

UNIT 3 TEST REVIEW

Work, Energy, and Momentum Chapters 6 - 7

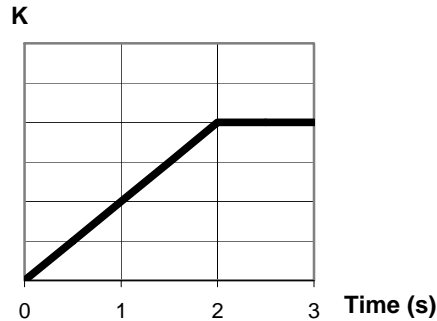
*** In studying for your test, make sure to study this review sheet along with your quizzes and homework assignments.**

Multiple Choice Review: On this portion of the test, you will not be allowed to use your calculator or AP formula sheet. (You may, however, use your AP table of information.) Approximate $g=10\text{m/s}^2$ for simplicity of calculations. No partial credit will be given.

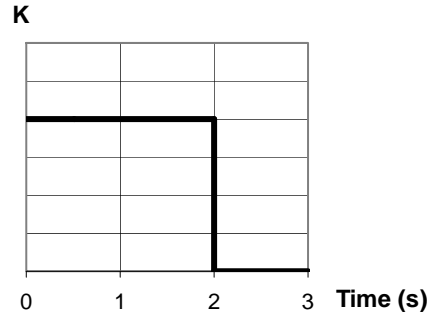
- Two objects, A and B, initially at rest, are "exploded" apart by the release of a coiled spring that was compressed between them. As they move apart, the velocity of object A is 5m/s and the velocity of object B is -2m/s . The ratio of the mass of A to the mass of M, m_A/m_B , is...
a. $4/25$ b. $2/5$ c. $1/1$ d. $5/2$ e. $25/4$
- A railroad car of mass m , moving at a speed v , collides with a second railroad car of mass M which is at rest. The two cars lock together and move along the track. What is the speed of the cars immediately after the collision?
a. $\frac{v}{2}$ b. $\frac{(m+M)}{v}$ c. $\frac{mv}{M}$ d. $\frac{mv}{(m+M)}$ e. $\frac{Mv}{m}$
- A solid metal ball and a hollow plastic ball of the same external radius are released from rest in a large vacuum chamber. When each has fallen 1m , they both have the same...
a. inertia d. speed
b. momentum e. kinetic energy
c. change in potential energy
- According to the work-kinetic energy theorem, what must be true about an object if the net work done on it during some time interval is equal to zero?
a. The object is sitting still. c. The object is slowing down.
b. The object is not accelerating. d. The object is speeding up.

5. An object is initially at rest, when a constant net force begins to act on the object for a time interval of 2s. After this, no forces act on the object. Which one of the following graphs best represents the kinetic energy K of the object as a function of time, during the interval during which the force acts?

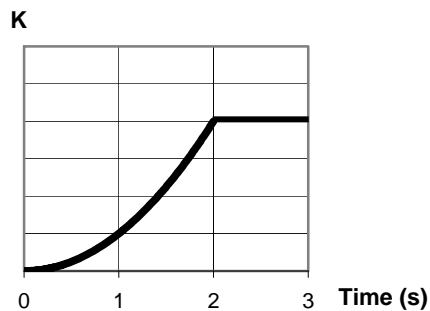
a.



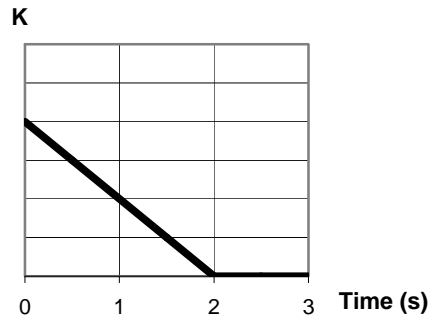
b.



c.



d.

