SAT II PHYSICS

Vector and Forces

torque=force $\times$ length of moment arm

the sum of the clockwise moments=the sum of the counterclockwise moments

Motion and Forces

average speed= $\frac{\text{distance covered}}{\text{time required}}$

average velocity= $\frac{\text{displacement}}{\text{time}}$

distance covered=average speed $\times$ time

$S = v_{av} t$

acceleration= $\frac{\text{change in velocity}}{\text{time required for change}}$

$a = \frac{v_f - v_i}{t} = \frac{v}{t}$

Motion with constant acceleration (starting from rest)

$v_{av} = v_f / 2$

$v_f = at (v_f = gt)$

$S = \frac{1}{2} at^2 (S = \frac{1}{2} gt^2)$

$v_f{}^2 = 2as (v_f{}^2 = 2gs)$

v_{av} = average speed

v_f = final velocity

a = acceleration

t = elapsed time

s = distance covered

$v_{av} = \frac{v_i + v_f}{2}$

$v_f = v_i + at$

$S = v_i t + \frac{1}{2} at^2$

$v_f{}^2 = v_i^2 + 2as$

Ft = change in momentum=mass $\times$ change in velocity

momentum=mass $\times$ velocity

Centripetal Force

$a_c = \frac{v^2}{r}$

SAT Online Physics Practice Tests:

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$$F_c = \frac{mv^2}{r}$$

$$v = \frac{2\pi r}{T}$$

$$a = \frac{4\pi^2 r}{T^2}$$

Gravitational Fields

$$F = \frac{Gm_1 m_2}{r^2}$$

$$v = \sqrt{\frac{GM_s}{r}}$$

Work, Energy, Simple Machines

$\text{work} = \text{force} \times \text{distance}$

gravitational potential energy=wh=mgh

kinetic energy=$\frac{1}{2}mv^2$

energy produced=mc^2

coefficient of sliding friction=$\frac{\text{force of friction during motion}}{\text{normal}}$

work against friction=friction $\times$ distance object moves

elastic potential energy=$\frac{1}{2}\text{kx}^2$

$$power = \frac{work}{time}$$

$$power = \frac{\text{force} \times \text{distance}}{\text{time}}$$

actual mechanical advantage(AMA)=$\frac{\text{resistance}}{\text{actual effort}}$

AMA=$\frac{\text{F}_\text{R}}{\text{F}_\text{E}}$

work output=resistance $\times$ distance resistance moves

work output=$\text{F}_\text{R}\text{R}_\text{R}$

work input=effort $\times$ distance effort moves

work input=$\text{F}_\text{E}S_E$

Under ideal conditions there is no useless work. Then

$$\begin{cases} \text{work output=work input} \\ \frac{\text{F}_\text{R}}{\text{F}_\text{E}} = \frac{\text{S}_\text{E}}{\text{S}_\text{R}} = \text{IMA(ideal mechanical advantage)} \end{cases}$$

For a machine

efficirncy=$\frac{\text{work output}}{\text{work input}}$

$$\text{efficiency}=\frac{\text{AMA}}{\text{IMA}}=\frac{\text{ideal effort}}{\text{actual effort}}$$

$$\frac{\text{weight of object}}{\text{ideal effort}}=\frac{\text{length of plane}}{\text{height of plane}}=IMA$$

Fluid Mechanics

$$density=\frac{mass}{volume}$$

For solids and liquids:

$$\begin{cases} sp.gr.=\dfrac{\text{density of substance}}{\text{density of water}} \\ sp.gr.=\dfrac{\text{weight of substance}}{\text{weight of equal volume of water}} \\ sp.gr.=\dfrac{\text{mass of substance}}{\text{mass of equal volume of water}} \end{cases}$$

$$P=\frac{F}{A}$$

$P=hdg$ (h=height, d=density)

$$F=hdgA$$

$$IMA=\frac{F}{f}=\frac{A}{a}=\frac{(\text{diameter of large piston})^2}{(\text{diameter of small piston})^2}$$

For a solid that sinks in water:

$$sp.gr.=\frac{\text{weight in air}}{\text{apparent loss of weight in water}}$$

For a liquid:

$$sp.gr.=\frac{\text{apparent loss in weight of solid in liquid}}{\text{apparent loss in weight of solid in water}}$$

Heat, Temperature, Thermal Expansion

change in length=oringinal length $\times$ coeff. of expansion $\times$ temp. change

$$\left.\begin{array}{l} \dfrac{V_1}{V_2}=\dfrac{T_1}{T_2} \\ p_1V_1=p_2V_2 \\ \dfrac{p_1V_1}{T_1}=\dfrac{p_2V_2}{T_2} \end{array}\right\} \text{V=volume, T=absolute temperature, P=pressure}$$

Measurement of Heat

heat required for melting=mass $\times$ H_F

heat required for vaporization=mass $\times$ H_V

heat gianed(or lost)=mass $\times$ sp.ht.temp.change

+mass melted $\times$ heat of fusion

+mass vaporized $\times$ heat of vaporization

Heat and Work; Heat Transfer

heat flow=change ininternal energy+work done by system

Q= U+W

Wave Motion and Sound

Periodic Motion

For a stretched spring:

$$\begin{cases} F = -kx \\ T = 2\pi\sqrt{\dfrac{m}{k}} \end{cases}$$

For waves:

$$\begin{cases} T = \dfrac{1}{f} \\ v = f \times \lambda \ (\lambda\text{=wavelength}) \end{cases}$$

the number of beats=the difference between the two frequence

$$\text{Vibrating Air Columns} \begin{cases} \text{Closed Pipes} \\ \lambda=4l_a \\ \text{Open Pipes} \\ \lambda=2l_a \\ \lambda=2l_s \end{cases}$$

