1: Min frequency = 88 MHz

Max frequency = 108 MHz

$L = 6.36 \times 10^{-7} H$

We know that $f = \frac{1}{2\pi\sqrt{LC}}$

$\therefore (2\pi f)^2 = \left(\frac{1}{\sqrt{LC}}\right)^2$

$4\pi^2 f^2 = \frac{1}{LC}$

$\therefore C = \frac{1}{4\pi^2 f^2 L}$

$C_{min} \Rightarrow$ max frequency

$C = \frac{1}{4\pi^2 \times (108 \times 10^6)^2 \times 6.36 \times 10^{-7}} = 3.414 \text{ PF}$

$C_{max} \Rightarrow$ min frequency

$C = \frac{1}{4\pi^2 \times 88 \times 10^6 \times 6.36 \times 10^{-7}} = 5.143 \text{ PF}$

② $f = 9.72 \times 10^{18}$ Hz.

$C = 3.0 \times 10^8$ m/s

$C/f = \lambda = \frac{3.0 \times 10^8}{9.72 \times 10^{18}} = 3.086 \times 10^{-11}$ m

③ $C = 3.00 \times 10^8$ m/s

$\lambda = 5.49 \times 10^{-7}$ m

$f = C/\lambda = \frac{3 \times 10^8}{5.49 \times 10^{-7}} = 5.464 \times 10^{14}$ Hz.

$546.4 \times 10^{12}$ Hz

④ $f = \frac{1}{Ld}\sqrt{T/\pi\delta}$ where $\delta$ is density
L = length
d = diameter
T = Tension

$V_1 = 280 m/s$

$f_1 = \frac{1}{Ld}\sqrt{T/\pi\delta}$

$f_2 = \frac{1}{2Ld}\sqrt{T/\pi\delta} = \frac{1}{2}\left[\frac{1}{Ld}\sqrt{T/\pi\delta}\right] = \frac{1}{2}f_1$

apparently $f_2 = \frac{1}{2}f_1$

$\lambda$ is constant

$f_1 = V_1/\lambda = 280/\lambda$

$f_2 = \frac{1}{2}(f_1) = \frac{1}{2}\left(\frac{280}{\lambda}\right) = \frac{140}{\lambda}$

From the relationship $C = f\lambda$

$C_1 = 280/\lambda \times \lambda = 280 m/s$

$C_2 = \frac{140}{\lambda} \times \lambda = \underline{\underline{140 m/s}}$

⑤ Min freq = 88 mHz

Max freq = 108 mHz

Being radio waves $V = 3.0 \times 10^8 m/s$

$C = V = f\lambda$

$\therefore \lambda_{max} = V/f = \frac{3.0 \times 10^8}{88 \times 10^6} = 3.41 m$

$\lambda_{min} = \frac{3.0 \times 10^8}{108 \times 10^6} = 2.778 m$

6 $U_G = 2.00 \times 10^6 m/s$

$V_T = 5.00 \times 10^5 m/s$

Emitted frequency $= 6.00 \times 10^{14} Hz$

Using doppler's effect relation

$\frac{\Delta f}{f} = V/c$

$$V_{observed} = V_{source}\sqrt{\frac{1+v/c}{1-v/c}}$$

v is positive when source is approaching

(a) $V_A = V_T - V_G = 5\times10^5 - 2\times10^6 = -1.5\times10^6$

$$\frac{v}{c} = \frac{-1.5\times10^6}{3\times10^8} = \cancel{0.5}\ -5\times10^{-3}$$

$$f_A = 6\times10^{14}\sqrt{\frac{1-0.005}{1+0.005}} = 5.97\times10^{14}\ \text{Hz}$$

b) $V_B = -V_T - V_G = -2.5\times10^6$ m/s

$$\frac{V_B}{c} = \frac{-2.5\times10^6}{3.0\times10^8} = -8.33\times10^{-3}$$

$$f_B = 6\times10^{14}\sqrt{\frac{1-8.33\times10^{-3}}{1+8.33\times10^{-3}}} = 5.95\times10^{14}\ \text{Hz}.$$

(7) distance = 35 km

$c = 3\times10^8$ m/s (mirror is octagonal)

$d = 2\times35 = 70$ km $= 70000$ m

t = time it takes for the light to reach the observer from one mirror, $t = \frac{d}{c} = \frac{\cancel{70000}}{\cancel{3\times10^8}} = \frac{70000}{3.0\times10^8} = 2.333\times10^{-4}$ s