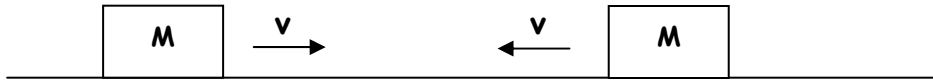


6. A child pushes horizontally on a box of mass m which moves with constant speed v across a horizontal floor. The coefficient of kinetic friction between the box and floor is μ . At what rate does the child do work on the box?

- a. μmgv b. $\frac{\mu mg}{v}$ c. mgv d. μmv^2 e. $\frac{v}{\mu mg}$

7. A rock of mass m is thrown horizontally off a building from a height h_0 . The speed of the rock as it leaves the thrower's hand at the edge of the building is v_0 . Disregarding air resistance, what is the kinetic energy of the rock just before it hits the ground?

- a. mgh_0 d. $\frac{1}{2}mv_0^2 - mgh_0$
 b. $\frac{1}{2}mv_0^2$ e. $\frac{1}{2}mv_0^2 + mgh_0$
 c. $mgh_0 - \frac{1}{2}mv_0^2$

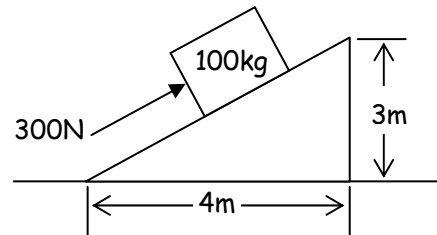


8. The two blocks of masses M shown above initially travel at the same speed v but in opposite directions. Momentum is conserved as they collide and stick together. How much mechanical energy is lost to other forms of energy during the collision?
- a. zero b. $\frac{1}{2}Mv^2$ c. Mv^2 d. $\frac{3}{4}Mv^2$ e. $\frac{3}{2}Mv^2$

9. A 5kg ball approaches a wall at a speed of 4m/s. It then bounces off of the wall in the opposite direction at the same speed. What is the magnitude of the average force exerted on the ball if it is in contact with the wall for 0.1s?
- a. 0N b. 100N c. 200N d. 400N e. 500N

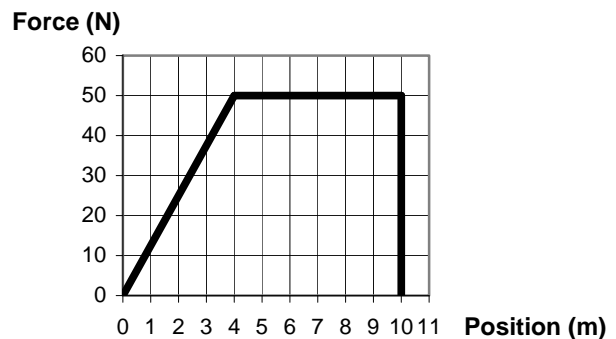
10. A constant force of 300N pushes a 100kg mass up the inclined plane shown in the diagram at a constant speed of 4m/s. The work done by the 300N force in pushing the mass from the bottom of the incline all the way to the top of the incline is most nearly...

- a. 0J
b. 900J
c. 1000J
d. 1500J
e. 3000J



11. The only force acting on an 8kg object varies as shown in the given graph. Determine the work done by this force to move the object from $x=0\text{m}$ to $x=10\text{m}$.

- a. zero
b. 50J
c. 300J
d. 400J
e. 500J



12. Assuming it started from rest at position 0m, the speed of the 8kg object in problem #11 at the end of the 10m displacement is closest to which one of the following?
- a. zero b. 2m/s c. 5m/s d. 7.1m/s e. 10m/s

