphi)$， $0.02 = 0.04\cos\varphi$， $v_0 > 0$， $\varphi = -\frac{\pi}{3}$

$0 = 0.04\cos(\frac{2\pi}{T}t - \frac{\pi}{3})$， $\frac{2\pi}{T}\times 1 - \frac{\pi}{3} = \frac{\pi}{2}$， $T = \frac{12}{5}(\mathrm{s}) = 2.4\ \mathrm{s}$

9. $\nu_1 = \frac{u}{u - v_s}\nu$， $\nu_2 = \frac{u}{u + v_s}\nu$， $\frac{\nu_1}{\nu_2} = \frac{u + v_s}{u - v_s}$， $v_s = \frac{\nu_1 - \nu_2}{\nu_1 + \nu_2}u = 30\ (\mathrm{m/s})$

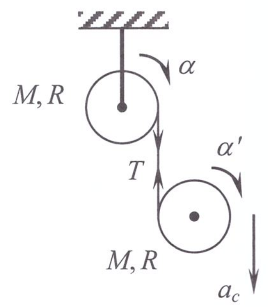
10. $\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{300}{400} = 25\%$， $e = \frac{Q}{A} = \frac{T_2}{T_1 - T_2} = \frac{300}{400-300}$， $A = \frac{Q}{3} = 400\ \mathrm{J}$

11. $E = \nu\frac{i}{2}RT = 6.23\times 10^3\ \mathrm{J}$， $\bar{\varepsilon}_t = \frac{3}{2}kT = 6.21\times 10^{-21}\ \mathrm{J}$， $\bar{\varepsilon} = \frac{5}{2}kT = 1.035\times 10^{-20}\ \mathrm{J}$

12. $E_A = -\frac{\sigma}{2\varepsilon_0} - \frac{\sigma}{2\varepsilon_0} - \frac{\sigma}{2\varepsilon_0} = -\frac{3\sigma}{2\varepsilon_0}$， $E_B = \frac{\sigma}{2\varepsilon_0} - \frac{\sigma}{2\varepsilon_0} - \frac{\sigma}{2\varepsilon_0} = -\frac{\sigma}{2\varepsilon_0}$

$E_C = \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0} - \frac{\sigma}{2\varepsilon_0} = \frac{\sigma}{2\varepsilon_0}$， $E_D = \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0} = \frac{3\sigma}{2\varepsilon_0}$

二、计算题：（6 题，共 52 分）



1. 解： $TR = \frac{1}{2}MR^2\alpha$， $Mg - T = Ma_c$， $TR = \frac{1}{2}MR^2\alpha'$，

$a_c = \alpha R + \alpha' R$

得： $\alpha = \frac{2g}{5R}$； $a_c = \frac{4}{5}g$； $\alpha' = \frac{2g}{5R}$； $T = \frac{1}{5}Mg$

2．解：角动量守恒：$mvl = m\dfrac{v}{2}l + J\omega_0$，$J = \dfrac{1}{3}Ml^2 + Ml^2 = \dfrac{4}{3}Ml^2$　得：$\omega_0 = \dfrac{3mv}{8Ml}$

机械能守恒：$\dfrac{1}{2}J\omega_0^2 = Mg\cdot 2l + Mgl + \dfrac{1}{2}J\omega^2$，$\omega \ge 0$，得：$v \ge \dfrac{4M}{m}\sqrt{2gl}$

3．解：（1）设反射波方程为：$y_2 = A\cos(\omega t - \dfrac{2\pi}{\lambda}x + \varphi)$

固定端，$(\omega t - \dfrac{2\pi}{\lambda}x + \varphi) - (\omega t + \dfrac{2\pi}{\lambda}x) = \varphi - \dfrac{4\pi}{\lambda}x = \varphi - \dfrac{4\pi}{\lambda}\dfrac{\lambda}{8} = (2k+1)\pi$

$$\varphi = 2k\pi + \frac{3\pi}{2},\quad y_2 = A\cos(\omega t - \frac{2\pi}{\lambda}x - \frac{\pi}{2})$$

