Final exam answers

Form A
1) D
2) C
3) B
4) C
5) B
6) C
7) A
8) A
9) B
10) B
11) B
12) A
13) A
14) D
15) C
16) A
17) A
18) C
19) A
20) D
21) A
22) D
23) A
24) C
25) D

Form B

1) A
2) B
3) B
4) C
5) C
6) A
7) A
8) A
9) B
10) B
11) B
12) A
13) B
14) B
15) A
16) A
17) C
18) B
19) C
20) D
21) D
22) B
23) B
24) A
25) C

Form C
1) C
2) D
3) D
4) C

5) B
6) A
7) A
8) D
9) A
10) D
11) B
12) D
13) A
14) D
15) D
16) B
17) C
18) C
19) C
20) B
21) A
22) B
23) A
24) D
25) A

Physics 1C Fall 2007

Final Exam form A

1)

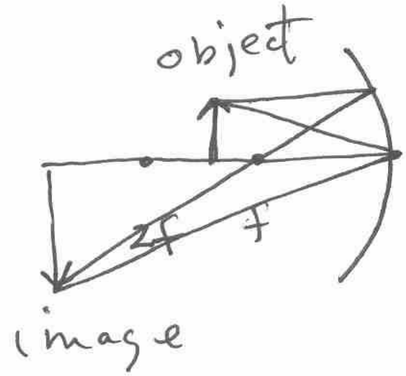
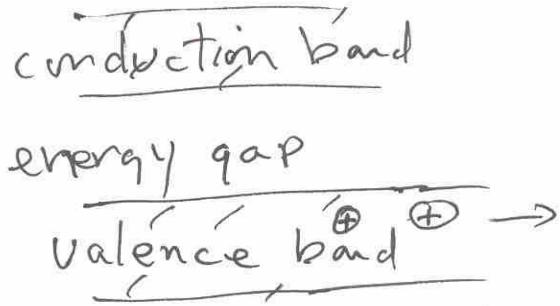


image is real
inverted and magnification
greater than 1

(D)

2)



To produce a p type semiconductor an impurity is added to produce <u>holes</u> in the <u>valence</u> band (C)

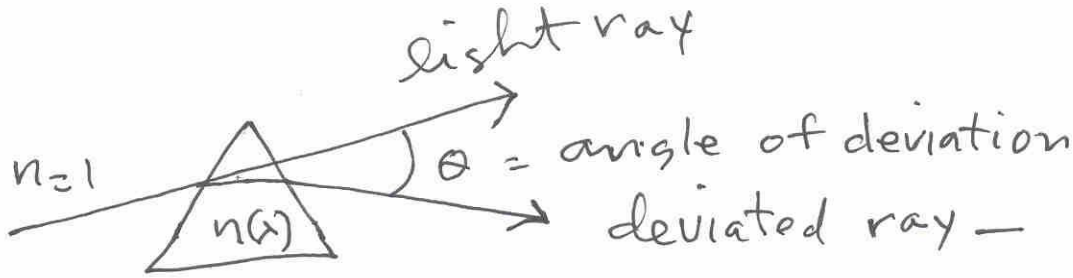
3) $^{239}Pu \longrightarrow$ products

energy released = no. of nucleons $\times \left(\frac{\Delta E}{\text{nucleon}}\right)$

$= 239 \text{ nucleons} \left(8.5 - 7.7\right) \text{MeV/nucleon} = 191 \text{ MeV}$

(B)

4)



The refractive index for violet light is the greatest. θ increases as n increases. Therefore violet light has the largest angle of deviation

5) Cell phones use microwave radiation

$f \sim 10^{10}\ Hz \sim$ GigaHz.

$$\lambda = \frac{c}{f} \cong \frac{3 \times 10^8}{10^{10}} = 3 \times 10^{-2}\ m$$

$$\sim 10^{-1}\ m$$

about the length of a cell phone antenna.