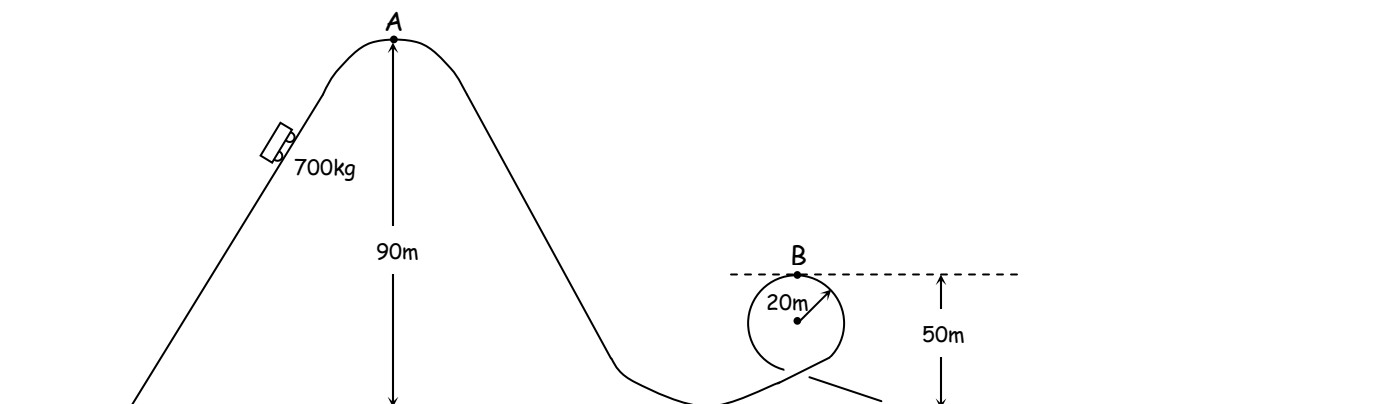
Problem Review: On this portion of the test, you may use your calculator, AP formula sheet, and AP table of information. Partial credit will be given on these problems.

13. A 50g ball is launched straight upward by a spring of spring constant 10 N/m. If the spring is initially compressed a distance of 15cm, use energy considerations to find the maximum height above its launch position to which the ball rises. (Note that the ball's launch position is where it leaves the spring, NOT at the spring's initial compressed position.)
14. A 0.12kg tennis ball is hit at Pete at a speed of 18m/s. He hits the ball back in exactly the opposite direction at a speed of 20m/s. What is the impulse delivered to the ball during the 32ms of contact time?
15. Starting with only conservation ideas and the definition of an elastic collision, derive the following expression: $v_{2f} = (v_{1i} - v_{2i}) + v_{1f}$

16. What is the launch velocity of a 100g ball fired into a 250g ballistic pendulum, if the 35cm-long pendulum reaches a maximum angle of 45° with the vertical, assuming the pendulum catches the ball when they collide?
17. Starting from rest, a 20kg block slides down 4m along a frictionless ramp that is inclined at 20° to the floor. Then the block slides another 3m along the flat, horizontal floor as it slows to a stop.
- Calculate the work done by gravity as the block slides down the ramp.
 - Use work and energy considerations to find the speed of the block at the base of the ramp.
 - Use work and energy ideas to find the coefficient of friction between the block and floor.

18. A 300g object slides down a frictionless 10° incline and reaches the bottom with a speed of 4.3m/s, where it elastically collides with a 400g object at rest. After the collision, how far back up the incline (measured along the incline) does the 300g object slide before it comes to a stop?
19. A 1300kg sports-car accelerates from rest to 25m/s in 5.1s. What is the average horsepower delivered by the engine?

20. Actual A.P. Physics B Free-Response Question (2004):



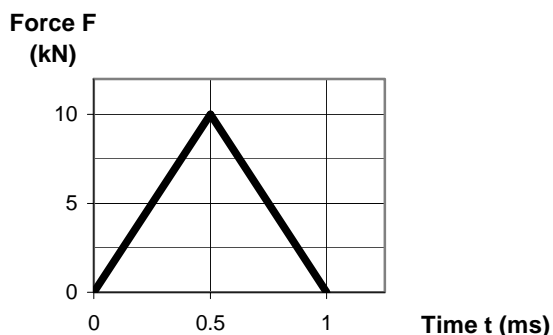
A roller coaster ride at an amusement park lifts a car of mass 700kg to point A at a height of 90m above the lowest point on the track, as shown. The car starts from rest at point A, rolls with negligible friction down the incline and follows the track around a loop of radius 20m. Point B, the highest point on the loop, is at a height of 50m above the lowest point on the track.

