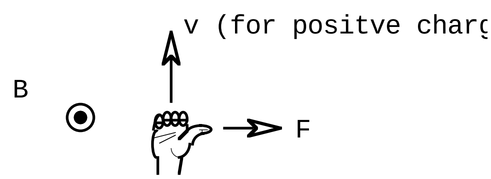
AP Physics | **Physics B Exam - 1998** | Solutions to Multiple Choice

	BASIC IDEA	SOLUTION	ANSWER
#1.	$v = at + v_i$	The acceleration of all object near the earth surface and in a vacuum is the same, that is 9.8 m/s^2	B
#2	$P = \frac{W}{t}$	$P = \frac{W}{t} = \frac{700N \cdot 8m}{10s} = 560$ W	C
#3.	Cons. of momentum $\vec{p} = m\vec{v}$	$mv + M(0) = (m + M)\, v_f \;\therefore\; v_f = \frac{mv}{m + M}$	E
#4.	Cons. of momentum $\vec{p} = m\vec{v}$	Refering to the "rain plus car" system, there is no external force in the x direction so momentum in that direction is conserved. We have an increasing mass and therefore a decreasing velocity.	C
#5.	$P = \frac{W}{t}$	Watt = $\frac{\text{Joule}}{\text{second}}$ but kilowatt·hr = $1000\frac{J}{s} \cdot 3600s = 3\,600\,000$ J This last is a unit of work nor of power.	C
#6.	$L = r_{\perp}p$	$L = (4m)(2kg)(3m/s) = 24\,\frac{kg \cdot m^2}{s}$	E
#7.	Newton's 1st Law $\Sigma\vec{F} = 0 \leftrightarrow \vec{a} = 0$	Choice I expresses this fact. No other restrictions apply	A
#8.	Cons. of Energy $U = \frac{1}{2}kx^2$	$U + K = \text{constant} \;\therefore\; K = \text{constant} - U = \text{constant} - \frac{1}{2}kx^2$ This should be recognized as having a graph that is a parabola and that is concave downward.	D
#9.	$\Sigma\vec{F} = 0 \leftrightarrow \vec{a} = 0$ $F = \mu N$ $P = Fv$	Applied force must be equal in magnitude to the friction. $P = \mu Nv = \mu mgv$	A
#10.	X-rays have high energy.	The energy step from the 1st level to the next is the largest Same principal quantum number would be a low energy difference.	A
#11.	Diffraction is a wave phenomenon	Both other experiments involve the particle nature of the electron.	B
#12.	Cons. of charge	There is no principle of conservation of protons or nucleii	A
#13.	$\vec{E} = \frac{\vec{F}}{q}$	$\vec{F} = q\vec{E}$ If the field is uniform, the net force on the sphere reqardless of the distribution of charge will be zero.	A
#14.	$\Delta V = Ed$	$E_o = \frac{\Delta V_o}{d_o}$ now $E = \frac{2\Delta V_o}{\frac{1}{5}d_o} = 10\,E_o \;\therefore\; E = 10(2{,}000) = 20000\frac{N}{C}$	E

#15.	$R_{series} = R_1+R_2$ $\frac{1}{R_{\parallel}} = \frac{1}{R_1} + \frac{1}{R_2}$	For top branch: R = 1Ω + 3Ω = 4Ω. Then top and bottom in parallel gives: $\frac{1}{R_{\parallel}} = \frac{1}{4\Omega} + \frac{1}{2\Omega} = \frac{3}{4\Omega}$ or $R = 1\frac{1}{3}\ \Omega$	A
#16.	V = IR	The same potential difference is applied across the top and bottom branches. Because the lower branch has a smaller resistance, the current through that branch will be greater.	E
#17.	$\vec{E} = \frac{\vec{F}}{q}$	The field at P caused by the +Q at the upper left will be downward, and the field at P caused by the +Q at the lower right will be to the left. The vector sum gives a result that is downward to the left.	C
#18.	$V = \frac{1}{4\pi\varepsilon_o}\frac{q}{r}$ U = qV	Potential is a scalar so the result is the simple sum. $V = \frac{1}{4\pi\varepsilon_o}\frac{Q}{d} + \frac{1}{4\pi\varepsilon_o}\frac{Q}{d} = \frac{2}{4\pi\varepsilon_o}\frac{Q}{d}$ then $U = \frac{2}{4\pi\varepsilon_o}\frac{qQ}{d}$	D
#19.	$\Phi_B = B_{\perp}A$	$\Phi_B = (2T)(.05m)(.08m) = 8 \infty 10^{-3}\ T/m^2$	C
#20.	P = IV $P = \frac{W}{t}$	P = 4A(120V) = 480 W = 0.48 kW. W = Pt = 0.48kW(2hrs) =.96 kW·hrs @10¢/kW·hr = 9.6¢	D
#21.	right hand rule	"fingers of the right hand in the direction of motion of the positive charge, then bent in direction of B field. Extended thumb points in direction of the force."	A