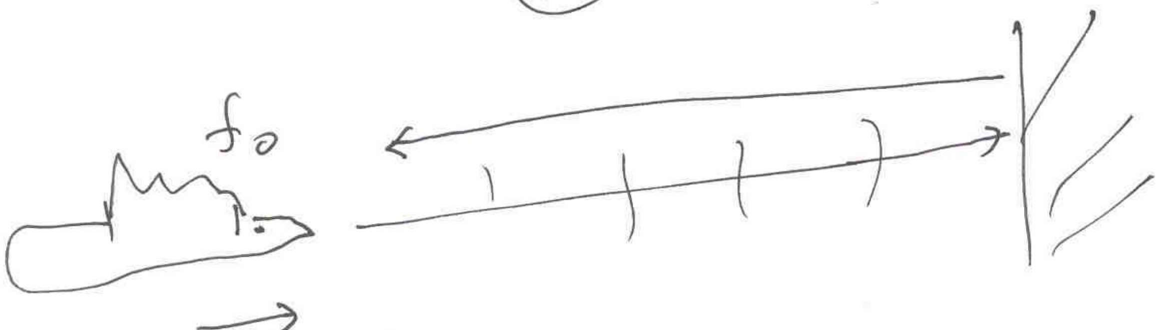
(B)

6) For $l = 4$ m_e can have values of $-4, -3, -2, -1, 0, 1, 2, 3, 4$

9 values for m_e (C)

7) When high voltage is applied to a low pressure gas the spectrum is line emission i.e. like the Balmer series for the hydrogen atom

(A)

8) 

$V_b = 5.00$ m/s

The frequency is shifted twice - once by the wall - (moving source)
once as viewed by the bat (moving observer)
(Both shifts increase the frequency)
the net frequency is.

$$f = f_o \frac{(V_{sound} + V_b)}{(V_{sound} - V_b)}$$

$$f = 50 \cdot \frac{(340 + 5)}{(340 - 5)} = 51.5 \text{ kHz}$$

9) $\beta = 10 \log \frac{I}{I_0}$

$\beta' = 10 \log \frac{100 I}{I_0}$

$= 10 \log \frac{I}{I_0} + 10 \log 100$

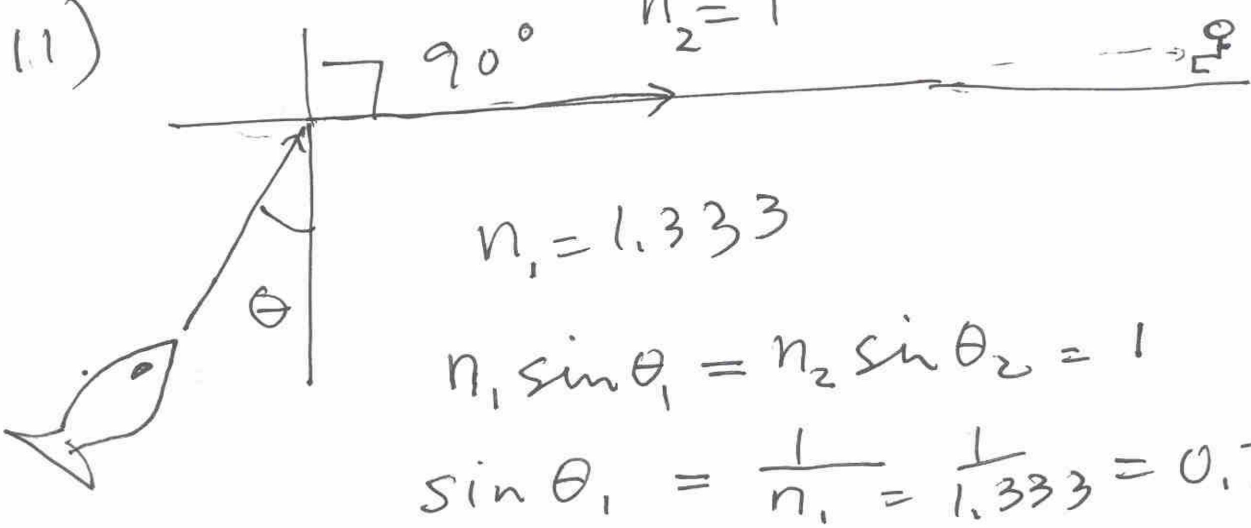
$\beta' = \beta + 20 \text{ dB}$

The new β' is 20 dB greater

(B)