The mirror has 8 sides

angular displacement $\theta = \frac{1}{8}\times360 = 45 = \pi/4$ radian

$$\omega = \frac{d\theta}{dt} = \frac{\pi}{4}\Big/2.333\times10^{-4} = \underline{3366.992\ \text{rad/s}}$$

8 distance = 7.1m

download speed = 248 mbps

speed of radio waves = $3\times10^{8}$ m/s

Time it takes to cover $\frac{(2\times7.1m)}{3\times10^{8}} = \frac{14.2\,m}{3\times10^{8}} = 47.33\times10^{-9}s$

$\underset{bits}{no.\,of} = 248\times\left[\frac{2^{20}}{2^{x}}\right] \times 47.33\times10^{-9} = 12.31$ bits

9. distance = 2.2m viewer, reporter 4.6 m from politician

speed of sound = 343 m/s

$V = \lambda f \Rightarrow f = V/\lambda = \frac{343}{4.6} = 74.57$ Hz of sound perceived reporter.

$\lambda = V/f \Rightarrow f = V/\lambda = \frac{343}{2.2} = 155.91$ Hz of sound p[...] by viewer

Time travel of the electromagnetic waves being used to broadcast the press conference is:

$t_{em} = t_{rep} - t_{viewer}$ --- ①

Max distance d btn the TV set and politician is $d = C\,t_{em}$ -- ②

Using eqn in the forms $d_{rep} = V_{sound} * t_{rep}$ and

$d_{viewer} = V_{sound} * t_{viewer}$, we can calculate the travel times $t_{rep}$ and $t_{viewer}$ of the sound waves through the air as follows

$t_{rep} = \frac{d_{rep}}{V_{sound}}$ and $t_{view} = \frac{d_{view}}{V_{sound}}$ --- ③

Using eqns ① and eqns ③ we find that eqn ② becomes:

$$d = c\left[\frac{d_{rep}}{V_{sound}} - \frac{d_{view}}{V_{sound}}\right]$$

$$d = 3.00\times10^{8}\left[\frac{4.6}{343} - \frac{2.2}{343}\right] = 2.099\times10^{6}\ m$$

10. $1.9\times10^{-3}$ m = radius

Power $= 1.80\times10^{-3}$ W

Intensity of a beam $= \frac{Power}{4\pi r^2} = \frac{1.80\times10^{-3}}{4\pi(1.9\times10^{-3})^2} = 158.71\ W/M^2$

11 $B = 3.3\times10^{-6}$ T

$c = 3.0\times10^{8}$ m/s

$E_0 = c B_0$

$= 3.0\times10^{8} \times 3.3\times10^{-6} = 990$ N/C

12 Intensity $= 1.4\times10^{3}$ W/m$^2$

$6.6 m^3$ of space

electromagnetic energy

$\eta = \frac{U}{V}$ , $S = P/A = 1.4\times10^{3}$ W/m$^2$ $= \eta c$

$\eta = \frac{1.4\times10^{3}}{3\times10^{8}} = 4.667\times10^{-6}$

$E = Q \times V$

$= I/c \times V$

$= \frac{1.4\times10^{3}\times6}{3\times10^{8}} = \underline{2.8\times10^{-5}\ \text{Joule}}$

13. Police car speed = 25 m/s

$f_1 = 9.00\times10^{12}$ Hz

$f_1 - f_2 = \cancel{9.00\times10^{12}}$ = 324 Hz

$\lambda = c/f = \frac{3.0\times10^{8}}{9.0\times10^{12}} = 3.333\times10^{-5}$ m

Solving for relative speeds of the cars

$V_{rel} \approx \left(\frac{f_s - f_o'}{2f_s}\right)c = \left(\frac{324}{2(9\times10^{12})}\right)3.0\times10^{8} = 5.4\times10^{-3}$ m/s

$V_{speeder} = V_{rel} + V_{police}$

$= 5.4\times10^{-3} + 25 = \underline{25.01\ \text{m/s}}$

Scanned with CamScanner

14. $V_T = 3.00\times10^{5}$ m/s , $V_G = 1.5\times10^{6}$ m/s

$f = 6.00\times10^{14}$ Hz.