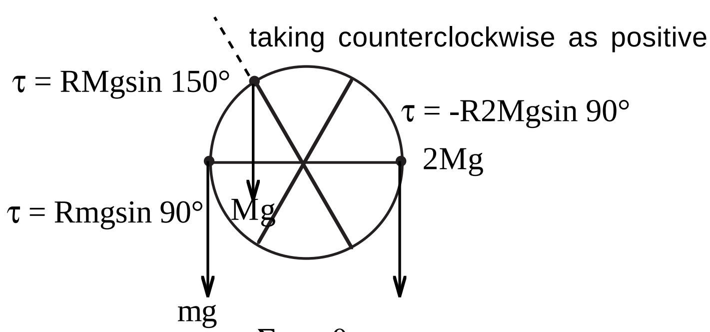


#22.	W = PΔV	Area under the curve represent the work.	A
#23.	PV = nRT	Greatest Temperature for the greatest product PV.	A
#24.	$\Delta U = Q - W_{by}$ *or* $\Delta U = Q + W_{on}$	ΔU = 400J - 100J = 300J (W_{by} means work done by the gas. W_{on} is the work done on the gas.)	C
#25.	Q = cmΔT Q = mL	Three processes: warm to melting point then melt the warm to final temperature. $Q = c_i m(273 - T_1) + mL + c_w m(T_2 - 273)$ $Q = m[c_i (273 - T_1) + L + c_w(T_2 - 273)]$	B
#26.	$f = \frac{R}{2}$	Because of the great distance the image is almost at the focal length. $f = \frac{1m}{2} = .5m$	B

#27.	$\frac{n_1}{n_2} = \frac{v_2}{v_1}$ $f\lambda = v$	Index of ref. of water is > index of ref. for air $\therefore v_w < v_{air}$ Because the frequency must remain the same a smaller velocity implies a shorter wavelength.	E
#28.	$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$ $M = \frac{h_i}{h_o} = -\frac{q}{p}$	$\frac{1}{6} + \frac{1}{q} = \frac{1}{9}$ $\quad \frac{1}{q} = \frac{1}{9} - \frac{1}{6} = \frac{-1}{18}$ $\quad q = -18cm$ $M = -\frac{-18cm}{+6cm} = 3$	D
#29.	• reflection at a fixed boundary • speed depends on the medium • energy conservation	Wave changes phase, that is it is "flipped over" Speed stays the same. Amplitude decreases as the result of dissipation. Cannot gain energy.	B
#30.	$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$ $\frac{h_i}{h_o} = -\frac{q}{p}$	$\frac{1}{1.5f} + \frac{1}{q} = \frac{1}{f} \therefore q = 3f$ (real) and $h_i = -\frac{3f}{1.5f} h_o = -2h_o$ (larger)	D
#31.	$n_1\sin\theta_1 = n_2\sin\theta_2$	Apply Snell's law to the two surfaces $n_1\sin\theta_1 = n_2\sin\theta_2 = n_3\sin\theta_3$ since the ray in 1 in parallel to the ray in 3, $\theta_1 = \theta_3$ and we have $n_1\sin\theta_1 = n_3\sin\theta_1$ and $n_1 = n_3$	A
#32.	half-life	One half of the substance has decayed in the first half hour. Two further half-lives will bring it to 500 counts per minute.	B
#33.	${}^{A}_{Z}X = {}^{A}_{Z+1}? + \beta$ γ is an electromagnetc emission	${}^{214}_{82}Pb = {}^{214}_{83}? + \beta$ That the new nucleus is Bi is not required to answer Beta decay involves the decay of a neutron into a proton. Gamma decay involves the change in energy of the nucleus.	D
#34.	$\lambda = \frac{h}{p}$	$\lambda_1 = \frac{h}{p_1} \quad \lambda_2 = \frac{h}{p_2} = \frac{h}{2p_1} = \frac{1}{2}\lambda_1$	B
#35.	Rutherford Scattering	Rutherford scattering involves the detection of the nucleus by bombardment with alpa particles. Collisions and electrostatic repulsion are involve but not quantum theory.	A
#36.	half-life	time period in which one half of a sample has decayed	A
#37.	$\lambda = \frac{h}{p}$ $f\lambda = v$	from the second equation we get $\lambda = \frac{c}{f}$ and substituting this into the first gives $\frac{c}{f} = \frac{h}{p}$ and the f is proportional to the momentum.	A
#38.	$F = kx$ $U = mgh$ $U = \frac{1}{2}kx^2$ cons. of energy	$3.0kg(10m/s^2) = k(0.12m) \therefore k = 250$ N/m $U = 4(10)h$ by conservation of energy this will become the U of spring as the spring reaches max. elongation, that is when the kinetic energy is zero, $4(10)h = \frac{1}{2}250(h)^2 \therefore h = 0.32m = 32$ cm	D

