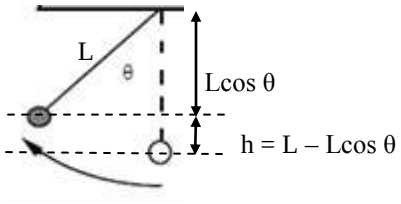
ANSWERS - AP Physics Multiple Choice Practice – Work-Energy

	Solution	Answer
1.	Conservation of Energy, $U_{sp} = K$, $\frac{1}{2} kA^2 = \frac{1}{2} mv^2$ solve for v	B
2.	Constant velocity → $F_{net}=0$, $f_k = Fx = F\cos\theta$ $W_{fk} = -f_k d = -F\cos\theta\, d$	A
3.	Try out the choices with the proper units for each quantity. Choice A … FVT = (N) (m/s) (s) = Nm which is work in joules same as energy.	A
4.	Two step problem. Do $F = k\Delta x$, solve for Δx then sub in the $U_{sp} = \frac{1}{2} k\Delta x^2$	A
5.	In a circle moving at a constant speed, the work done is zero since the Force is always perpendicular to the distance moved as you move incrementally around the circle	E
6.	 The potential energy at the first position will be the amount "lost" as the ball falls and this will be the change in potential. $U=mgh = mg(L-L\cos\theta)$	A
7.	A force directed above the horizontal looks like this To find the work done by this force we use the parallel component of the force (Fx) x distance. $= (F\cos\theta)\, d$	B
8.	The maximum speed would occur if all of the potential energy was converted to kinetic $U = K$ $16 = \frac{1}{2} mv^2$ $16 = \frac{1}{2} (2) v^2$	B
9.	The work done by the stopping force equals the loss of kinetic energy. $-W=\Delta K$ $-Fd = \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2$ $v_f = 0$ $F = mv^2/2d$	A
10.	The work done by friction equals the loss of kinetic energy $-f_k d = \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2$ $v_f = 0$, plug in values to get answer	D
11.	P = Fd / t. Since there is no distance moved, the power is zero	E
12.	This is a conservative situation so the total energy should stay same the whole time. It should also start with max potential and min kinetic, which only occurs in choice C	C
13.	Stopping distance is a work-energy relationship. Work done by friction to stop = loss of kinetic $-f_k d = -\frac{1}{2} mv_i^2$ $\mu_k mg = \frac{1}{2} mv_i^2$ The mass cancels in the relationship above so changing mass doesn't change the distance	B
14.	Same relationship as above … double the v gives 4x the distance	E
15.	Half way up you have gained half of the height so you gained ½ of potential energy. Therefore you must have lost ½ of the initial kinetic energy so $E_2 = (E_k/2)$. Subbing into this relationship $E_2 = (E_k/2)$ $\frac{1}{2} mv_2^2 = \frac{1}{2} m v^2 / 2$ $v_2^2 = v^2 / 2$ …. Sqrt both sides gives answer	B
16.	At the top, the ball is still moving (v_x) so would still possess some kinetic energy	A
17.	Same as question #1 with different variables used	E

18. $P = F\,d / t \quad = (ma)d / t \quad = (kg)(m/s^2)(m) / (s) \quad = kg\ m^2 / s^3$ C

19. $P = Fv$, plug in to get the pushing force F and since its constant speed, $F_{push} = f_k$ A

20. Total energy is always conserved so as the air molecules slow and lose their kinetic energy, there is a heat flow which increases internal (or thermal) energy C

21. The work done must equal the increase in the potential energy $mgh = (10)(10)(1.3)$ D

22. Based on $F = k\,\Delta x$. The mass attached to the spring does not change the spring constant so the same resistive spring force will exist, so the same stretching force would be required C

23. The work done must equal the total gain in potential energy
10 boxes * mgh (25)(10)(1.5) of each B

24. Eliminating obviously wrong choices only leaves A as an option. The answer is A because since the first ball has a head start on the second ball it is moving at a faster rate of speed at all times. When both are moving in the air together for equal time periods the first faster rock will gain more distance than the slower one which will widen the gap between them. A

25. All of the $K = \frac{1}{2}\,m\,v^2$ is converted to U. Simply plug in the values D

26. For a mass on a spring, the max U occurs when the mass stops and has no K while the max K occurs when the mass is moving fast and has no U. Since energy is conserved it is transferred from one to the other so both maximums are equal D

27. Since the ball is thrown with initial velocity it must start with some initial K. As the mass falls it gains velocity directly proportional to the time ($V=Vi+at$) but the K at any time is equal to $1/2\ mv^2$ which gives a parabolic relationship to how the K changes over time. E

28. Since the speed is constant, the pushing force F must equal the friction force $f_k = \mu F_n = \mu mg$. The power is then given by the formula $P = Fv = \mu mgv$ C

29. Since the speed is constant, the pushing force F must equal the friction force (10 N). The distance traveled is found by using $d = vt = (3)(60\ sec)$, and then the work is simply found using $W=Fd$ E