10) In a nuclear reactor the control rods are used to <u>capture neutrons</u> (B)

11)



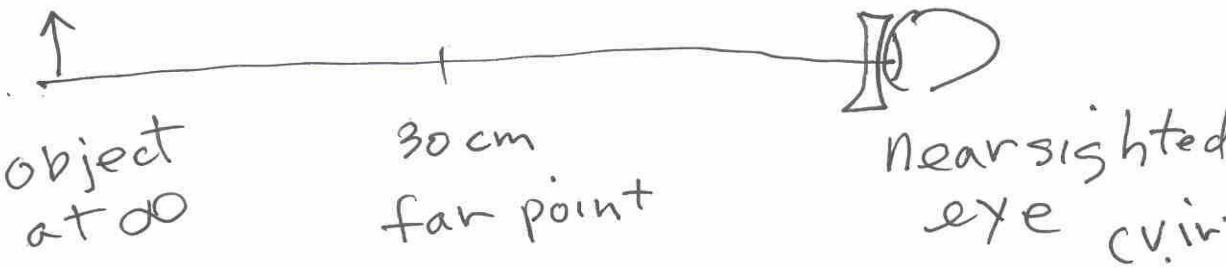
$n_1 = 1.333$

$n_1 \sin\theta_1 = n_2 \sin\theta_2 = 1$

$\sin\theta_1 = \frac{1}{n_1} = \frac{1}{1.333} = 0.750$

$\theta_1 = 48.6°$

12.



The corrective lens should form an (virtual) image of an object placed at infinity at 30 cm (the point where the eye can see it)

Thin lens equation

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

$$\frac{1}{\infty} + \frac{1}{-30} = \frac{1}{f}$$

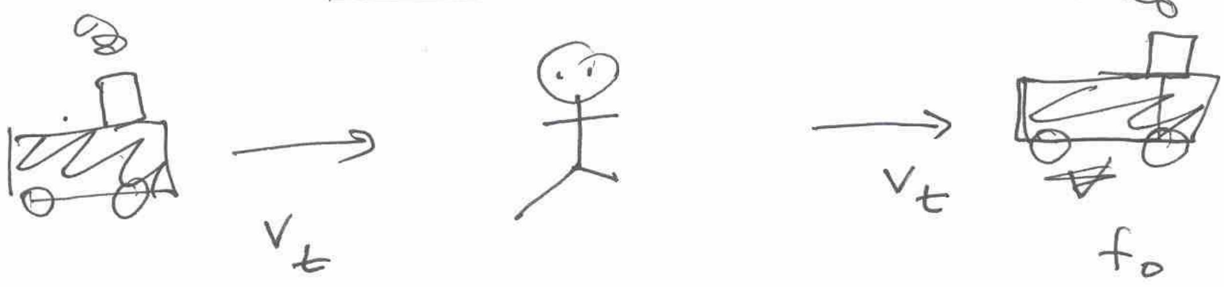
$$f = -30 \text{ cm}$$

(note q is -30 cm since it is virtual & it needs to be virtual to be upright)

$$P = \frac{1}{f} = \frac{1}{-0.3} = -3.3 \text{ m}^{-1} \text{ (diopters)}$$

moving source

13.