（2）　$y = y_1 + y_2 = 2A\cos(\dfrac{2\pi}{\lambda}x + \dfrac{\pi}{4})\cos(\omega t - \dfrac{\pi}{4})$

（3）波节 $\cos(\dfrac{2\pi}{\lambda}x + \dfrac{\pi}{4}) = 0$ $(0<x<2\lambda)$；$x = k\cdot\dfrac{\lambda}{2} + \dfrac{\lambda}{8}$，$k=0,1,2,3$；　$x = \dfrac{\lambda}{8}, \dfrac{5\lambda}{8}, \dfrac{9\lambda}{8}, \dfrac{13\lambda}{8}$

4．解：（1）$f(v) = \begin{cases} av/v_0 & 0 \le v < v_0 \\ a & v_0 \le v \le 2v_0 \\ 0 & v > 2v_0 \end{cases}$，$\int_0^{v_0}\dfrac{a}{v_0}v\mathrm{d}v + \int_{v_0}^{2v_0}a\mathrm{d}v = \dfrac{3}{2}av_0 = 1$；$a = \dfrac{2}{3v_0}$

（2）　$f(v) = \begin{cases} 2v/(3v_0^2) & 0 \le v < v_0 \\ 2/(3v_0) & v_0 \le v \le 2v_0 \\ 0 & v > 2v_0 \end{cases}$

（3）　$\Delta N = N\int_{0.5v_0}^{1.2v_0} f(v)\mathrm{d}v = N\int_{0.5v_0}^{v_0}\dfrac{a}{v_0}v\mathrm{d}v + N\int_{v_0}^{1.2v_0}a\mathrm{d}v = \dfrac{23}{60}N$

（4）　$\overline{v} = \int_0^{\infty} vf(v)\mathrm{d}v = \int_0^{v_0}\dfrac{a}{v_0}v^2\mathrm{d}v + \int_{v_0}^{2v_0}av\mathrm{d}v = \dfrac{11}{9}v_0$

5．解：　$-A = -A_p = p_0(4V_0 - V_0) = 3p_0V_0$

$$Q = \nu C_p(T_2 - T_1) + \nu C_V(T_3 - T_2) = \frac{5}{2}p_0(4V_0 - V_0) + \frac{3}{2}(0.5p_0 4V_0 - p_0 4V_0) = \frac{9}{2}p_0V_0$$

$\Delta E = \nu C_V(T_3 - T_1) = \dfrac{3}{2}(0.5p_0 4V_0 - p_0V_0) = \dfrac{3}{2}p_0V_0$　或：　$\Delta E = Q + A = \dfrac{3}{2}p_0V_0$

$$\Delta S = \nu C_p\ln\frac{T_2}{T_1} + \nu C_V\ln\frac{T_3}{T_2} = \nu C_p\ln\frac{V_3}{V_1} + \nu C_V\ln\frac{p_3}{p_1} = R(\frac{5}{2}\ln 4 + \frac{3}{2}\ln\frac{1}{2}) = \frac{7}{2}R\ln 2$$

6．解：　$\mathrm{d}q = \lambda\mathrm{d}l = \lambda R\mathrm{d}\phi = \lambda_0 R\sin\phi\mathrm{d}\phi$，$\mathrm{d}E = \dfrac{\mathrm{d}q}{4\pi\varepsilon_0R^2} = \dfrac{\lambda_0\sin\phi\mathrm{d}\phi}{4\pi\varepsilon_0R}$

$E_x = 0$　，$\mathrm{d}E_y = -\mathrm{d}E\sin\phi = -\dfrac{\lambda_0}{4\pi\varepsilon_0R}\sin^2\phi\mathrm{d}\phi$，

$E_y = -\dfrac{\lambda_0}{4\pi\varepsilon_0R}\int_0^{\pi}\sin^2\phi\mathrm{d}\varphi = -\dfrac{\lambda_0}{8\varepsilon_0R}$　　方向竖直向