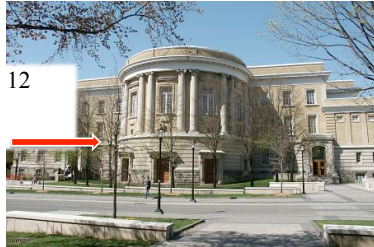


PHY132H1F Introduction to Physics II
Class 8 – **Outline:**

- Finishing up Chapter 25
- Review of Chs 20, 21, 23, 24, 25

Test Tuesday Oct. 12
6:00pm-7:30pm
SF 3201



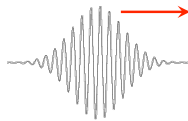
Last time: The Photon Model of Electromagnetic Waves

$$E_{\text{photon}} = hf$$

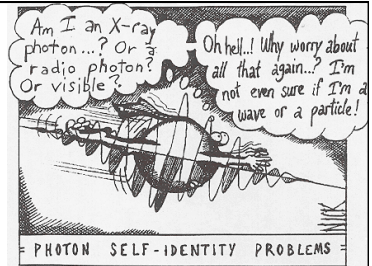
where f is the frequency of the electromagnetic waves, and h is a *universal constant* called **Planck's constant**. The value of Planck's constant is $h = 6.63 \times 10^{-34}$ J s.

Which has more energy?

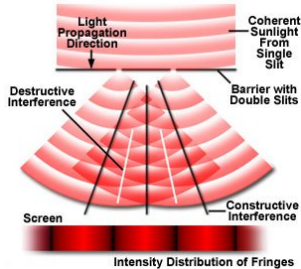
- A. A red photon.
- B. A green photon.
- C. A blue photon.



The Wave / Particle Duality



- Some experiments, such as the double-slit experiment, clearly show that Electromagnetic Radiation is a **WAVE**. It interferes and it has a frequency and wavelength.
- Other experiments, such as the photoelectric effect, clearly show that Electromagnetic Radiation is a **STREAM OF PARTICLES**. It is granular and the individual point-particles have position and velocity.



Double Slit Experiment

- The bright fringes in a double-slit experiment are places where the waves from each slit interfere constructively. The dark fringes correspond to destructive interference from the two slits.
- When you count photons, you find that photons are **more likely** to fall at the location of the bright fringes than at the dark fringes. When enough have fallen, you see the same pattern as you predict for waves.
- This works even if you let the photons go through the slits **one at a time!**

Double Slit Experiment

- Also, the double slit experiment works if you use electrons instead of photons. The wavelength of electrons is usually smaller, though, so the fringes are very close together.
- Also, it works with protons, neutrons and helium nuclei. Again, the fringes are very closely spaced, so it's more difficult to do the experiment as the mass of the particles increases.
- But we believe that it would work with bullets, baseballs and even people. They would all constructively and destructively interfere if passed through a double slit.

The de Broglie Wavelength

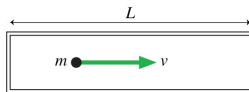
De Broglie postulated that a particle of mass m and momentum $p = mv$ has a wavelength

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

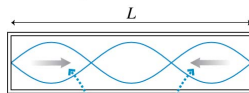
where h is Planck's constant. This wavelength for material particles is now called the **de Broglie wavelength**. It depends *inversely* on the particle's momentum, so the largest wave effects will occur for particles having the smallest momentum.

FIGURE 25.16 A particle of mass m confined in a box of length L .

- (a) A classical particle of mass m bounces back and forth between the ends.



- (b) Matter waves moving in opposite directions create standing waves.



An atom is like a "box" for an electron. The electron is confined, and forms a standing wave based on its de Broglie wavelength.

Periodic Table of the Elements

1	H	2	He																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
3	Li	4	Be	5	B	6	C	7	N	8	O	9	F	10	Ne																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
11	Na	12	Mg	13	Al	14	Si	15	P	16	S	17	Cl	18	Ar																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
19	K	20	Ca	21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
37	Rb	38	Sr	39	Y	40	Zr	41	Nb	42	Mo	43	Tc	44	Ru	45	Rh	46	Pd	47	Ag	48	Cd	49	In	50	Sn	51	Sb	52	Te	53	I	54	Xe																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
55	Cs	56	Ba	57-70	Lu	71	Hf	72	Ta	73	W	74	Re	75	Os	76	Ir	77	Pt	78	Au	79	Hg	80	81	Tl	82	Pb	83	Bi	84	Po	85	At	86	Rn																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
87	Fr	88	Ra	89-102	Lr	103	Rf	104	Db	105	Sg	106	Bh	107	Hs	108	Mt	109	Uun	110	Uu	111	Uub	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000

* Lanthanide series

57	La	58	Ce	59	Pr	60	Nd	61	Pm	62	Sm	63	Eu	64	Gd	65	Tb	66	Dy	67	Ho	68	Er	69	Tm	70	Yb
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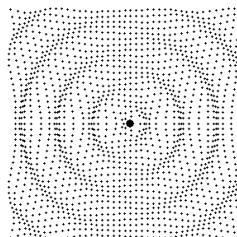
* Actinide series