30. Only conservative forces are acting which means mechanical energy must be conserved so it stays constant as the mass oscillates E

31. The box momentarily stops at x(min) and x(max) so must have zero K at these points. The box accelerates the most at the ends of the oscillation since the force is the greatest there. This changing acceleration means that the box gains speed quickly at first but not as quickly as it approaches equilibrium. This means that the K gain starts of rapidly from the endpoints and gets less rapid as you approach equilibrium where there would be a maximum speed and maximum K, but zero force so less gain in speed. This results in the curved graph. D

32. Point IV is the endpoint where the ball would stop and have all U and no K. Point II is the minimum height where the ball has all K and no U. Since point III is halfway to the max U point half the energy would be U and half would be K C

33. Apply energy conservation using points IV and II. $U_4 = K_2 \quad mgh = \frac{1}{2}\,mv^2$ B

34. Force is provided by the weight of the mass (mg). Simply plug into $F=k\Delta x$, $mg=k\Delta x$ and solve E

35. Since the track is rough there is friction and some mechanical energy will be lost as the block slides which means it cannot reach the same height on the other side. The extent of energy lost depends on the surface factors and cannot be determined without more information — E

36. The force needed to lift something at a constant speed is equal to the object weight F=mg. The power is then found by P = Fd / t = mgh / t — E

37. Simple energy conservation $K=U_{sp}$ $\quad \frac{1}{2} mv_o^2 = \frac{1}{2} k \Delta x^2$ solve for Δx — D

38. Simple application of $F_g=mg$ — D

39. $F_n = F_{gy} = mg \cos \theta$. Since you are given the incline with sides listed, $\cos \theta$ can be found by using the dimensions of the incline … $\cos \theta$ = adj / hyp = 4/5 to make math simple. This is a good trick to learn for physics problems — C

40. As the box slides down the incline, the gravity force is parallel to the height of the incline the whole time so when finding the work or gravity you use the gravity force for F and the height of the incline as the parallel distance. Work = $(F_g)(d) = (20)(3)$ — B

41. The student must exert an average force equal to their weight (F_g) in order to lift themselves so the lifting force F=mg. The power is then found with P = Fd / t = (F_g)d / t — C

42. As the object oscillates its total mechanical energy is conserved and transfers from U to K back and forth. The only graph that makes sense to have an equal switch throughout is D — D

43. To push the box at a constant speed, the child would need to use a force equal to friction so $F=f_k=\mu mg$. The rate of work (W/t) is the power. Power is given by P=Fv → μmgv — A

44. Two steps. I) use hookes law in the first situation with the 3 kg mass to find the spring constant (k). $F_{sp}=k\Delta x$, $mg=k\Delta x$, k = 30/.12 = 250. II) Now do energy conservation with the second scenario (note that the initial height of drop will be the same as the stretch Δx).
U top = U_{sp} bottom, $mgh = \frac{1}{2} k \Delta x^2$, $(4)(10)(\Delta x) = \frac{1}{2} (250) (\Delta x^2)$ — D

45. In a circular orbit, the velocity of a satellite is given by $v = \sqrt{\frac{Gm_e}{r}}$ with $m_e = M$. Kinetic energy of the satellite is given by $K = \frac{1}{2} m v^2$. Plug in v from above to get answer — B

46. Projectile. V_x doesn't matter $V_{iy} = 0$. Using $d = v_{iy}t + \frac{1}{2} at^2$ we get the answer — E

47. Energy conservation $E_{top} = E_{bot}$, $K_t+U_t = K_b$. Plug in for K top and U top to get answer — D

48. A is true; both will be moving the fastest when they move through equilibrium. — A

49. X and Y directions are independent and both start with the same velocity of zero in each direction. The same force is applied in each direction for the same amount of time so each should gain the same velocity in each respective direction. — C

50. Kinetic energy is not a vector and the total resultant velocity should be used to determine the KE. For the 1st second the object gains speed at a uniform rate in the x direction and since KE is proportional to v^2 we should get a parabola. However, when the 2nd second starts the new gains in velocity occur only in the y direction and are at smaller values so the gains essentially start over their parabolic trend as shown in graph B — B

51. Simple P = Fv — E

52. The force needed to lift something at a constant speed is equal to the object weight F=mg. The power is then found by P = Fd / t = mgh / t — B

53. As the system moves, m_2 loses energy over distance h and m_1 gains energy over the same distance h but some of this energy is converted to KE so there is a net loss of U. Simply subtract the $U_2 - U_1$ to find this loss — A

54. In a force vs. displacement graph, the area under the line gives the work done by the force and the work done will be the change in the K so the largest area is the most K change — E

55. Compare the U+K ($mgh + \frac{1}{2} mv^2$) at the top, to the K ($\frac{1}{2} mv^2$) at the bottom and subtract them to get the loss. — C

