#	BASIC IDEA	SOLUTION	ANSWER
#1.	$W = \vec{F} \cdot \vec{d}$	$W = Fd\cos\theta$	B
#2	projectile motion	v_h remains constant because there is no force in that direction v_v is zero, that is why it goes no higher $a = g$ because gravity is still acting on it as a net force.	E
#3	$v = \frac{dx}{dt}$	Reading the given graph says the slope of the postion graph must start at zero and increase to a maximum for the first section. The slope then remains constant and positive for the second section, and finally , the slope remains positive but decrease to zero at the end of the graph.	D
#4	$\vec{F} = m\vec{a}$ $a = \frac{dv}{dt}$ and $v = \frac{dx}{dt}$	$x = t^3 - 6t^2 + 9t$ $v = \frac{dx}{dt} = 3t^2 - 12t + 9$ $a = \frac{dv}{dt} = 6t - 12$ the $F = m(6t-12) = 0$ when $t = 2s$	B
#5	$\tau = r_\perp F$	Torque is a vector. Lets call clockwise negative and counter clockwise positive $-3R(2F) + 2R(F) + 3R(F) + 3R(F) = 2RF$	C
#6.	$v_t = r\omega$ no slipping $v_t = v_{cm}$ $p = mv$	$p = Mv = MR\omega$ (note these equations deal only with the magnitudes of the quantities)	A
#7.	$\vec{F} = -G\frac{Mm}{r^2}\hat{r}$ Universal Lay of Gravitation	Force of gravitation is pulls toward the asteroid haver as the distances increases the force decreases with the inverse square.	A
#8.	$\vec{F} = -G\frac{Mm}{r^2}\hat{r}$ $\vec{F} = m\vec{a}$	At the highest point $r = 2R$ so the force is one-fouth of the value at the surface of the asteroind and the acceleration must also be one-fourth	D
#9.	$F = -kx$ $ma = -kx$ $a = -\frac{k}{m}x$ $\omega = \sqrt{\frac{k}{m}}$ $T = \frac{2\pi}{\omega}$	Here $\sqrt{\frac{k}{m}} = \sqrt{9} = 3$ $\therefore T = \frac{2\pi}{3}$	D
#10.	$T = 2\pi\sqrt{\frac{l}{g}}$	squaring the equation gives $T^2 = 4\pi^2\frac{l}{g}$ so if T is doubled T^2 is quadrupled and since everything else on the right is constant g must be one fourth as great.	A
#11.	$v = r\omega$ $a_T = \frac{dv_T}{dt}$ $a = \frac{v^2}{r}$	solved this equation gives ω v/R v_T is the speed and is constant therefore $a_T = 0$ here v is the speed (v_T), again constant and r = R a consant	E
#12.	$F = \frac{\Delta p}{\Delta t}$	$F\Delta t = \Delta p$, so Δp equals the area bounded by the force function on a F *vs.* t graph. Here the positive areas and the negative areas are of equal magnitude and add to zero.	C

#13	Cons. of Momentum	$p_m + p_{2m} = p_{3m}$ $mv + 2m(v/2) = 3mv_f$ $2mv = 3mv$ therefore $v_f = \frac{2}{3}mv$	C
#14.	$F = -kx$	$F = -100((.03) = -3$ N Magnitude is 3N	B
#15.	$W = \int_A^B \mathbf{F} \cdot d\mathbf{s}$	Since F is perpendicular to the instantaneous displacement ds and any moment	A
#16.	conservation of energy	$\Delta U + \Delta K = 0$ $(3U_o - U_o) + (0 - \frac{1}{2}mv^2) \quad \therefore \quad v = \sqrt{\frac{4U_o}{m}}$	C
#17.	$F = -\frac{dU}{dr}$	$F = -\left(-\frac{3}{2}br^{-\frac{5}{2}}\right) = \frac{3}{2}br^{-\frac{5}{2}}$	A
#18.	conservation of energy	$U_i + K_i = U_f + K_f$ $10J + 0 = 5J + K. \quad \therefore \quad K = 5J$	B
#19.	$W_R = \Delta K$	Resulting force on the elevatior is the force of the cable minus the force of gravity (weight) on the elevator: 11,000 - 1,0000(9.8) = 1,200N therefore the work of the rusultant force is 1,200N(8m) cos 180° = -9,600 J and this must equal the change in kinetic energy. $9{,}600 = K_f - K_i = = 0 - \frac{1}{2}mv^2 = -500\ v^2$. It then follows that $v^2 = 19.2$ and $v = \sqrt{19.2}$ which is about 4.4 m/s.	A
#20.	$F = G\frac{Mm}{r^2}$ $F = ma$ $a = \frac{v^2}{r}$	$F = G\frac{MM}{D^2} = M\frac{v^2}{\frac{D}{2}} = 2M\frac{v^2}{D}$ $GM/_{2D} = v^2$	B
#21.	$F = ma$ components	$F\cos\phi - f = ma \ \therefore \ a = \frac{F\cos\phi - f}{m}$	D
#22.	$F = \mu N$ $F = ma$ components	$\mu = \frac{\mathbf{F}}{N} = \frac{f}{mg - F\sin\phi}$ r_{new}^2 must $= 2r^2$ and it follows that $r_{new} = \sqrt{2}\,r$	E
#23.	This question was not counted when the exam was scored		-
#24.	Newton's 3 Law	No net external force so the center of mass does not accelerate. $v_i = 0$ therefore v remains zero.	A
#25.	$v = \frac{d}{t}$ $a = \frac{v^2}{r}$	Since the speed is constant the dancer will take equal time intervals for each segment *PQ,QR,RS,* and *SP,* of the path. The only acceleration is the centripetal acceleration on the semicircular arcs, and these are of equal magnitude because v is of constant magnitude and r is the same for each arc.	B