#39.	$F = G\frac{Mm}{r^2}$	$W = G\frac{Mm}{R^2}$ $W_2 = G\frac{Mm}{(4R)^2} = \frac{1}{16}W$	E
#40.	$F = G\frac{Mm}{r^2}$ $F = ma$ $a_c = \frac{v^2}{r}$ $k = \frac{1}{2}mv^2$	$G\frac{Mm}{R^2} = ma = m\frac{v^2}{R}$ then $mv^2 = G\frac{Mm}{R}$ and $K = \frac{1}{2}G\frac{Mm}{R}$	B
#41.	cons. of momentum	$p_{yi} = 0 = p_{yf} = m_1v_1 + m_2v_2$	A
#42.	$n_1\sin\theta_1 = n_2\sin\theta_2$	As the indices of refract become closer the refraction becomes less (approaching zero) for all colors	E
#43.	$\vec{p} = m\vec{v}$ slope of a d vs. t graph represents velocity	constant mass, so momentum increases if and only if velocity increases. Slope and therefore velocity increases in III, not inI or II.	B
#44.	$\Sigma\vec{F} = 0 \leftrightarrow \vec{a} = 0$	Since a must be zero the velocity must be constant. In I and II the slope is constant.	C
#45.	$\mathcal{E} = -\frac{\Delta\Phi}{\Delta t}$	D is the only choice which doesn't involve a change of flux	D
#46.	$W = W = Fd\cos\theta$	$W = Fd\cos\theta$ The force is always perpendicular to the motion therefore no work is done. The force of a constant magnetic field on a moving charge is always perpendicular to the instantaneous displacement.	A
#47.	$F = qvB$ $F = m\frac{v^2}{r}$	The magnetic field supplies the centripetal force on the protons. Setting the two equal and solving for v gives $v = \frac{qBr}{m} = \frac{(1.6\times10^{-19})(0.1)(0.1)}{(1.67\times10^{-27})}$ equals approx 10^6	C
#48.	Lenz's Law	Field out of the page is decreasing. The induced current will try to maintain the flux. The right hand rule would give a counter clockwise current to produce a field out of the page.	D
#49.	Doppler Effect	An apparent increase in frequency occurs when the source approaches and listener. A decrease occurs when the source is receding from the listener.	C
#50.	$D_o = -D_i$	The image of the each part of the arrow will be the same distance behind the mirror as that part is in front, and each part will appear directly opposite itself in the mirror. (ray tracing will demonstrate this last point)	D
#51.	$\lambda = \frac{d}{n}\sin\theta$	1st order constructive interference therefore n = 1. Solve for d you have $d = \frac{\lambda}{\sin\theta} = \frac{0.12\text{m}}{3/5} = 0.20$ m	D

