

- 436 A sound wave is best described by the terms  
 a) Electromagnetic and transverse  
 b) Electromagnetic and longitudinal  
 c) Mechanical and longitudinal  
 d) Mechanical and transverse
- 437 Which of the following waves listed has the highest frequency?  
 a) Infrared  
 b) Green Light  
 c) Blue light  
 d) Yellow Light
- 438 Three quarks cannot have a combined charge of  
 a) 1  
 b) 2  
 c) -2  
 d) -1
- 439 As a fire truck moves away from a person standing on a side walk, the frequency of the siren heard by the person will  
 a) Remain the same  
 b) Decrease  
 c) Increase  
 d) Increase then decrease
- 440 A photon is best classified as a  
 a) Quark  
 b) Boson  
 c) Lepton  
 d) Baryon
- 441 As a light wave in water moves into air at an incident angle of  $10^\circ$  the light will  
 a) Reflect and speed up  
 b) Reflect and slow down  
 c) Refract inward and slow down  
 d) Refract outward and speed up  
*It will reflect but at same speed*
- 442 Which of the following particles produces an electromagnetic wave when oscillated?  
 a) electron charged  
 b) Neutron neutral  
 c) Hydrogen atom neutral  
 d) Tau neutrino neutral
- 443 Determine the frequency of a radio wave with a wavelength of 1875 m moving in air.  
 a)  $1.6 \times 10^5$  Hz  
 b)  $6.75 \times 10^{-1}$  Hz  
 c)  $1.5 \times 10^{11}$  Hz  
 d)  $6.1 \times 10^5$  Hz  

$$f = \frac{c}{\lambda} = \frac{3 \times 10^8 \text{ m/s}}{1875 \text{ m}} = 1.6 \times 10^5 \text{ Hz}$$
- 444 A particle consisting of 2 protons and 2 neutrons contains  
 a) 15 leptons  
 b) 15 quarks  
 c) 12 quarks  
 d) 5 quarks  
*2 (udd) 2 (uud)  
 6 quarks 6 quarks*
- 445 A tau neutrino is classified as which type of particle?  
 a) Quark  
 b) Baryon  
 c) Lepton  
 d) Hadron
- 446 A wave cycle takes 4 seconds. Determine the frequency of the wave.  
 a) 4 Hz  
 b) 0.25 Hz  
 c) 1 Hz  
 d) 25 Hz  
*1 cycle / 4s*
- 447 The combination of an up quark and an anti up quark produces  
 a) A baryon  
 b) A lepton  
 c) A meson  
 d) Energy from annihilation
- 448 A wave completes 15 waves cycles in 37.5 m. What is the wavelength?  
 a) 0.33 m  
 b) 45 m  
 c) 675 m  
 d) 2.5 m  

$$\frac{\text{meters}}{\text{cycle}} = \frac{37.5 \text{ m}}{15 \text{ cycle}} = 2.5 \text{ m}$$
- 449 Which fundamental force holds the particles in the nucleus together  
 a) Gravity  
 b) Electromagnetic force  
 c) Strong force  
 d) Weak Force
- 450 A wave moving from one material to another with a different index of refraction is called  
 a) Resonance  
 b) refraction  
 c) Diffraction  
 d) Polarization
- 451 Compared to the speed of a sound wave in air at STP, the speed of a radio wave is  
 a) Less  
 b) More  
 c) The same  
 d) More  
*Sound in air at STP = 331 m/s  
 Radio wave is EM wave =  $3 \times 10^8$  m/s*

452 Which of the following wave categories is a type of mechanical wave

- a) Radio c) Ultrasound  
b) Microwave d) Ultraviolet

453 What is the speed of a wave with a wavelength of 0.3 m and a frequency of 12 Hz?

- a) 27 m/s c) 3.6 m/s  
b) 60 m/s d)  $3.0 \times 10^8$  m/s

454 What is the speed of light with a frequency of  $5.09 \times 10^{14}$  Hz when traveling through water?

- a)  $5.9 \times 10^{14}$  m/s c)  $2.25 \times 10^8$  m/s  
b)  $3.0 \times 10^8$  m/s d)  $4.4 \times 10^8$  m/s

455 Which color of light has a wavelength of  $5.0 \times 10^{-7}$  m in air?

- a) Blue c) Orange  
b) Green d) Violet

456 Which characteristic is the same for every color of light in a vacuum?

- a) Frequency c) Speed  
b) wavelength d) Period

$$c = 3 \times 10^8 \text{ m/s}$$

457 In which way does blue light change as it travels from crown glass into diamond?

- a) Its frequency decreases frequency remains the same  
b) Its frequency increases  
c) Its speed decreases  $v = \frac{c}{n}$  (inverse)  
d) Its speed increases

$$n_{\text{crown glass}} = 1.52 \quad n_{\text{diamond}} = 2.42$$

458 The slope of a graph of photon energy vs. frequency equals

- a) Photon speed  
b) Wavelength  
c) Planck's constant  
d) Speed of light squared

$$\frac{E_{\text{photon}}}{f} = h$$

459 How much energy is produced from the complete conversion of an electron into energy?

- a)  $1.6 \times 10^{-19}$  J c)  $3.2 \times 10^{-19}$  J  
b)  $2.7 \times 10^{-22}$  J d)  $8.2 \times 10^{-14}$  J

$$\text{Joules} \rightarrow \text{use } E=mc^2$$

460

Compared to the speed of a radio wave in air, the speed of a microwave in air is

- a) Less c) The same  
b) More Both EM waves

461

Determine the energy of photon with a frequency of  $5.09 \times 10^{14}$  Hz.