$V_{observed} = V_{source}\sqrt{\frac{1+v/c}{1-v/c}}$

$V$ is positive when source is approaching

(a) $V_A = V_T - V_G = 3.0\times10^{5} - 1.5\times10^{6} = -1.2\times10^{6}$ m/s

$\frac{v}{c} = \frac{-1.2\times10^{6}}{3\times10^{8}} = -4.0\times10^{-3}$

$f_A = f_{source}\sqrt{\frac{1+v/c}{1-v/c}} = 6\times10^{14}\sqrt{\frac{0.996}{1.004}}$

$= 5.976\times10^{14}$ Hz.

(b) $V_B = -V_T - V_G = -3\times10^{5} - 1.5\times10^{6} = -1.8\times10^{6}$

$v/c = \frac{-1.8\times10^{6}}{3\times10^{8}} = -6\times10^{-3}$

$f_B = f_{source}\sqrt{\frac{1+v/c}{1-v/c}} = 6\times10^{14}\sqrt{\frac{0.994}{1.006}}$

$= 5.964\times10^{14}$ Hz.

16. Intensity $= 49$ W/m²

A) $I = I_0/2 = 49/2 = 24.5$ W/m²

30 30
-30 60
60 30

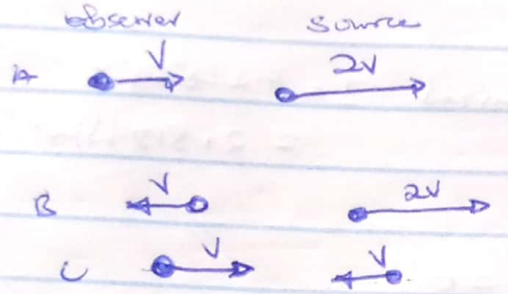
$S_t = 24.5\cos^2(30-30) = 24.5$ W/m²

(B) $S_t = 24.5\cos^2(60+30) = 0$

c) $S_t = 24.5\cos^2(60-30) = 18.38$ W/m²

15
$\overline{\overline{18}}$

$f = 4.57 \times 10^{14}\ Hz$
$V = 2.7 \times 10^{6}\ m/s$




$V_A = V_S - V_O = V - 2V = -V$

$\frac{V_A}{c} = \cancel{\frac{2.7 \times 10^{6}}{4.57 \times 10^{14}}} = \frac{-2.7 \times 10^{6}}{3.0 \times 10^{8}} = -9.00 \times 10^{-3}$

$f_A = f_{source} \sqrt{\frac{1 - 9.00 \times 10^{-3}}{1 + 9.00 \times 10^{-3}}}$

$= 4.57 \times 10^{14} \left[\frac{0.991}{1.009}\right] = 4.488 \times 10^{14}\ Hz.$

$V_B = -V - 2V = -3V = -8.1 \times 10^{6}\ m/s$

$\frac{V_B}{c} = \frac{-8.1 \times 10^{6}}{3 \times 10^{8}} = -2.7 \times 10^{-2}$

$f_B = 4.57 \times 10^{14} \sqrt{\frac{0.973}{1.027}} = 4.33 \times 10^{14}\ Hz$

$V_C = -V + V = 0$

$f_C = 4.57 \times 10^{14} \sqrt{\frac{1+0}{1-0}} = 4.57 \times 10^{14}\ Hz.$

(17) 93%

$S/S_0 = 0.93$    $S$ = amt of light leaving
$S_0$ = amt of light entering

$S/S_0 = \cos^2\theta$
$0.93 = \cos^2\theta$
$0.9644 = \cos\theta \Rightarrow \theta = 15.34°$    $\theta = 90 - 15.34 = \underline{\underline{74.66°}}$
$\theta = \underline{105.3°}$

18 Intensity of incident light = $4.2\ W/m^2$

Sol

$I = I_0 \cos^2 \theta$

$I = 4.2 \cos^2 \theta = 4.2\ W/m^2$ Unpolarized $I = 4.2 \cos^2 35 =$

Polarized parallel to z-axis $= 2.818\ W/m^2$

$I = I_0 \cos^2 \theta = 4.2 \cos^2 90 = 0$

$I = I_0 \cos^2 \theta = 4.2 \cos^2 55 = 1.382\ W/m^2$

Polarized parallel to y-axis

$I = I_0 \cos^2 \theta$

$= 4.2 \cos^2 90 = 0$

$I = I_0 \cos^2 \theta = 4.2 \cos^2 \cancel{55} = 1.382\ W/m^2$