$$f_+ = f_0 \frac{V}{V - V_t}$$

$$f_- = f_0 \frac{V}{V + V_t}$$

Take the ratio $\frac{f_+}{f_-} = \frac{V + V_t}{V - V_t} = \frac{1000}{800} = 1.25$

$$V + V_t = 1.25\,(V - V_t)$$

$$1.25V - V = 1.25V_t + V_t$$

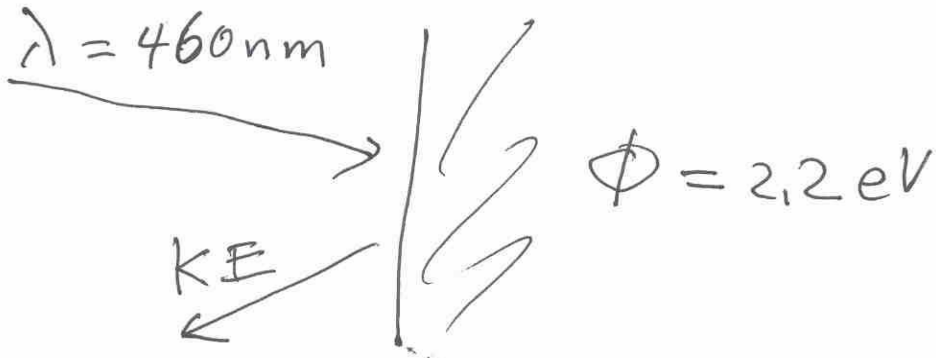
$$0.25V = 2.25V_t$$

$$V_t = \frac{0.25}{2.25}V = \frac{0.25}{2.25}(340)$$

$$V_t = 37.8\,\text{m/s}$$

(A)

14)



$$hf_{photon} = KE + \phi$$

$$hf = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}(3\times10^{8})}{460\times10^{-9}} =$$

$$= \frac{4.3\times10^{-19}\,J}{1.6\times10^{-19}\,J/eV} = 2.7\,eV$$

$$KE = hf - \phi = 2.7 - 2.2 = \boxed{0.5\,eV}$$

(D)

15)

$$V = \sqrt{\frac{T}{\mu}}$$

$$V' = \sqrt{\frac{1.2T}{\mu}} = \sqrt{1.2}\,V = 1.095V$$

$$V' = 1.095(60) = \boxed{66\,m/s}$$

(C)

16)

$I = 1000\ W/m^2$

Solar cell

$1\ cm^2 = \left(10^{-2}\ \frac{m}{cm}\right)^2 = 10^{-4}\ m^2$

$I = 0.2A$

area $= 10\ cm^2 = 10 \times 10^{-4}\ m^2$

$= 10^{-3}\ m^2$

power output

$V = 0.8V$

$$\text{Power in} = I \cdot A = 1000\ W/m^2\ (10^{-3}\ m^2)$$

$$P_{in} = 1.00\ W$$

$$\text{Power out} = IV$$

$$\text{efficiency} = \frac{P_{out}}{P_{in}} = \frac{IV}{P_{in}}$$

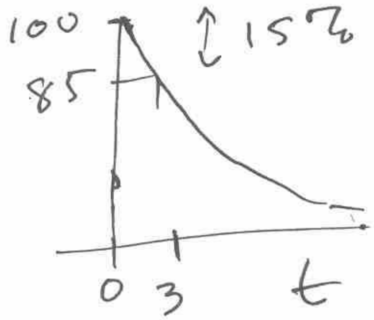
$$e = \frac{(0.2)(0.8)}{1.00} = 0.16$$

16% efficiency (A)

17). Classical theories of black body radiation predicted that most of the energy should be radiated as ultraviolet light.

Ultraviolet catastrophe.