- a)  $1.6 \times 10^{-19}$  J c)  $3.4 \times 10^{-19}$  J  
b)  $3.0 \times 10^8$  J d)  $5.9 \times 10^{-7}$  J

$$E = hf = (6.63 \times 10^{-34} \text{ J}\cdot\text{s})(5.09 \times 10^{14} \text{ Hz}) = 3.4 \times 10^{-19} \text{ J}$$

462

Determine the energy in electronvolts of photon with a wavelength of  $5 \times 10^{-7}$  m

- a)  $4.0 \times 10^{-19}$  eV c) 2.5 eV  
b)  $6 \times 10^{-14}$  eV d)  $3.8 \times 10^{33}$  eV

$$E = hf = \frac{hc}{\lambda} = \frac{(6.63 \times 10^{-34} \text{ J}\cdot\text{s})(3 \times 10^8 \text{ m/s})}{(5 \times 10^{-7} \text{ m})} = 3.98 \times 10^{-19} \text{ J} \times \frac{1 \text{ eV}}{1.6 \times 10^{-19} \text{ J}} = 2.5 \text{ eV}$$

463

Light with a frequency of  $5.09 \times 10^{14}$  Hz in air is incident on a boundary with water at an angle of  $30^\circ$ . What is the angle of refraction?

- a)  $15.4^\circ$  c)  $0^\circ$   
b)  $45^\circ$  d)  $22^\circ$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$1 \sin 30^\circ = 1.33 \sin \theta_2$$

$$\theta_2 = 22^\circ$$

464

Light with a frequency of  $5.09 \times 10^{14}$  Hz in air is incident on a boundary with another substance.

The angle of incidence is  $45^\circ$  and the angle of refraction is  $30^\circ$ . What is the index of refraction for the substance?

- a) 1.4 c) 1.66  
b) 0.7 d) 1.33

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$1 \sin 45^\circ = n_2 \sin 30^\circ$$

465

What is the minimum amount of energy required to ionize an electron in the ground state of a mercury atom?

- a) 13.6 eV c) 4.64 eV  
b) 10.38 eV d) 20 eV

466

Determine the energy emitted by an electron as it falls from  $n=3$  to  $n=2$  in a hydrogen atom.

- a) 12.09 eV c) 15.11 eV  
b) 1.89 eV d) 1.51 eV

467

A singer breaking a glass by hitting a specific frequency is known as the phenomena of

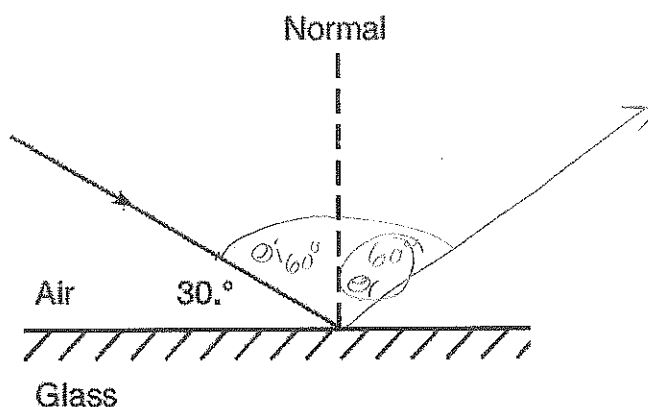
- a) Diffraction c) Interference  
b) Doppler effect d) Resonance

- 468 How much energy is produced when 2 universal mass units are converted into energy?

a)  $1.86 \times 10^3 \text{ MeV}$  c)  $3.0 \times 10^8 \text{ MeV}$   
b)  $2.8 \times 10^3 \text{ MeV}$  d)  $1.6 \times 10^{-19} \text{ MeV}$

$$2u \times \frac{9.31 \times 10^3 \text{ MeV}}{1u} = 1862 \text{ MeV}$$

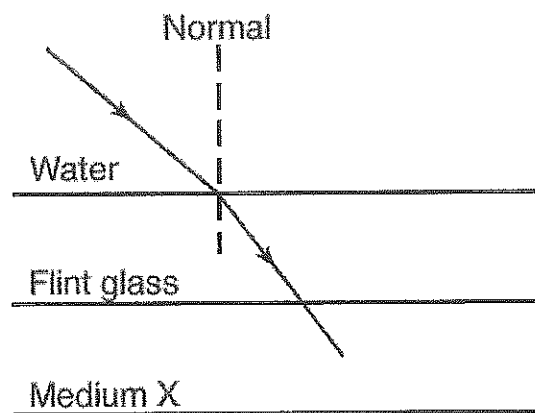
- 469 Draw the reflected ray on the diagram below. Label the angle of reflection including value of angle



