	Solution	Answer
1.	Energy conservation. $U_{sp} = K$ $\frac{1}{2} k A^2 = \frac{1}{2} mv^2$	B
2.	The period of a mass-spring is only affected by mass and k so its stays the same	C
3.	The period of a pendulum is only affected by length and "g" so it stays the same	C
4.	Energy conservation. $U_{sp} = K$ $\frac{1}{2} k d^2 = \frac{1}{2} mv^2$	E
5.	The amplitude from the graph is 0.04 not 0.08, the rest are true	A
6.	The mass is irrelevant, only the length matters. T is found with $2\pi \sqrt{(L/g)}$	B
7.	Mass does not affect the period, only the length matters	C
8.	Energy is conserved here and switches between kinetic and potential which have maximums at different locations	D
9.	Sub into $T = 2\pi \sqrt{(L/g)}$ and solve for L	B
10.	Only conservative forces are acting which means mechanical energy must be conserved so it stays constant as the mass oscillates	E
11.	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 KE 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
12.	Pendulum is unaffected by mass. Mass-spring system has mass causing the T to change proportional to $\sqrt{m}$ so since the mass is doubled the period is changed by $\sqrt{2}$	B
13.	At T/4 the mass reaches maximum + displacement where the restoring force is at a maximum and pulling in the opposite direction and hence creating a negative acceleration. At maximum displacement the mass stops momentarily and has zero velocity	D
14.	See #13 above	A
15.	+ Acceleration occurs when the mass is at negative displacements since the force will be acting in the opposite direction of the displacement to restore equilibrium. Based on $F=k\Delta x$ the most force, and therefore the most acceleration occurs where the most displacement is	A
16.	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
17.	For the spring, equilibrium is shown where the maximum transfer of kinetic energy has occurred and likewise for the pendulum the bottom equilibrium position has the maximum transfer of potential energy into spring energy.	A
18.	Set period formulas equal to each other and rearrange for k	E
19.	In a mass-spring system, both mass and spring constant (force constant) affect the period.	E

20. The mass spring system in unaffected because the attached mass and spring constant are the same. Based on $g = GM_p / R^2$ and the given values, g on planet X would be greater. Using the pendulum period formula, larger g means smaller period.   E

21. Mass does not affect the period of a pendulum   C

22. At the current location all of the energy is gravitational potential. As the spring stretches to its max location all of that gravitational potential will become spring potential when it reaches its lowest position. When the box oscillates back up it will return to its original location converting all of its energy back to gravitational potential and will oscillate back and forth between these two positions. As such the maximum stretch bottom location represents twice the amplitude so simply halving that max Δx will give the amplitude. Finding the max stretch: → The initial height of the box h and the stretch Δx have the same value (h=Δx)
$U = U_{sp}$ $mg(\Delta x_1) = \frac{1}{2} k \Delta x_1^2$ $mg = \frac{1}{2} k \Delta x_1$ $\Delta x_1 = .05$ m.
This is 2A, so the amplitude is 0.025 m or 1/40 m.   A

    Alternatively, we could simply find the equilibrium position measured from the initial top position based on the forces at equilibrium, and this equilibrium stretch measured from the top will be the amplitude directly. To do this:
$F_{net} = 0$ $F_{sp} = mg$ $k\Delta x_2 = mg$ $\Delta x_2 = 0.025$ m, which is the amplitude

23. Plug into period for mass-spring system $T = 2\pi \sqrt{(m/k)}$ C

24. Based on free fall, the time to fall down would be 1.4 seconds. Since the collision with the ground is elastic, all of the energy will be returned to the ball and it will rise back up to its initial height completing 1 cycle in a total time of 2.8 seconds. It will continue doing this oscillating up and down. However, this is not simple harmonic because to be simple harmonic the force should vary directly proportional to the displacement but that is not the case in this situation   D

25. Energy will never be negative. The max kinetic occurs at zero displacement and the kinetic energy become zero when at the maximum displacement   B

26. Same reasoning as above, it must be C   C

27. First use the initial stretch to find the spring constant. $F_{sp} = mg = k\Delta x$ $k = mg / d$ A

    Then plug that into $T = 2\pi \sqrt{(m/k)}$ $$T = 2\pi \sqrt{\frac{m}{(\frac{mg}{d})}}$$

28. Based on $T = 2\pi \sqrt{(m/k)}$ the larger spring constant makes a smaller period   C

29. Basic fact about SHM. Amplitude is max displacement   C

30. Basic fact about SHM. Spring potential energy is a min at x=0 with no spring stretch   A

31. Based on $T = 2\pi \sqrt{(L/g)}$, ¼ the length equates to ½ the period   A

32. Based on $T = 2\pi \sqrt{(L/g)}$, ¼ g would double the period   A

33. At max displacement, the total energy is equal to the potential energy of 10J. Energy is conserved so when the K becomes 5J the U would have to be 5J also to conserve E.   B

34. Using energy conservation. $U_{sp} = K$ $\frac{1}{2} k A^2 = \frac{1}{2} mv_m^2$ solve for k   D

35. Plug into $T = 2\pi \sqrt{(L/g)}$ D

36. Since this is a mass spring, only the attached mass and k affect the period and both are the same. C

37. Based on $g = GM_p / R^2$, g of mars is 4/9 that of earth. Then based on $T = 2\pi \sqrt{(L/g)}$, with g D
changing to "4/9 g" gives a period changing by $\sqrt{9/4}$ or 3/2 T

38. Using energy conservation. $U_{sp} = K$ $\frac{1}{2} k A^2 = \frac{1}{2} mv_m^2$ solve for v A

39. Since the frequencies are the same, the periods are also the same. Set the period for the B
mass-spring system equal to the period for the string pendulum and rearrange for L.

40. Based on $T = 2\pi \sqrt{(m/k)}$, in order to double the period, the mass would have to be increased by D
4x the original amount. Here is the tricky part …. you are to increase the mass to 4 x its
original value by adding mass the to 2kg tray. So to make the total mass have a value of
8 kg, only 6 kg of extra mass would need to be added to the tray.