#52.	isothermal $PV = nRT$	Isothermal means $T_1 = T_3$. From the graph at *point 2* P is the same as at *1*, and V is greater so the product PV is greater and the temperature must be higher at *point 2* than it is at *point 1*. $T_2 > T_1$	B
#53.	$\rho = \frac{M}{B}$	Changing the temperature doesn't change the mass and the volume is given as constant, so the density doesn't change.	C
	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$	Doubling the temperature will double the pressure.	
#54.	Avogadro's Number *or* diameter of an atom is ♠ 0.1nm	Clearly the mass of the entire pin head is less than one mole. This eliminates all but choices A) and B). Choice A) is far too small to be reasonable. It is almost countable. A more certain answer can be arrived at if the student is aware of the Bohr radius and can therefore estimate the diameter of an atom: Area of the pinhead = πr_p^2 and the area of an atom is about πr_a^2, therefore the approximate number of atoms that would fit on the top is $\frac{\pi r_p^2}{\pi r_a^2} = \frac{(0.5\times10^{-3}\text{ m})^2}{(0.05\times10^{-9}\text{m})^2} = \frac{(0.5\times10^{-3}\text{ m})^2}{(0.5\times10^{-10}\text{m})^2} = 10^{14}$	B
#55.	photoelectric effect $E = hf$ $f\lambda = c$	Less kinetic energy implies photon has a lower frequency, that is a increased wavelength. To have more electrons ejected more photons must hit, therefore the light must be of greater intensity.	B
#56.	$T = \frac{2\pi}{\omega}$	This is simply the period of the mathematical function.	D
#57.	$Ft = \Delta p$	The impulse is Ft and equals the change in momentum. $\Delta p = 0.4\text{kg}(5.0\text{m/s}) - 0 = 2\text{ kg}\bullet\text{m/s or } 2\text{ N}\bullet\text{s}$	C
#58.	$\Sigma\vec{\tau} = 0$ $\tau = r F \sin\theta$		C



$\Sigma\tau = 0$

$RMg\sin150° + Rmg\sin90° + -R2Mg\sin90° = 0$

$0.5M + m - 2M = 0$

$m = 1.5M = \frac{3M}{2}$

#59.	$\Delta y = v_i t + \frac{1}{2}at^2$	$h = \frac{1}{2}gt^2$ then $t = \sqrt{\frac{2h}{g}}$	E
#60.	$K = \frac{1}{2}mv^2$	$K = K_{horiz} + K_v = \frac{1}{2}mv_o^2 + \frac{1}{2}m(0^2 + 2gh)$	D
	$v_f^2 = v_i^2 + 2a\Delta y$	$K = \frac{1}{2}mv_o^2 + mgh$	
#61.	ideal gas model	Collisions are taken as <u>elastic</u>.	D
#62.	$K = \frac{3}{2}kT$	combining the two equations: $\frac{1}{2}mv_2^2 = \frac{3}{2}kT_2$; $\frac{1}{2}mv_1^2 = \frac{3}{2}kT_1$	C
	$K = \frac{1}{2}mv^2$	dividing the first by the second gives: $\frac{v_2^2}{v_1^2} = \frac{T_2}{T_2} = \frac{600}{300} = 2$	
		taking the root gives $\frac{v_2}{v_1} = \sqrt{2}$	
#63.	cons. of momentum	$p_i = 0 = p_f = p_1 + p_2 \therefore p_1 = -p_2$ and $\lvert p_1\rvert = \lvert p_2\rvert$	C
#64.	$C = \varepsilon_o\frac{A}{d}$	By doubling d, the capacitance is halved. V = E and is constant	B
	$C = \frac{Q}{V}$	so if C is halved the second equation, say the charge must also be halved.	
#65.	$R = \rho\frac{L}{A}$	The same wire, so the cross sectional area of the wire is the same and so is the resistivity, ρ. The outer loop has twice the radius so the circumference, that is the length is double, and it follows from the equation that the resistance is doubled.	D
#66.	$\Phi = BA\cos\theta$	The flux surrounded by the two loops is the same, (note the	C
	$E = -\frac{\Delta\Phi}{\Delta t}$	area is the area of the flux region) so as B changes, the rate of change of the flux through the loops will be the same.	
#67.	cons. of momentum	$\vec{p_i} = \vec{p_f}$ the initial momentum was zero therefore $\vec{p_f} = 0$ The two momentum vectors given add up (by pythagorean therorem) to be $\sqrt{2(mV)^2} = \sqrt{2}$ mV and it is at 45° toward the upper right. To get 0, the momentum of the third piece must be of this magnitude and at 45° to the lower left. Its mass is 3m, so we have $(3m)v = mV\sqrt{2}$ and $v = \frac{\sqrt{2}V}{3}$	D
#68.	$\tau = rF\sin\theta$	Given torque is $\tau = LF\sin\theta$ and it must equal the new torque. $LF\sin\theta = rF\sin 90° = rF$. Solving for r gives $r = L\sin\theta$.	A
#69.	Pauli Excl. Prin.	No two electrons in an atom can occupy the same exact quantum state. Because one can have spin up and an other spin down we can have two in the same energy state.	B
#70.	$W = \frac{1}{2}CV^2$	$W = \frac{1}{2}(4\times10^{-6})(100)^2 = 2\times10^{-2}$ J	E