CHP. 19
SHORT QUESTIONS

Q19.1. What are the measurements on which two observers in relative motion will always agree upon?

Ans: Force, acceleration, mass, time

Q19.2. Does the dialation mean that time really passes more slowly in moving system or that it only seems to pass more slowly.

Ans: According to time dialation formula

$$t = \frac{t_o}{\sqrt{1 - v^2/c^2}}$$

time dialation means that moving clock appears to run slow, so time dilation is apparent change and is not the actual change. It is simply a feeling which observer in one frame has about the time in the second frame in uniform relative motion. Time dialation is on reciprocatory basis.

Q19.3. If you are moving in a spaceship at a very high speed relative to the Earth, would you notice a difference (a) in your pulse rate (b) in the pulse rate of people on Earth?

Ans: A man stationed in a spaceship moving at a very high speed will feel no change in his pulse rate. However, he may feel a change in the pulse rate of the people on the Earth. The same will be the feeling of the man on the Earth about the man in the spaceship.

Q19.4. If the speed of light were infinite, what would the equations of special theory of relativity reduces to?

Ans: The eqs. of special theory of relativity hold good only so long as $V < c$ (velocity of light). In case $c \geq \infty$, the eqs. of special theory of relativity becomes $m = m_o$, $l = l_o$, $t = t_o$ and $E = mc^2 \rightarrow \infty$ and will convey no sense.

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Q 19.5. Since mass is a form of energy, can we conclude that a compressed spring has more mass than the same spring when it is not compressed.

Ans: Mass is a form of energy, according to the theory of relativity the variation of mass is due to motion and not due to position. Therefore, we conclude that a compressed spring has no more mass then the same spring when it is not compressed. In this case there is change of P.E only.

Q 19.6. As a solid is heated and begins to glow, why does it first appear red?

Ans: White light is a mixture of seven colours out of which red colour has the longest wavelength but the smallest frequency. Energy of photon $E = hf = \frac{hc}{\lambda}$ points out that photon of red light is the weakest of photons of other colours or wavelengths. Since emission of radiation depends on the temperature of the emitter, originally photon of red light having the least energy will be emitted. However, with rise of temp. of the emitter more and more energetic photons of component colours will be emitted.

Q 19.7. What happens to total radiation from a black body if its absolute temp is doubled?

Ans: According to Stefan-Boltzmann law, heat energy of all wavelengths emitted per second per unit area is directly proportional to the fourth power of absolute temp. i.e; $E = \sigma T^4$. It follows that if the temp. of the emitter is doubled, total radiation from the emitter will become sixteen times as shown

$$E' = \sigma(2T)^4 = 16\sigma T^4 = 16E$$

Q 19.8. A beam of red light and of blue light have exactly the same energy. Which beam contains the greater number of photons?

Ans. Energy of photon depends on the frequency of radiation. Since $f_B > f_R$, photon of blue colour has more energy than photon of red colour. As such beam of red colour having the same energy as that of blue colour will contain greater number of photons.

Q 19.9. Which photon, red, green, blue carries the most (a) energy and (b) momentum?

Ans: Energy of photon $E = hf = \frac{hc}{\lambda}$ $\because c = f\lambda$

and momentum of Photon $P = \frac{hf}{c} = \frac{h}{\lambda}$

So $E = \frac{hc}{\lambda} = P \times c$ ——— (1)

We see that **blue colour** photon has the most energy and momentum due to the highest frequency and the smallest wavelength.

Q 19.10. Which one has the smallest energy quanta, radiowaves or x-rays?

Ans: Radiowaves have the lower energy quanta due to their smallest frequency and longest wavelength.

Q 19.11. Does the brightness of a beam of light primarily depend on the frequency or number of photons?

Ans: The brightness of a beam of light depends on the number of photons contained in it rather than frq. of photons which simply determine the energy of photon.

Q 19.12. When ultraviolet light falls on certain dyes, visible light is emitted. Why does this not happen when infra red light falls on these dyes?

Ans: The ultraviolet light is consisted of photons of high energy. Due to this, these photons have

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ability to excite the atoms of dyes. When these photons are de-excited, the emit frequencies, which are detectable by normal human eye.

