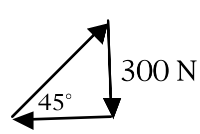
	BASIC IDEA	SOLUTION	ANSWER
#1.	$\Delta x = \int_a^b v dt$	By examination the area under the graph increases until the graph drops to the t axis. Then negative area is added until the total area is zero by the end. The graph of x vs. t should increase to a maximum and then drop back down to zero. (alternate method is to note that the derivative of x vs. t is the velocity so the graph must start with a positive slope which reaches zero and then becomes negative.)	A
#2	$\Delta y = v_o t + \frac{1}{2}at^2$	$v_o = 0$, $a = 10\text{m/s}^2$	D
#3	$\vec{F}dt = \Delta\vec{p}$ components	There is no change in the x component of the momentum, but the y component goes from down to up, so the impulse must be upward.	E
#4	$\vec{F}_{net} = m\vec{a}$	String C as the total forward applied force must accelerate all of the mass and oppose the sum of all of the friction on the three blocks. Each other string must accelerate a lesser mass and fewer friction forces.	C
#5	$\vec{F}_{net} = m\vec{a}$	The mass is 3kg and from the graph the force at t = 2s is 4N.	B
#6.	$\int_a^b \vec{F}dt = \Delta\vec{p}$ area = integral $\vec{p} = m\vec{v}$	$\int_0^2 \vec{F}dt = \Delta\vec{p} = mv_2 - 0$ and the area under the graph, which is the integral is $\frac{1}{2}bh = \frac{1}{2}(2s)(4N) = 4N \cdot s$ so we have $4Ns = 3kgv_2$ and $v_2 = 4/3$ m/s	A
#7.	Conservation of Energy $\Delta U = mgh$ $K = \frac{1}{2}mv^2$	Taking U= 0 at the bottom of the incline we have the total energy at the top U = Mgh since the object is at rest. Since the plane is frictionless the ball will **slide with no rotation** so the kinetic energy at the bottom of the incline is simply $K = \frac{1}{2}Mv^2$ and we can write $Mgh = \frac{1}{2}Mv^2$ and solve for v.	A
#8.	Conservation of Energy $K = \frac{1}{2}mv^2$ $K_{rot} = \frac{1}{2}I\omega^2$ $v_{cm} = r\omega$	We now can consider the kinetic energy in two parts, rotation and translation of the center of mass. Then $Mgh = \frac{1}{2}Mv_{cm}^2 + \frac{1}{2}I\omega^2 = \frac{1}{2}Mv_{cm}^2 + \frac{1}{2}I\left(\frac{v_{cm}}{r}\right)^2$ Solving for v_{cm} yields $\sqrt{\frac{2Mghr^2}{I + Mr^2}}$	E
#9.	equilibrium $\Sigma\vec{F} = 0$	 Since we have a 45°, 90° triangle it is isosceles and the horizontal leg must also be 300N.	D
#10.	$\vec{F}_{net} = m\vec{a}$	The sum of the force must be up the ramp. Clearly not the case for any but the last choice.	E
#11.	equilibrium $\Sigma\vec{F} = 0$	A has a net component down the ramp and E has a net component up the ramp. B has the Normal improperly drawn, and D mistaken switches the component of the weight. (Actually the weight should not be shown in addition to the components of the weight at any rate. One or the other should be included in the FBD or some indication made that these are not additional forces.)	C

#12. equilibrium $\Sigma\vec{F} = 0$

A has a net component down the ramp and E has a net component up the ramp. B has the Normal improperly drawn, and D mistaken switches the component of the weight. (Actually the weight should not be shown in addition to the components of the weight at any rate. One or the other should be included in the FBD or some indication made that these are not additional forces.) **C**

#13 $\vec{F} = \dfrac{d\vec{p}}{dt}$

$$\frac{d\vec{p}}{dt} = 3kt^2$$

A

#14. Mechanical Energy

centripetal acceleration

Kepler's 2nd Law

The new speed makes $\frac{v^2}{r} > a_r$ required for a circular orbit so the gravitational force that had maintained the orbit is not great enough and the spacecraft rises increasing its potential energy. [Choices A) and C) are thereby eliminated] Thus begins and elliptical orbit. A second burst of the rockets would be required return to a circular orbit as in B) and that does not occur. Kepler's 2nd Law states that the satellite will have an elliptical orbit with the body being orbited at one focus. That is not the case for E). **D**

#15. $W = Fd\cos\theta$

In this problem the angle between the tension and the displacement is 90° therefore no work is done. **A**

#16. $v_{\tan} = r\omega$

Switching frames of reference from the center of mass to the momentarily stationary point on the rime of the wheel gives $v_{\tan} = v_{cm}$. Then $v_{cm} = r\omega$ gives $\omega = \dfrac{v_{cm}}{r} = \dfrac{\left(\frac{20m}{5s}\right)}{0.5} = 8 radians \cdot s^{-1}$ **C**