56. Use energy conservation, U top = K bottom. As in problem #6 (in this document), the initial height is given by L – Lcos θ, with cos 60 = .5 so the initial height is ½ L. — A

57. Use application of the net work energy theorem which says … $W_{net} = \Delta K$. The net work is the work done by the net force which gives you the answer — A

58. First use the given location (h=10m) and the U there (50J) to find the mass. U=mgh, 50=m(10)(10), so m = 0.5 kg. The total mechanical energy is given in the problem as U+K = 100 J. The max height is achieved when all of this energy is potential. So set 100J = mgh and solve for h — B

59. There is no U_{sp} at position x=0 since there is no Δx here so this is the minimum U location — A

60. Simple P = Fv to solve — E

61. Using energy conservation in the first situation presented K=U gives the initial velocity as — C
$v = \sqrt{2gh}$. The gun will fire at this velocity regardless of the angle. In the second scenario, the ball starts with the same initial energy but at the top will have both KE and PE so will be at a lower height. The velocity at the top will be equal to the v_x at the beginning
$v_x = v\cos\theta = \left(\sqrt{2gh}\right)\cos 45 = \left(\sqrt{2gh}\right)\left(\frac{\sqrt{2}}{2}\right) = \sqrt{gh}$. Now sub into the full energy conservation problem for situation 2 and solve for h_2. $K_{bottom} = U_{top} + K_{top}$
$\frac{1}{2}m\left(\sqrt{2gh}\right)^2 = mgh_2 + \frac{1}{2}m\left(\sqrt{gh}\right)^2$

62. To find work we use the parallel component of the force to the distance, this gives Fcos θ d — B

63 The centripetal force is the force allowing the circular motion which in this case is the spring force $F_{sp}=k\Delta x=(100)(.03)$ — B

64. In a circle at constant speed, the work done is zero since the Force is always perpendicular to the distance moved as you move incrementally around the circle — A

65. At the maximum displacement the K=0 so the 10J of potential energy at this spot is equal to the total amount of mechanical energy for the problem. Since energy is conserved in this situation, the situation listed must have U+K add up to 10J. — B

66. Using the work-energy theorem. $W_{nc} = \Delta ME$, A
$W_{Ft} = \Delta U + \Delta K$,
$-Fd = (mgh_f - mgh_i) + (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2)$,
$-(11000)(8) = (0 - (1000)(10)(8)) + (0 - \frac{1}{2}(1000)(v_i^2)$ … solve for v_i

67. Use energy conservation $K=U_{sp}$ $\frac{1}{2} mv_m^2 = \frac{1}{2} k \Delta x^2$, with $\Delta x=A$, solve for k D

68. To lift the mass at a constant velocity a lifting force equal to the objects weight would be needed, so F=(mg). Simply plug into P = Fd / t and solve for d. C

69. Using the vertical distance with the vertical force ($Fd_{\parallel}$) B
W = 10 cartons * (mg)(d_y) = 10 * (25)(10m/s^2)(1.5m) = 3750J

70. The ΔU will equal the amount of initial K based on energy conservation, $U = K = 1/2\ m\ v^2$ D

71. Using work-energy. $W_{nc} = \Delta K = K_f - K_i$ $-Fd = 0 - \frac{1}{2} m v_f^2$ $-F(95) = -\frac{1}{2}(500)28^2$ C

72. Based on net work version of work energy theorem. $W_{net} = \Delta K$, we see that since there is a constant speed, the ΔK would be zero, so the net work would be zero requiring the net force to also be zero. A

73. As the block slides back to equilibrium, we want all of the initial spring energy to be dissipated by work of friction so there in no kinetic energy at equilibrium where all of the spring energy is now gone. So set work of friction = initial spring energy and solve for μ. The distance traveled while it comes to rest is the same as the initial spring stretch, d = x. C
$\frac{1}{2} kx^2 = \mu mg(x)$

74. V at any given time is given by $v = v_i + at$, with $v_i = 0$ gives $v = at$, D
V at any given distance is found by $v^2 = v_i^2 + 2\ ad$, with $v_i = 0$ gives $v^2 = 2ad$
This question asks for the relationship to distance.
The kinetic energy is given by $K = \frac{1}{2} m v^2$ and since $v^2 = 2ad$ we see a linear direct relationship of kinetic energy to distance (2*d → 2*K)
Another way of thinking about this is in relation to energy conservation. The total of $mgh+1/2mv^2$ must remain constant so for a given change in (h) the $\frac{1}{2} mv^2$ term would have to increase or decrease directly proportionally in order to maintain energy conservation.

75. Similar to the discussion above. Energy is conserved so the term $mgh + \frac{1}{2} mv^2$ must remain constant. As the object rises it loses K and gains U. Since the height is H/2 it has gained half of the total potential energy it will end up with which means it must have lost half of its kinetic energy, so its K is half of what it was when it was first shot. B

76. Since the force is always perpendicular to the incremental distances traveled as the particle travels the loop, there is zero work done over each increment and zero total work as well. A