- Indicate on the figure the point P at which the maximum speed of the car is attained.
- Calculate the value v_{\max} of this maximum speed.
- Calculate the magnitude of all the forces acting on the car when it is upside down at point B.
- In order to stop the car at point B, some friction must be introduced. Calculate the work that must be done by the friction force in order to stop the car at point B.

21. Actual A.P. Physics B Free-Response Question (2002):

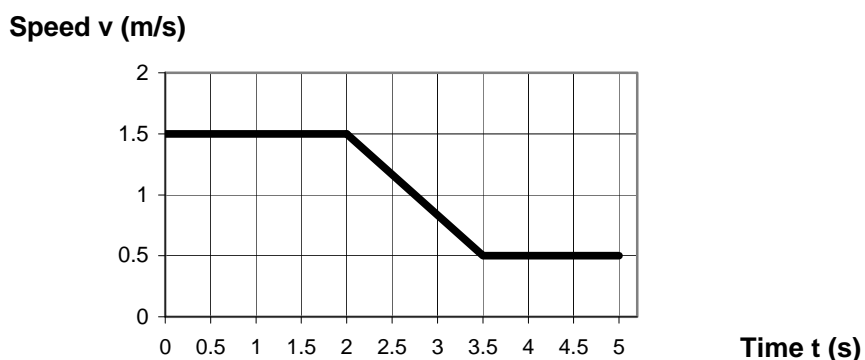


A 2.0kg frictionless cart is moving at a constant speed of 3.0m/s to the right on a horizontal surface, as shown above, when it collides with a second cart of undetermined mass M that is initially at rest. The force F of the collision as a function of time t is shown in the graph below, where $t=0$ is the instant of initial contact. As a result of the collision, the second cart acquires a speed of 1.5m/s to the right. Assume that friction is negligible before, during, and after the collision.



- Calculate the magnitude and direction of the velocity of the 2.0kg cart after the collision.
- Calculate the mass M of the second cart.

After the collision, the second cart eventually experiences a ramp, which it transverses with no frictional losses. The graph below shows the speed v of the second cart as a function of time t for the next 5s, where $t=0$ is now the instant at which the carts separate.



FREE-RESPONSE ANSWERS:

13. If you assume the zero-level for the problem to be where the spring is compressed to (the lowest place the ball ever is, and also 15cm below launch height), then $\frac{1}{2}kx_i^2 = mgh_f$ gives $\frac{1}{2}(10)(.15^2) = (.05)(9.8)(h_f)$. This gives an h_f value of 0.23m. This means that the ball's max height above launch position is 23cm - 15cm = 8cm above launch height.

14. $F\Delta t = \Delta p = (.12)(20) - (.12)(-18) = 4.56\text{kg} \cdot \text{m} / \text{s}$

15. -same as derivation given in class-

16. $U = mgh = (.350)(9.8)(.35 - .35 \cos 45^\circ) = .352\text{J}$

and K right after the collision = U at max angle, so $.352 = \frac{1}{2}mv^2 = \frac{1}{2}(.350)v^2$

and $v = 1.418\text{m/s}$ (This v is for the total mass and ball right after the collision.) Now they collide, so use $m_A v_A + m_B v_B = (m_A + m_B)v'$ which yields $(.100)(v_A) + 0 = (.350)(1.418)$ so, $v_A = 4.96\text{m/s}$

