

**Accelerated Physics I**  
**Exam 4 Ver 2 (In Class Portion)**

**5/29/2007**

**Dr. Nash**

1. Which of the following units is not a unit of work.

- (a) J
- (b) N
- (c) Nm
- (d) kJ
- (e) All are units of work

2. A  $4.66 \times 10^{-27}$  kg alpha particle moves at 1350 m/s in the +x direction. What is its momentum (be sure to use the proper units)

3. A spring is designed to maintain a constant 225 N of opposing force while it is being compressed. Such a spring is compressed 0.25 m. What is the potential energy of the spring?

4. A 150 kg man falls for 5 seconds and therefore hits the ground at 490 m/s to comes to rest (in peace) after 0.20 seconds. What was the force applied by the ground on the him?

5. What is the (gravitational) potential energy relative to the ground of a 150 kg ball at a height of 75 m.

6. Imagine a 50 kg box laying on a flat surface with a coefficient of friction,  $\mu=0.33$ . How much force would you need to apply to get it to move and how much work would you need to do in order to move it 25 m? How much work would you need to do if the coefficient of friction was zero?

7. A typical soda bar contains perhaps 200 Calories of chemical (potential) energy, this amounts to say 830 kJ. Now a typical soda has a mass of perhaps 65 kg. Imagine this candy bar eater wants to climb stairs in to work off last night's candy bar. How high (in meters) would this candy bar eater have to climb to have done enough work to equal the energy candy bar? (be sure to convert kJ to J)

8. What is the kinetic energy of a  $4.66 \times 10^{-27}$  kg alpha moving with a velocity of -1300 m/s?

9. What is the kinetic energy as it reaches the ground of a 150 kg ball dropped from a height of 150 m

10. Why is the sky blue? (**See Diagram Below**)

**Background:**

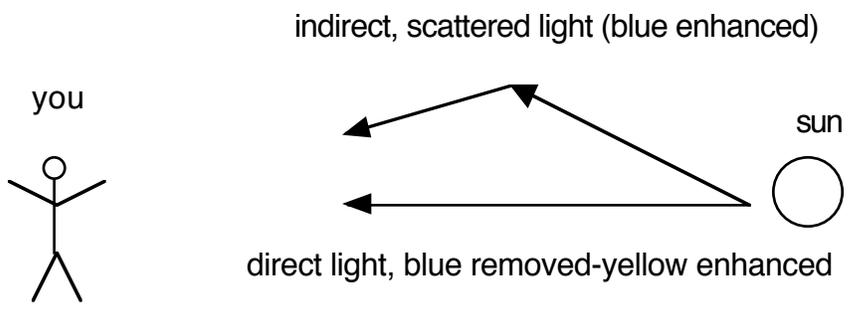
When photons from the sun strike the Earth they are scattered by gasses that make up the atmosphere, principally N<sub>2</sub> and O<sub>2</sub>. This is known as Rayleigh scattering. It turns out that blue light is scattered more effeciently than red light and this is why when you look into the sky but not directly into the sun you see blue. You are looking at the light that has been scattered by the atmosphere and because blue is easier to scatter, the light you see is enhanced in blue. Incidentally, the sun appears yellow for the same reason. If blue is scattered more effeciently then red/yellow is scattered less effeciently and therefore light that comes directly from the sun is depleted in blue and enhanced in yellow. Note that this means our sun is not yellow- it just appears that way because of the interaction of its light with out atmosphere.

**Question:**

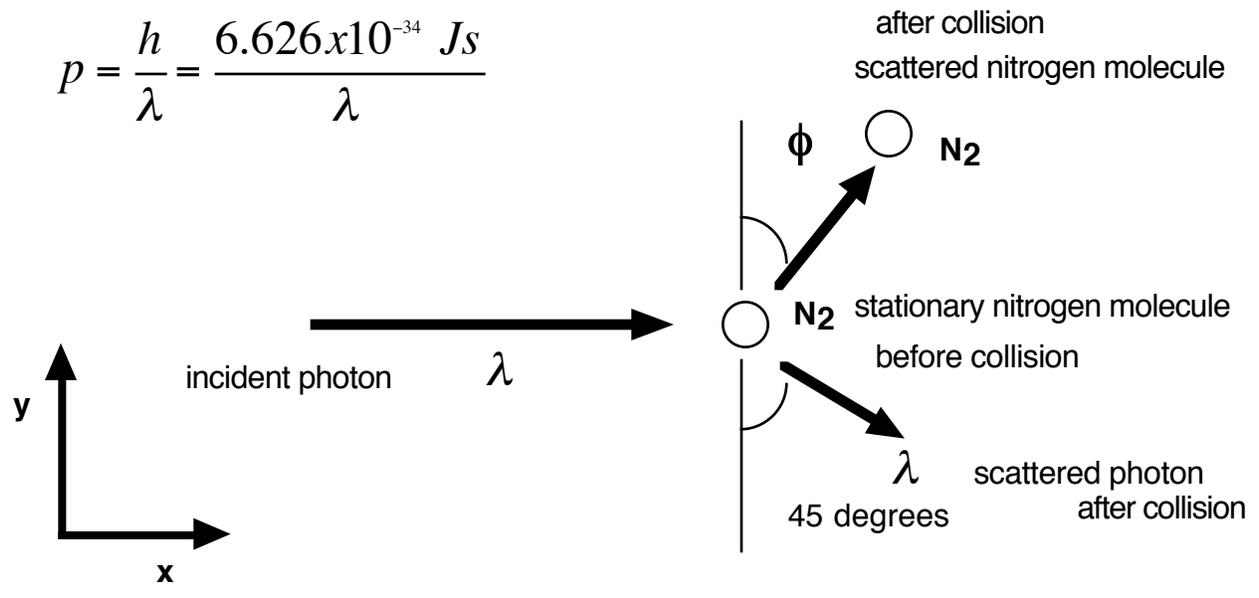
Anyway, even though it has no 'rest' mass, a photon does have momentum that is inversely proportional to its wavelength (according to the equation below). Assume that a photon of ultraviolet light, having a wavelength of say 275 nm, enters the atmosphere and is scattered in a collision with a N<sub>2</sub> molecule as in the diagram below. (Note that the wavelength and therefore the magnitude of the momentum of the photon does not change during the collision)

$$p = \frac{h}{\lambda} = \frac{6.626 \times 10^{-34} \text{ Js}}{\lambda(\text{in meters})}$$

(SEE FOLLOWING DIAGRAM)



$$p = \frac{h}{\lambda} = \frac{6.626 \times 10^{-34} \text{ Js}}{\lambda}$$



275 nm photon  $\lambda = 2.75 \times 10^{-8} \text{ m}$   
 $m(\text{N}_2) = 4.65 \times 10^{-26} \text{ kg}$

a) What is the total momentum of the (stationary)  $\text{N}_2$  molecule before the collision?

b) What is the total momentum of the incident photon?

what is its momentum in the x direction?

what is its momentum in the y direction?

c) What is the total momentum of the scattered photon?

what is its momentum in the x direction?

what is its momentum in the y direction?

d) What is the total momentum of the scattered  $\text{N}_2$  molecule?

what is its momentum in the x direction?

what is its momentum in the y direction?

e) At what angle  $\phi$  with respect to the y axis will the  $\text{N}_2$  molecule be scattered?