But when infrared radiations fall on the atoms of dyes, they may also be excited, but during de-excitation, frequencies emitted by these photons are below the least value of frequency of visible spectrum, therefore, these can not be detected by normal eye.

Q19.13. Will bright light eject more electrons from a metal surface than dimmer light of the same colour?

Ans: Bright light being more intense contains comparatively large no. of photons which will eject more electrons than that ejected by dimmer light.

Q19.14. Will higher frequency light eject greater no. of electrons than low frq. light?

Ans: The no. of Photoelectrons ejected depends upon the intensity of incident light but not on the frq. of light. Thus higher frq. light will not eject greater no. of electrons than low frq. light.

Q19.15. When light shines on a surface, is momentum transferred to the metal surface?

Ans: Yes, both momentum and energy are transferred to the metal surface on which light shines.

Q19.16. Why can red light be used in a photographic dark room when developing films, but a blue and white light cannot?

Ans: The photons of red light in visible spectrum have less energy than for blue or white lights. Red colour is least scattered on account of its large wavelength. Therefore photographic films and the material concerned are less effected, in the presence of red light.

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Q 19.17. Photon "A" has twice the energy of photon "B". What is the ratio of the momentum of "A" to that of "B"?

Ans: The momentum of photon is

$$P = \frac{h}{\lambda} = \frac{hf}{c} = \frac{E}{c} \quad \text{———} (1)$$

Momentum of photon "A" = $P_A = \frac{hf_A}{c}$ ——— (2)

" " " "B" = $P_B = \frac{hf_B}{c}$ ——— (3)

As photon "A" has twice the energy of photon "B"

$\therefore \quad f_A = 2f_B$ ——— (4) $\quad \because \; hf_A = 2hf_B$

So eq. (2) becomes;

$$P_A = \frac{2hf_B}{c} \quad \text{———} (4)$$

Dividing eq. (4) by (3), we get

$$\frac{P_A}{P_B} = \frac{2hf_B/c}{hf_B/c} = 2/1$$

or $\quad P_A = 2P_B \qquad P_A : P_B :: 2 : 1$

Therefore the ratio of the momentum of A to that of B is 2:1

Q 19.18. Why don't we observe a Compton effect with visible light?

Ans. The Compton's wavelength of electron is very small as compared to the wavelength of visible light. As the photons of visible light have smaller energy and momentum than the photons of x-rays. Also their penetrating power is almost negligible. So, photons of visible light are unable to show Compton's effect.

Q 19.19. Can pair production take place in vacuum? Explain.

Ans: No, pair production cannot take place in vacuum, because in vacuum there is no heavy nucleus which is essential for the pair production to take place and takes a recoil to conserve momentum.

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Q 19.20. Is it possible to create a single electron from energy? Explain.

Ans: Electron has negative charge. Energy has no charge. Production of a single electron from energy means violation of law of conservation of charge. So single electron cannot be created from energy.

Q 19.21. If electrons behaved only like particles, what pattern would you expect on the screen after the electrons pass through the double slit?

Ans: When electrons have particle like properties only, then these would pass through the slits straight and fall on the screen just in front of the slits to give exact images of the double slit on the screen.

Q 19.22. If an electron and a proton have the same de Broglie wavelength, which particle has greater speed?

Ans: From the relation,

$$\lambda = \frac{h}{mv}$$

we have;

$$\lambda_e = \frac{h}{m_e v_e} \quad \text{and} \quad \lambda_p = \frac{h}{m_p v_p}$$

Comparing the two for equal wavelength, we get

$$\frac{h}{m_e v_e} = \frac{h}{m_p v_p}$$

or

$$\frac{v_p}{v_e} = \frac{m_e}{m_p}$$

$$\therefore \quad \frac{v_p}{v_e} = \frac{m_e}{1836\, m_e} = \frac{1}{1836} \qquad \because m_p = 1836\, m_e$$

Hence $v_e = 1836\, v_p$

Q 19.23. We do not notice the de Broglie wavelength for a pitched cricket ball, Explain, why?

Ans: According to de-Broglie's rel. $\lambda = \frac{h}{mv}$.

For particles of large mass, the value of 'λ' becomes so small that it cannot show wave characteristics and cannot be noticed.

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