17.a. $W_g = F_g d \cos \theta = 268.14\text{J}$

b. On the incline, $U_i = K_f$ gives $m(9.8)(4 \sin 20) = \frac{1}{2}mv_f^2$ so $v_f = 5.18\text{m/s}$
(Or you could just say $W_g = \Delta K$ and get the same answer.)

c. On the floor, $W_{\text{net}} = \Delta KE$ gives $F_{\text{fric}} \Delta r (\cos \theta) = 0 - KE_i$

So $F_{\text{fric}}(3)(-1) = 0 - \frac{1}{2}(20)(5.18^2)$ and $F_{\text{fric}} = 89.4\text{N}$

So $\mu = \frac{F_{\text{fric}}}{N} = \frac{89.4}{(20)(9.8)} = .46$

18. Use conservation of momentum during the initial collision, first.

$(.3)(4.3) = (.3)(v_A') + (.4)(v_B')$ But since it's an elastic collision, you can substitute for v_B' , and get the following: $1.29 = (.3)(v_A') + (.4)(4.3 + v_A')$

Solve to arrive at $v_A' = -0.614\text{m/s}$.

Use this speed as block A's initial speed when sliding back up the incline in an energy-conservation problem. $\frac{1}{2}(.614^2) = (9.8)h_f$ So $h_f = .019\text{m}$

Lastly, note that you weren't asked for h_f . You were asked for the distance the block moves along the incline. Some simple triangle trig gives you 11cm.

19. $P = \frac{W}{\Delta t} = \frac{\frac{1}{2}(1300)(25^2) - 0}{\Delta 5.1} = 79,656.9\text{W} = 106.8\text{hp}$

- 20.a. You know the car will be going the fastest when all of its initial mgh is converted into KE.
- b. Use ME-conservation for $(9.8)(90) = \frac{1}{2}v^2$ which gives $v = 42\text{m/s}$.
- c. At the top of the loop, F_g acts downward on the car, and F_N (the force of the track pushing on the cart) also acts downward. $F_g = 700(9.8) = 6860\text{N}$. To find F_N , you must use centripetal acceleration ideas, which means you need to know how fast the car is traveling at the top of the loop. Use simple ME-conservation to find $v = 28\text{m/s}$. Now you're ready for centripetal stuff.

$$\Sigma F = ma_c \quad \text{yields} \quad F_g + F_N = m \frac{v^2}{r} \quad \text{yields} \quad 6860 + F_N = (700) \frac{28^2}{20}$$

and $F_N = 20,580\text{N}$.

- d. W_{fric} , which is the energy friction steals between point A and point B, just equals the difference between initial and final energies (which would both be just potential energies).
- 21.a. If you find the area under the curve in the graph, you would be finding impulse acting on the carts during the collision. (The two impulses are equal in magnitude and opposite in direction.) So $J = F\Delta t = \Delta p = 5\text{kgm/s}$. Now use this change in momentum to find the 2kg cart's final velocity. (Keep in mind that the impulse acting on this cart must push to the left, and therefore be negative in the equation.)
 $-5 = (2)(v_f - 3)$ so $v_f = 0.5\text{m/s}$ to right.
- b. Either use the same strategy as in part a, or use conservation of momentum. Either way, $M = 3.33\text{kg}$.
- c. $a = \text{slope} = -0.667\text{m/s}^2$
- d. The total distance traveled during the 5s is $d_1 + d_2 + d_3$ for the three different types of motion shown in the graph.
 $d_{\text{total}} = (1.5)(2) + [(1.5)(1.5) + \frac{1}{2}(0.667)(1.5^2)] + (0.5)(1.5) = 5.25\text{m}$
 (You could also find this distance by finding the area under the curve.)
- e. The ramp goes up because the cart slows down. Use ME-conservation to find h_f . $\frac{1}{2}(1.5^2) = \frac{1}{2}(0.5^2) + 9.8h_f$ and $h_f = 10.2\text{cm}$