18)



$$N = N_0 \left(\frac{1}{2}\right)^{t/T_{1/2}} = N_0 \left(\frac{1}{2}\right)^n$$

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$$

$$\frac{85}{100} = \left(\frac{1}{2}\right)^n$$

$$0.85 = 0.5^n$$

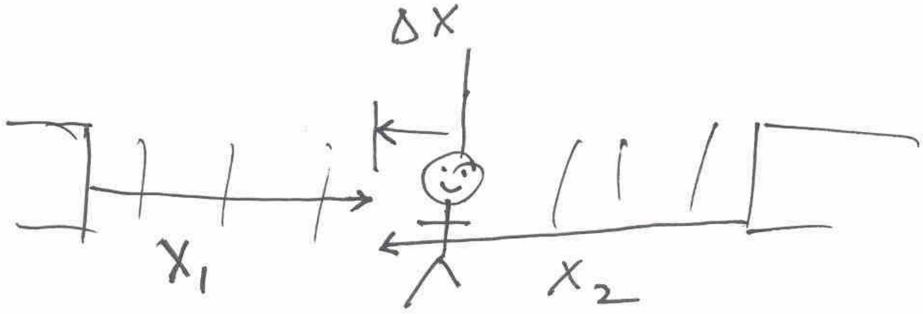
$$\ln 0.85 = n \ln(0.5)$$

$$n = \frac{\ln 0.85}{\ln 0.5} = 0.234 = \frac{t}{T_{\frac{1}{2}}}$$

⇑

$T_{\frac{1}{2}} = \frac{t}{0.234}$
$T_{1/2} = \frac{3}{0.234} =$
$T_{\frac{1}{2}} = 12.8$ hrs

19)



Initially path difference = 0 (in phase)

∴ constructive interference

The path difference is

$\delta = X_2 - X_1 = 2\Delta X$

for destructive interference (minimum intensity)

$\delta = (m + \frac{1}{2})\lambda \quad (m = 0, 1 \ldots)$

The first minimum is at $m = 0$

The second minimum is at $m = 1$

$\delta = \frac{3}{2}\lambda = 2\Delta X$

$\Delta X = \frac{3}{4}\lambda = \frac{3}{4}\frac{V_s}{f} = \frac{3}{4}\frac{(340 \text{ m/s})}{500 \text{ Hz}}$

$\Delta X = \boxed{0.51 \text{ m}}$

(A)

20)

for a pipe closed at one end open at the other

$$\lambda_1 = 4L$$

$$f_1 = \frac{V_s}{\lambda_1} = \frac{V_s}{4(L)} = \frac{340}{4(L)}$$

allowed frequencies ar

$$f_n = n f_1 \qquad n = 1, 3, 5, \ldots$$

odd harmonics

the difference between two harmonics is

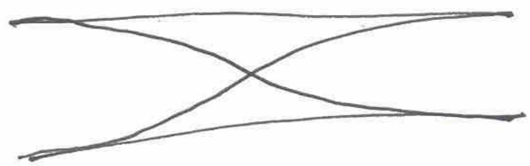
$$f_n - f_{n-2} = 2f_1$$

$$f_1 = \frac{f_n - f_{n-2}}{2} = \frac{650 - 550}{2} = 50\,Hz$$

$$L = \frac{V_s}{4f_1} = \frac{340}{4(50)} = \boxed{1.7\,m}$$

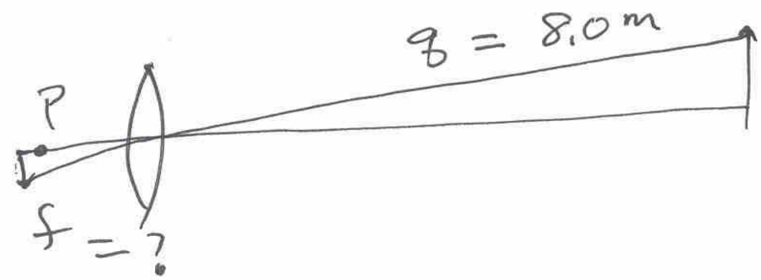
(D)

21. Two ends open



The standing wave must have at least 2 antinodes and 1 node – (A)

22.