#17. No net external torque… therefore no change in angular momentum **E**

No net external force…therefore no change in linear momentum

#18. $T = 2\pi\sqrt{\dfrac{L}{g}}$

Solving for the length gives… $L = \dfrac{T^2 g}{4\pi^2} = \dfrac{(2)^2(10)}{4(3.14)^2} = \dfrac{40}{40} = 1m$ **D**

#19. $\theta = \theta_{\max}\sin(\omega t + \delta)$

$$T = \frac{2\pi}{|\omega|}$$

$$\omega = \frac{2\pi}{\mathrm{T}} = \frac{2\pi}{2} = \pi$$

B

#20. $\vec{\mathrm{F}}_{\mathrm{net}} = \mathrm{m}\vec{\mathrm{a}}$

The weight of M, Mg, is trying to accelerate the system of two blocks one way and the weight of m, mg, is trying to accelerate it the other way. Net accelerating force is then Mg-ma. This net force is accelerating a total Mass of M+m. We then have Mg-mg = (M+m)a **E**

#21. $W = \int_a^b \vec{F} \cdot d\vec{s}$

$$W = \int_0^{x_o} Fds\cos\theta = \int_0^{x_o} kx^2 dx(1) = k\frac{x_o^3}{3} - 0$$

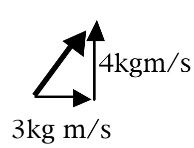
E

#22. $K = \dfrac{1}{2}mv^2$

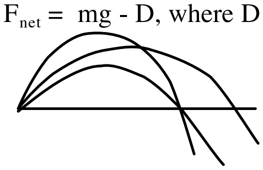
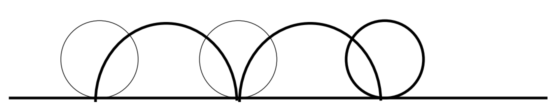
Energy is a scalar so simply: $\frac{1}{2}(1.5)(2.0)^2 + \frac{1}{2}(4.0)(1.0)^2 = 5.0J$ **B**

#23. $\vec{p} = m\vec{v}$

Vectors so:



The Pythagorean Theorm gives 5 kgm/s **C**

#24.	$a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$	$\frac{dx}{dt} = 6.0t + 1.5$ and then $\frac{d^2x}{dt^2} = 6.0m/s$	B
#25.	momentum conservation	After ball tossed it has momentum toward back so the boat must have forward momentum to maintain the zero initial momentum. After the catch both the ball and boat the two must be at the same speed and this must be at rest to have momentum zero as it was originally	C
#26.	$\Sigma\vec{\tau} = I\alpha$ $\tau = r_{\perp}F$	RT_2-RT_1=Iα	D
#27.	$W = \int_a^b \vec{F} \cdot d\vec{s}$	Here then the limits of integration are R_2 and infinity.	E
#28.	equilibrium $\Sigma\vec{F} = 0$ $F_{fr} \leq \mu N$	We have F_{fr} -mg = 0. and the Normal is F. Then μF-mg=0	C
#29.	$T = 2\pi\sqrt{\frac{M}{k}}$	Neither the mass, M, nor the spring constant, k, depend on the gravitational force of the planet.	C
#30.	$P = \frac{\Delta W}{\Delta t}$ $W = \Delta U = mgh$	then W = Pt =mgh, so $h = \frac{Pt}{mg} = \frac{(1000W)(10s)}{(100kg)(9.8m/s^2)} \doteq 10m$	C
#31.	$x = x_0 \sin(\omega t + \delta)$ $v = \frac{dx}{dt} = x_0\omega\cos(\omega t + \delta)$ $\omega = \sqrt{\frac{k}{m}}$	The speed at the equilibrium position is the max (no longer accelerated) and that occurs when $v = x_o\omega = (0.10m)\sqrt{\frac{400N/m}{1kg}} = 2m/s$	A
#32.	concept of drag force F=ma	F_{net} = mg - D, where D is most likely a function of speed.	D
#33.	max **range** for projectile is if fired at 45°	 The 45° angle gives the maximum horizontal travel to the original elevation, but the smaller angle causes the projectile to have a greater horizontal component of velocity, so given the additional time of travel allows such a trajectory to advance a greater horizontal distance. In other words given enough time the smaller angle of launch gives a parabola which will eventual cross the parabola of the 45° launch.	C
#34.	the path of a point on the rim of a non-slipping rolling wheel is a cycloid.		A
#35.	$v = \sqrt{\frac{2GM}{R}}$	If M is doubled you place a factor of $\sqrt{2}$ into the equation.	B