CAREER ENDEAVOUR
ACADEMY PRIVATE LIMITED
Best Institute for NET-JRF/GATE & IIT-JAM Exams

Physical Sciences (NET-JRF/GATE)

Test: Classical Mechanics

Time : 01:00 Hour **Date : 14-02-2014**
M.M. : 40

Instructions:

1. **Question Paper contains two sections. Section-A contains 10 objective type questions, each question carry 3 marks. Section-B contains 2 Subjective type questions, each question carry 5 marks each.**
2. **There is negative marking, 1 mark will be deducted for each wrong answer in Section-A.**
3. **Attempt all the questions, use of calculator is not allowed.**

Section-A

1. A Particle A is moving in x-y plane with speed $c/\sqrt{2}$ such that its direction makes 45° with +x direction in the first quadrant. Another particle B is moving with speed c/2 along +x direction. Velocity of particle B with respect to A is,

(a) $c/2\hat{j}$ (b) $c/\sqrt{3}\hat{j}$ (c) $-c/2\hat{j}$ (d) $-c/\sqrt{3}\hat{j}$

2. In an inertial frame S, a stationary rod makes an angle θ with the x-axis. Another inertial frame S' moves with a velocity 'v' with respect ot S along the common $x - x'$ axis. As observed from S' the angle made by the rod with the $x'-$axis is θ'. Which of the following statements is correct?

(a) $\theta' < \theta$ (b) $\theta' > \theta$
(c) $\theta' < \theta$ if v is negative and $\theta' > \theta$ if v is positive
(c) $\theta' > \theta$ if v is negative and $\theta' < \theta$ if v is positive.

3. A small raindrop of mass m experiences a viscous drag force $F_d = bv$, proportional to its instantaneous speed 'v'. If it starts from rest at a height h, its speed after a time 't' is

(a) $\upsilon(t) = \frac{mg}{b}\tanh\left(\frac{bt}{m}\right)$ (b) $\upsilon(t) = \frac{mg}{b}e^{-bt/m}$
(c) $\upsilon(t) = \frac{mg}{2b}(1-e^{-2bt/m})$ (d) $\upsilon(t) = \frac{mg}{b}(1-e^{-bt/m})$

4. A beam of light moves in a slab of glass of refractive index n in the positive x-direction. The slab itself is also moving in the positive with a speed v in laboratory frame. What is the speed of the beam of light as measured in the laboratory frame ?

(a) c (b) $\left(c^2n + cv\right)/\left(c + nv\right)$
(c) $c\left(1-\frac{1}{n}\right)$ (d) $\left(c^2 + vcn\right)/\left(cn + v\right)$

5. In the special theory of relativity, consider a Lorentz boost by a velocity 'v' along the x-direction. If $u = ct + x$, then the boosted value $u' = ct' + x'$ is:

(a) $u' = \sqrt{\frac{1+v/c}{1-v/c}}u$ (b) $u' = \sqrt{\frac{1-v/c}{1+v/c}}u$ (c) $u' = \frac{1+v/c}{1-v/c}u$ (d) $u' = \frac{1-v/c}{1+v/c}u$

6. Agalaxy is receding relative to us at a speed of 3000 km/s. It emits hydrogen redline of wavelength 6560 Å. When seen by us, the wavelength of this radiation will appear to be
(a) higher by approximately 65Å (b) lower by approximately 65Å
(c) lower by approximately 6Å (d) higher by approximately 6Å

7. Planck's constant (h), the speed of light in vacuum (c) and Newton's gravitational constant (G) are three fundamental constants of nature. Which of the following combinations has the dimensions of length?

(a) $\sqrt{hG}/c^{3/2}$ (b) $\sqrt{hG}/c^{5/2}$ (c) $\sqrt{hc/G}$ (d) $\sqrt{Gc}/h^{3/2}$

8. Vector form of Lorentz Transformation can be expressed as, (here $[\vec{v} = v\hat{n}]$)

(a) $\vec{r}' = \gamma\left[(\hat{n}.\vec{r})\hat{n}.\vec{v}t\right], \quad t' = \gamma\left[t - \vec{v}.\vec{r}/c^2\right]$

(b) $r' = \gamma\left[(\hat{n}.\vec{r})\hat{n} - \vec{v}t\right] + \left[\vec{r} - (\hat{n}.\vec{r})\hat{n}\right], \; t' = \gamma\left[t - \vec{v}.\vec{r}/c^2\right]$

(c) $\vec{r}' = \gamma\left[\vec{r} - (\hat{n}.\vec{r})\hat{n}\right], \quad t' = \gamma\left[t - (\hat{n}.\vec{v})/c^2\right]$

(d) $\vec{r}' = \gamma\left[\vec{r} - (\hat{n}.\vec{v})\hat{n}\right], \quad t' = \gamma\left[t - (\hat{n}.\vec{r})v/c^2\right]$

9. Dynamic mass of a particle is measured to be $\sqrt{3}$ times its rest mass. Ratio of kinetic energy and total energy is

(a) $\frac{\sqrt{5}-1}{\sqrt{5}}$ (b) $\frac{\sqrt{3}-1}{\sqrt{3}}$ (c $\frac{\sqrt{2}-1}{\sqrt{2}}$ (d) $\frac{\sqrt{7}-1}{\sqrt{7}}$

10. A pion of mass m_π at rest decays into a muon of mass m_μ and a neutrino of zero mass. Speed of muon is

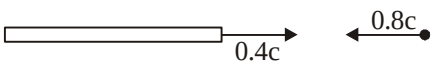
(a) $\frac{m_\pi^2 - m_\mu^2}{m_\pi^2 + m_\mu^2}c$ (b) $\frac{m_\pi - m_\mu}{m_\pi + m_\mu}c$ (c) $\frac{m_\pi}{m_\pi + m_\mu}c$ (d) $\frac{m_\mu}{m_\pi + m_\mu}c$

Section-B

11. A particle of rest mass m_o moves along x axis of S frame according to the law $x = \sqrt{a^2 + c^2t^2}$ where a is a constant and c is the velocity of light, and t is time. Calculate force acting on the particle in this frame.

12. A rod is moving with a speed of 0.4c along its length in the positive x-direction, and a particle is moving along the negative x-direction with a speed 0.8c as shown in the figure below. Both the speeds are measured in an inertial frame S, and c is the velocity of light in free space. The length of the rod as measured in the S-frame is 3.6 m.

(a) Find the relative velocity of the rod (in terms of c) in the rest frame of the particle.
(b) Find (i) the time taken for the particle to cross the rod in the S-frame and in the rest frame of the rod, and (ii) time taken by the rod to cross the particle in the rest frame of the particle.



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1. (d)	**2. (b)**	**3. (d)**	**4. (d)**	**5. (b)**	**6. (d)**	**7. (a)**
8. (b)	**9. (b)**	**10. (a)**				

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