$$\frac{q}{p} = 10$$

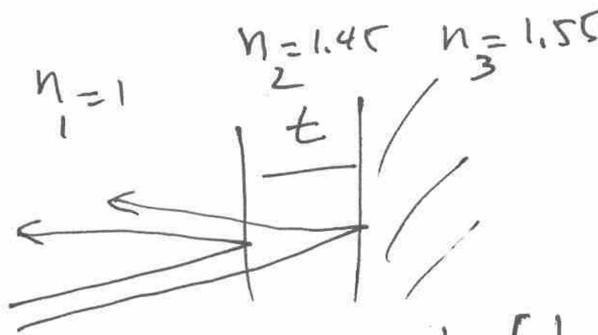
$$p = \frac{q}{10} = \frac{8}{10} = 0.8 \text{ m}$$

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

$$\frac{1}{0.8} + \frac{1}{8} = \frac{1}{f}$$

$$f = \frac{8(0.8)}{8+0.8} = \boxed{0.73 \text{ m}}$$

23)



no phase shift between reflected rays

∴ for destructive interference

$$\delta = 2t = (m + \tfrac{1}{2})\frac{\lambda}{n_2}$$

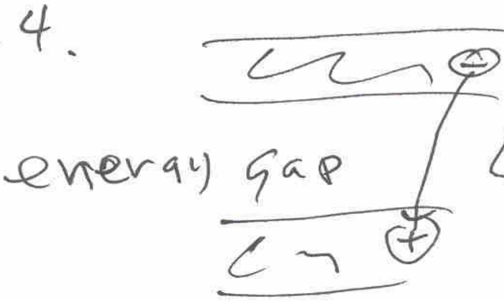
$$\lambda = \frac{2 t n_2}{m + \frac{1}{2}} = \frac{2(90)(1.45)}{m + \frac{1}{2}}$$

for $m = 0$ $\boxed{\lambda = 522 \text{ nm}}$

~~for m = 1 λ =~~

closest to 510 nm (A)

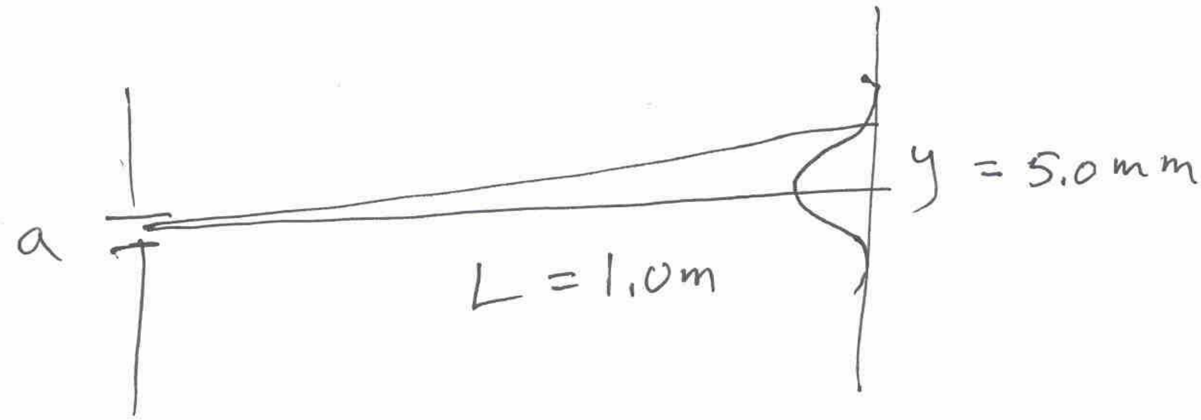
24.



$$\Delta E = hf = \frac{hc}{\lambda}$$ (C)

The wavelength is dependent on the energy gap.

25)



$a \sin\theta = \lambda$

$a\left(\frac{y}{L}\right) = \lambda$

$a = \frac{\lambda L}{y} = \frac{580 \times 10^{-9}(1.0)}{5 \times 10^{-3}}$

$a = 1.16 \times 10^{-4} = \boxed{0.12 \text{ mm}}$

(D)