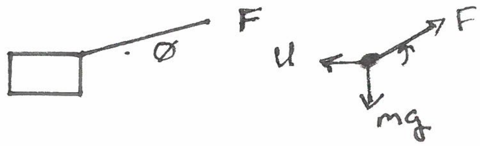
Unit 4 Pre Exam – Energy – AP Physics

KEY

Multiple-Choice questions

1. A force F is at an angle θ above the horizontal and is used to pull a heavy suitcase of weight mg a distance d along a level floor at constant velocity. The coefficient of friction between the floor and the suitcase is μ. The work done by the force F is:
   A. Fdcos θ - μ mgd
   B. Fdcos θ
   C. -μ mgd
   D. 2Fdsin θ - μ mgd



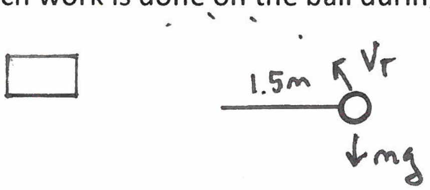
V = constant ∴ $a=0$

$W = Fd$

$W = Fd\cos\varnothing$

friction

2. A 4 kg ball is attached to a 1.5 m long string and whirled in a horizontal circle at a constant speed 5 m/s. How much work is done on the ball during one period?
   A. 9 J
   B. 4.5 J
   C. 2 J
   D. 0 J



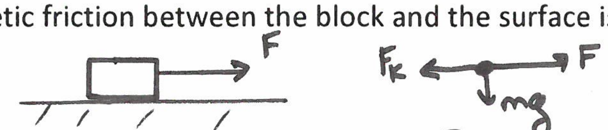
$W = Fd \nearrow 0$ $\quad W = \Delta KE \nearrow 0$ constant speed

No displacement

3. You need to move three identical couches from the first to the second floor of an apartment building. The first time, you and a friend make a mistake and carry a couch up to the third floor and then back down to the second floor. The second couch is carried directly from the first to the second floor. On your third trip, you decide to put a ramp over the staircase and you both push the couch up the ramp to the second floor. During which trip did you perform the most work on the couch?
   A. The first trip
   B. The second trip
   C. The third trip
   D. The same work was performed for each trip.

Final Displacement is the Same each time

4. A force F is applied in horizontal to a 10 kg block. The block moves at a constant speed of 2 m/s across a horizontal surface. The coefficient of kinetic friction between the block and the surface is 0.5. The work done by the force F in 1.5 minutes is:
   A. 9000 J
   B. 5000 J
   C. 3000 J
   D. 2000 J



m = 10 kg

$\Delta t = 1.5\text{ m}\left(\frac{60\text{ sec}}{1\text{ min}}\right) = 90\text{ sec}$

$V = 2$ m/s constant ∴ $a = 0$

$u_k = 0.5$

How far Δd in 90s?

$\Delta x = V_x t + \frac{1}{2}\cancel{a}t^2$

$= (2\text{ m/s})(90\text{ s})$

$\Delta x = 180$ m

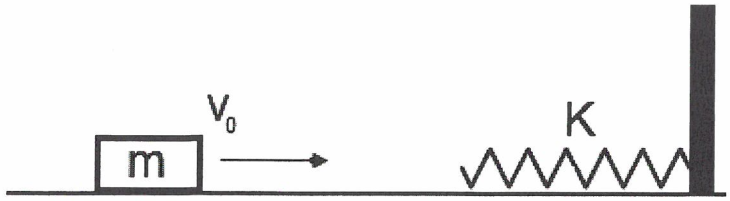
$W = Fd$

W = Force to overcome friction

$W = -u m g d$

$= (.5)(10\text{ kg})(9.8\text{ m/s}^2)(180)$

$= 9000$ J



a=0

5. As shown above, a block with a mass of m slides at a constant velocity V_0 on a horizontal frictionless surface. The block collides with a spring and comes to rest when the spring is compressed to the maximum value. If the spring constant is K, what is the maximum compression in the spring?