#26.	$s = \frac{1}{2} at^2 + v_i t$	Applying this equation to the horizontal motion: $x = v_h t$ Applying this equation to the vertical motion: $y = \frac{1}{2} gt^2$ Eliminating the t between the two equations gives $y = \frac{1}{2} g(\frac{x}{v_h})^2$ Solving for v_h gives: $v_h = \sqrt{\frac{gx^2}{2y}}$ and substituting the given values yields $v_h = \sqrt{\frac{9.8(3)^2}{2(10)}}$ taking g as 10 we get v $v_h = \sqrt{\frac{10(3)^2}{2(10)}} = \sqrt{\frac{3^2}{2}} = \frac{3}{\sqrt{2}}$	C
#27.	$\Delta U = -\int_A^B \mathbf{F} \cdot d\mathbf{s}$	$\Delta U = -\int_0^2 -(40x - 6x^2)dx$ notice that the force exerted by the spring is opposite in direction to the externally applied force. This becomes $\Delta U = \int_0^2 (40x - 6x^2)dx = \frac{40x^2}{2} - \frac{6x^3}{3} \Big\vert_0^2 = [20(4) - 2(8)] - [0] = 64J$	D
#28.	$\Delta U = -\int_A^B \mathbf{F} \cdot d\mathbf{s}$	This equation states that ΔU is the negative of the work of the conservative force. Here then, the work of gravity is the negative of the change in potential energy.	C
#29.	$a = \frac{dv}{dt}$ $v = \frac{ds}{dt}$ vector addition	$a_x = \frac{dv_x}{dt}$ $v_x = \frac{dx}{dt} = -A\omega \sin \omega t \therefore a_x = -A\omega^2 \cos \omega t$ $a_y = \frac{dv_y}{dt}$ $v_y = \frac{dy}{dt} = A\omega \cos \omega t \therefore a_x = -A\omega^2 \sin \omega t$ $\vert a \vert = \sqrt{a_x{}^2 + a_y{}^2} = \sqrt{(-A\omega^2 \cos \omega t)^2 + (-A\omega^2 \sin \omega t)^2} = A\omega^2$ substituting the given values yields $(1.5)(2)^2 = 6$ m/s^2	E
#30.	$\vec{\tau} = \vec{r} \times \vec{F}$ $\Sigma\tau = 0$	clockwise torque = $m_2 gb$ counterclockwise torque =$m_1 ga$ $m_2 gb = m_1 ga$ $m_2 b = m_1 a$	B
#31.	cons. of momentum vector addition	two vector must add up to the orginal vector	E
#32.	$L = I\omega$ $\tau = \frac{dL}{dt}$	$\tau = \frac{\Delta L}{\Delta t} = \frac{I\omega_f - O}{T} = \frac{I\omega_f}{T}$	E
#33.	$P = \frac{\Delta W}{\Delta t}$ $W = \Delta K$ $K = \frac{1}{2} I \omega^2$	$P = \frac{\frac{1}{2} I \omega_f^2 - O}{T} = \frac{I\omega_f^2}{2T}$ accomplished by making L one fourth. (note mass of bob and amplitude don't affect the period. This eliminate choices C,D,E, and without a calculation you can see that L must be decreased.)	B
#34	inspection $a = \frac{dv}{dt}$	At t = 0 it is given that v =0.Choices (B) and (E) don't match this condition. As time goes on the acceleration given by $a = g - bv$ must drop to zero when $bv = g$. This means a terminal velocity is reached. Choice(C) gives an equation which actually has the velocity going negative at some time. Choice (D) has the velocity increasing without bound. (A) is the only reasonable choice. If you had the time and ignored the suggestion in the question you might actually derive the answer as follows: Substituting into the given equation we have: $\frac{dv}{dt} = g - bv$	A

separating vatiables gives $\frac{dv}{g-bv}$ = dt then

$$\int_0^v \frac{dv}{g-bv} = \int_0^t dt$$ substituting u = g -bv gives

$$\frac{-1}{b}\int_g^{g-bv} \frac{du}{u} = t$$ integrating gives $\frac{-1}{b}[\ln(g-bv) - \ln g] = t$

$\ln(1 - \frac{b}{g}v) = -bt$ and $(1 - \frac{b}{g}v) = e^{-bt}$ and $v = \frac{g}{b}(1 - e^{-bt})$

#35. Conservation of Energy $U_o + K_o = U_A + K_A$ Where "o" indicates the equilibrium position and "A" indicates maximum amplitude. Substituting into this equation we have: $0 + \frac{1}{2}Mv_m^2 = \frac{1}{2}kA^2 + 0 \therefore k = \frac{Mv_m^2}{A^2}$ D

$U = \frac{1}{2}kx^2$

$K = \frac{1}{2}mv^2$