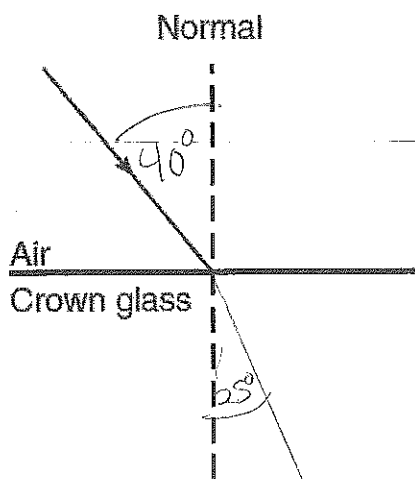
471

- What happens to the speed of the light wave as it moves from water to flint glass?

a) Are in phase  
b) Out of phase by  $90^\circ$   
c) Out of phase by  $180^\circ$   
d) Out of phase by  $45^\circ$



472.



For the light ray to the left

- a) Use a protractor to determine the angle of incidence [1]

- b) Determine the angle of refraction (show all work including equation, and substitution with units) [2]

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$1 \sin 40^\circ = 1.52 \sin \theta_2$$

$$\theta_2 = 25^\circ$$

- c) Draw in the angle of refraction on the diagram at left [1]

473 A photon with a frequency of  $6.0 \times 10^{14}$  hertz is absorbed by an excited hydrogen atom. This causes the electron to be ejected from the atom, forming an ion.

- a) Calculate the energy of this photon in joules. [Show all work, including the equation and substitution with units.] [2]

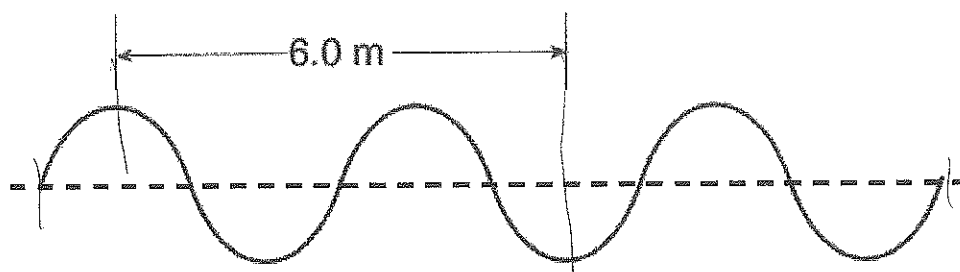
$$E = hf = (6.63 \times 10^{-34} \text{ Js})(6.0 \times 10^{14} \text{ Hz}) = 3.98 \times 10^{-19} \text{ J}$$

- b) Determine the energy of this photon in electronvolts. [1]

$$3.98 \times 10^{-19} \text{ J} \times \frac{1 \text{ eV}}{1.6 \times 10^{-19} \text{ J}} = 2.486 \text{ eV}$$

- c) What was the initial energy level of the electron before being ejected from the atom by the photon?  $n=3$  or higher

474



- a) d) For the wave pictured above, determine the wavelength of a single cycle [1]

$$\frac{6 \text{ m}}{1.5 \text{ cycles}} = 4 \text{ m}$$

- b) e) If the entire wave train above took 12 seconds to pass, what is the frequency of the wave? (show work including equation, substitution and units) [2]

$$\frac{3 \text{ cycles}}{12 \text{ seconds}} = .25 \text{ Hz}$$

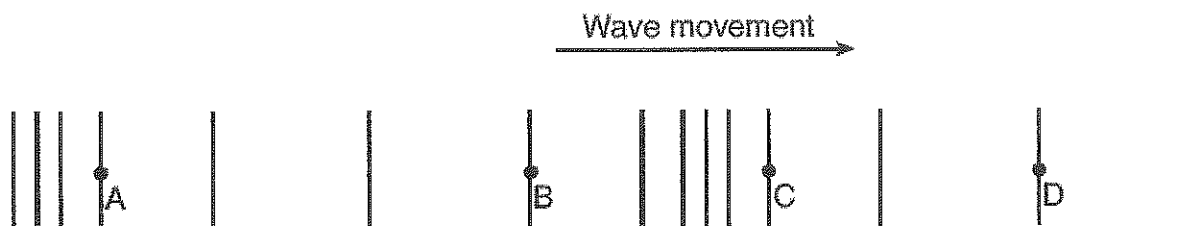
- c) f) Determine the speed of the wave (show all work including equation, substitution and units)? [2]

$$v = f\lambda = (.25 \text{ Hz})(4 \text{ m}) = 1 \text{ m/s}$$

- d) g) What type of wave motion is pictured in the diagram above? [1]

Transverse

475 A sound wave moving through STP is pictured below.



a) What type of wave motion is represented in the picture above? *longitudinal*

b) List two points (by letter) that are one wavelength apart.

*A & C*

c) What is the speed of this wave at STP?

*331 m/s*

d) What is the speed of this wave in a vacuum?

*It doesn't move in a vacuum*