   A. $V_0\,(m/K)^{1/2}$
   B. KmV_0
   C. V_0K/m
   D. $V_0\,(K/m)^{1/2}$

KE Us Ug   KE Us Ug   ? ΔX ?

KE = Us

$\frac{1}{2} m v_0^2 = \frac{1}{2} K x^2$

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

$x = V_0 \sqrt{\frac{m}{K}}$

6. A crane lifts a 300 kg load at a constant speed to the top of a building 60 m high in 15 s. The average power expended by the crane to overcome gravity is:

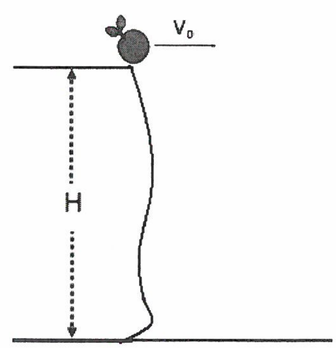
   A. 10,000 W
   B. 12,000 W
   C. 15,000 W
   D. 30,000 W

Constant speed
a = 0
t = 15s
P = ?
60m
300kg

$W = Fd$ $P = W/t$

$P = \frac{Fd}{t} = \frac{(300kg)(9.8 m/s^2)(60m)}{15s}$

P = 11760



Questions 7-8: An apple of mass m is thrown horizontally from the edge of a cliff of height H, as shown to the right.

7. What is the total mechanical energy of the apple with respect to the ground when it is at the edge of the cliff?

   A. $\frac{1}{2} mv_0^2$
   B. mgH
   C. mgH + $\frac{1}{2} mv_0^2$
   D. $\frac{1}{2} mv_0^2$ - mgH

$ME_i = KE_i + Ug_i$
$= \frac{1}{2} m V_0^2 + mgH$

8. What is the kinetic energy of the apple just before it hits the ground?

   A. $\frac{1}{2} mv_0^2$ + mgH
   B. $\frac{1}{2} mv_0^2$ - mgH
   C. mgH
   D. $\frac{1}{2} mv_0^2$

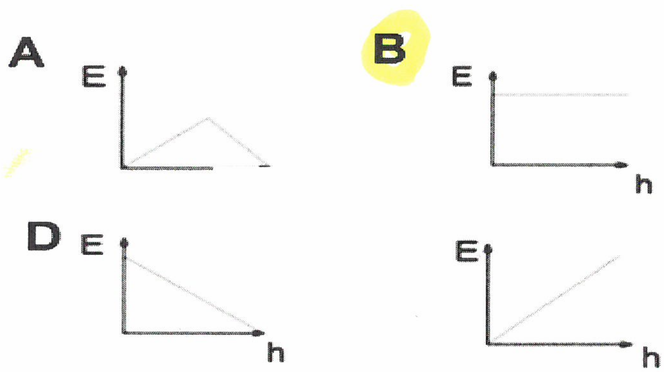
$ME_f = KE_f + \cancel{Ug_f}$
$= \frac{1}{2} m V_0^2 + mgH$

9. Two projectiles A and B are launched from the ground with velocities of 50 m/s at 60° (projectile A) and 50 m/s at 30° (projectile B) with respect to the horizontal. Assuming there is no air resistance involved, which projectile has greater kinetic energy when it reaches the highest point?
   A. projectile A
   B. projectile B
   C. they both have the same non-zero kinetic energy
   D. they both have zero kinetic energy

A: 50m/s = V_A, 60°
V_{xA}
50 cos 60°
25 m/s

B: V_B = 50m/s, 30
V_{xB}
50 cos 30°
43 m/s

10. A metal ball is held stationary at a height h_0 above the floor and then thrown downward. Assuming the collision with the floor is elastic, which graph best shows the relationship between the net energy E of the metal ball and its height h with respect to the floor?