89	Ac	90	Th	91	Pa	92	U	93	Np	94	Pu	95	Am	96	Cm	97	Bk	98	Cf	99	Es	100	Fm	101	Md	102	No
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The Periodic Table is one of the predictions of Quantum Physics

Ch.20

- One-dimensional waves
- Sinusoidal Waves
- Waves in 2-D and 3-D
- Spherical waves and plane waves
- Power and Intensity of Waves (Decibels)
- The Doppler Effect



Valerie is standing by the side of the road. A police car with a siren that has a frequency of f_0 is driving down the road towards her at a constant velocity. As it drives toward her, she hears a frequency, f .

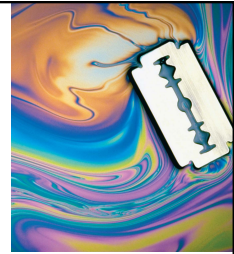
- A. $f > f_0$
- B. $f < f_0$
- C. $f = f_0$

Valerie is standing by the side of the road. A police car with a siren that has a frequency of f_0 is driving down the road towards her at a constant velocity. As it drives toward her, she hears a frequency, f .

- A. f is constant.
- B. f is not constant: it decreases with time.
- C. f is not constant: it increases with time.

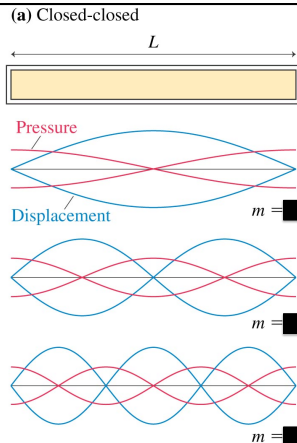
Ch.21

- Principle of Superposition
- Standing Waves on a String
- Standing Sound Waves in closed-closed, open-open, and closed-open tubes
- Wave Interference
- Beats



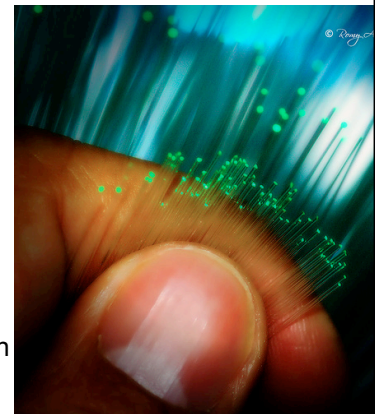
From top to bottom, what are the mode numbers of these standing sound waves?

- A. $m = 1, m = 2, m = 3$
- B. $m = 2, m = 3, m = 4$
- C. $m = 2, m = 4, m = 6$
- D. $m = 1, m = 3, m = 5$
- E. $m = 3, m = 5, m = 7$



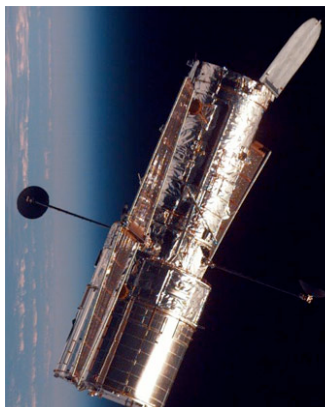
Ch.23

- Reflection and Refraction
- Fibre-Optics
- Colour and Dispersion
- Thin Lens Equation
- Image Formation



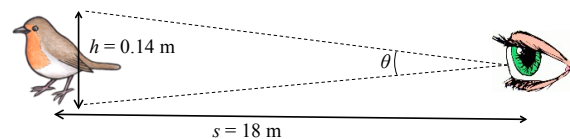
Ch.24

- Lenses Used in Combination
- Vision
- Telescopes
- Microscopes



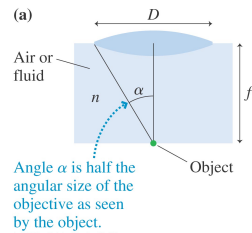
End of Chapter Problem 24.15

- You use your $8\times$ binoculars to focus on a 14 cm long bird in a tree 18 m away from you. What angle (in degrees) does the image of the warbler subtend on your retina?



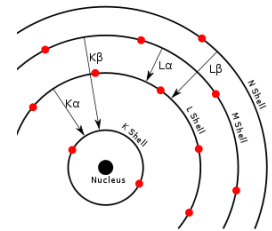
End of Chapter Problem 24.19

- A $20\times$ microscope objective is designed for use in an oil immersion microscope with a 16 cm tube length. The lens is marked $NA = 0.90$. What is the diameter of the objective lens?



Ch.25

- The Hydrogen Atom
- Photons
- The de Broglie wavelength
- Quantum Physics



Before The Test:

- The test on Tuesday, Oct. 12 will cover Chapters 20 - 25 (excluding Ch.22).
- Try the suggested end-of-chapter problems for Chapter 25

*See you Tuesday Evening
at 6:00 in SF 3201.*