Geometrical Optics: Reflection and Refraction

For a special mirror the focal length is equal to one-half of the radius of the spherical shell

$$f = R/2$$

Law of Refraction

$$n = \frac{\sin\theta_1}{\sin\theta_2} (n = \text{index of refraction})$$

$$n = \frac{\text{speed of light in vacuum(or air)}}{\text{speed of light in the substance}}$$

$$\frac{n_2}{n_1} = \frac{\sin\theta_1}{\sin\theta_2}$$

Images Formed by Lenses

$$\frac{1}{\text{object distance}} + \frac{1}{\text{image distance}} = \frac{1}{\text{focal length}}$$

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

$$\frac{\text{size of image}}{\text{size of object}} = \frac{\text{image distance}}{\text{object distance}} = magnification(m)$$

OBJECT DISTANCE	**IMAGE CHARACTERISTICS**
Convex Lens(or Concave Mirror)	
greater than 2f	**real, smaller, between f and 2f, inverted**

2f **between f and 2f** **less than f**	**real, same size, 2f, inverted** **real, larger, greater than 2f, inverted** **virtual. ;larger, q more than p, erect**
Concave Lens(or Convex Mirror)	
any distance	**virtual smaller, erect, q less than p**

$$\text{telescopic magnification}=\frac{\text{focal length of the objective}}{\text{focal length of the eyepiece}}$$

$$\text{illmination}=\frac{\text{intensity of source}}{\text{distance}^2}$$

Physical Optics: Interference and Diffraction

$$\frac{\lambda}{\text{d}}=\frac{\text{x}}{L}$$

λ = wavelength

d=distance between the two silts

L=distance between the barrier and the screen

x=distance between the central maximum and the first bright fringe

Static Electricity—Electric Circuits

$$F=\frac{kq_1q_2}{d^2}$$

$E=F/q$ (E=electric field intensity,F=the force exerted on positive charge q)

$$\text{potential difference}=\frac{\text{work}}{\text{charge}}$$

$$V=\frac{work}{q}$$

$E=V/d$ (E=electric field intensity,V=the difference of potential between the plates)

$$V=\frac{work}{q}$$

$$R=\frac{kL}{A}\begin{cases}L=\text{length in meters}\\ \text{R=resistance in ohms}\\ \text{A=cross-sectional area in meter}^2\\ \text{k=a constant for the material and is called resistivity; unit is ohm-meter}\end{cases}$$

$I_T=V_T/R_T$

$R_T=V_T/I_T$

$V_T=I_TR_T$

	series circuit	**parallel circuit**	**series-parallel circuit**
current	$I_T=I_1=I_2$	$I_T=I_1+I_2$	$I_T=I_3=I_1+I_2$
resistance	$R_T=R_1+R_2$	$\frac{1}{R_T}=\frac{1}{R_1}+\frac{1}{R_2}$	$R_T=R_3+\frac{R_1R_2}{R_1+R_2}$

voltage	$V_T = V_1 + V_2$	$V_T = V_1 = V_2$	$V_T = V_1 + V_3 = V_2 + V_3; V_1 = V_2$
IR-drop	$V_T = I_T R_T; V_1 = I_1 R_1; V_2 = I_2 R_2, etc$		
symbols	$I_1 =$ current through R_1; $V_2 =$ potential difference across R, etc.		

$V_T = emf - Ir$

$H = 0.24 I^2 Rt$

$H = I^2 Rt$

$P = VI; P = I^2 R; P = V^2 / R$

$energy = power \times time$

Magnetism; Meters, Motors, Generators

$F = ILB$ ($L =$ the length of wire in the magnetic field, B=the flux desity)

$F = qvB$ (v=velocity)

$$\frac{\text{second emf}}{\text{primary emf}} = \frac{\text{number of turns on secondary}}{\text{number of turns on primary}}$$

power supplied by secondary=efficiency $\times$ power supplied to primary

when the efficiency is 100%, $V_s I_s = V_p I_p$

$V_s I_s = V_p I_p \times efficiency$

$\omega = 2\pi / T = 2\pi f$

$I = I_{\max} \sin \omega t$

$V = V_{\max} \sin \omega t$

$V = I_{\max} R \sin \omega t$

$P = I^2 R = I^2{}_{\max} R \sin^2 \omega t$

$$\overline{I^2} = \frac{1}{2} I^2{}_{\max}$$

$$I_{rms} = \sqrt{\frac{1}{2} I^2{}_{\max}} = 0.0707 I_{\max}$$

$$P_{avg} = I^2{}_{rms} R = \frac{1}{2} I^2{}_{\max} R$$

$V_{rms} = 0.707 V_{\max}$

Elements of Electronics

Capacitors and Capacitance

Q=CV

$1\, farad = 10^6\, microfarads$

potential energy=$\frac{1}{2}CV^2$

$$P.E.=\frac{1}{2}CV^2=\frac{1}{2}QV=\frac{1}{2}\frac{Q^2}{C}$$

Photons, Atoms, Nuclei

$E_k = hf - W$

$E_k =$ kinetic energy

h=Planck's constant=6.63×10^{-34} joule-second

W=work

f=frequency

momentum of the photon=$\frac{\text{Planck's constant}}{\text{wavelength}}$

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

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

$$E=mc^2$$

Special Relativity

$$L=L_0\sqrt{1-(v^2/c^2)}$$

$$t=\frac{t_0}{\sqrt{1-(v^2/c^2)}}$$

$$m=\frac{m_0}{\sqrt{1-(v^2/c^2)}}$$