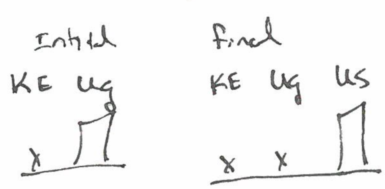


Net Energy = KE + PE
↑ Conserved
∴ Constant

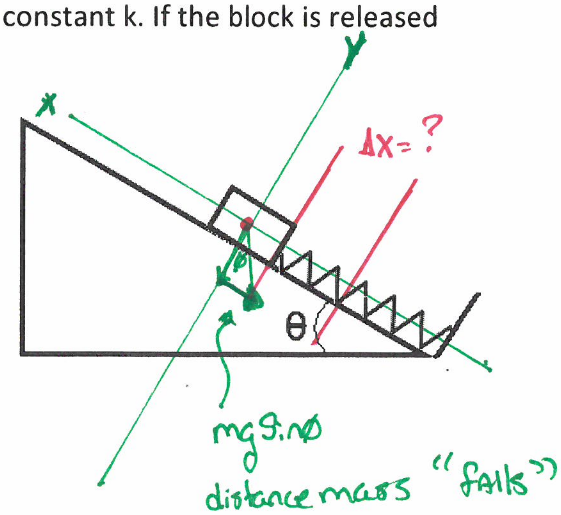
11. A rocket is launched from the surface of a planet with mass M and radius R. What is the minimum velocity the rocket must be given to completely escape from the planet's gravitational field?
   A. $(2GM/R)^{1/2}$
   B. $(2GM/R)^3$
   C. $(GM/R)^{1/2}$
   D. $2GM/R$

$$v^2 = \frac{2GM}{R}$$
$$= \sqrt{\frac{2GM}{R}}$$

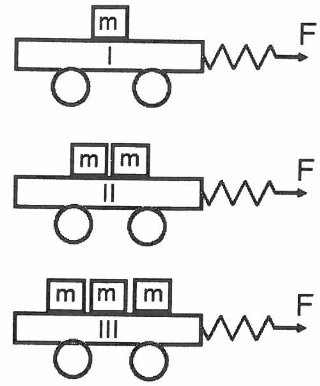
12. A block of mass m is placed on the frictionless inclined plane with an incline angle θ. The block is just in a contact with a free end on an unstretched spring with a spring constant k. If the block is released from rest, what is the maximum compression in the spring:
   A. kmg sinθ
   B. kmg cosθ
   C. 2mg sinθ /k
   D. mg/k



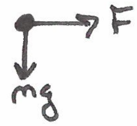
$U_g = U_s$?
$mgh = \frac{1}{2}kx^2$
$h = \sin\theta$
$mg\sin\theta = \frac{1}{2}kx^2$
$x^2 = \frac{2mg\sin\theta}{k}$



Questions 13-15: In a physics lab, a student uses three light, frictionless wheeled carts as shown to the right. Each cart is loaded with blocks of equal mass.



13. The same force F is applied to each cart and they move equal distances d. In which one of these three cases is more work done by force F?
   A. cart I
   B. cart II
   C. cart III
   D. the same work is done on each cart



$W = Fd$

Since frictionless

mass won't mat

14. The same force F is applied to each cart and they move equal distances d. Which cart will have more kinetic energy at the end of distance d?
   A. cart I
   B. cart II
   C. cart III
   D. all three will have the same kinetic energy

$ME_i = ME_f$

$KE_i = KE_f$

$\frac{1}{2}\cancel{m}v_i^2 = \frac{1}{2}\cancel{m}v_2^2$

mass cancels

15. The same force F is applied to each cart and they move equal distances d. Which cart will move faster at the end of distance d?
   A. cart I
   B. cart II
   C. cart III
   D. all three will move with the same velocity

~~$W = FD$~~

$W = \Delta KE$

$W = FD$

or ΔV

$FD = \frac{1}{2} m (v_f^2 - v_i^2)$

$\Delta V = \frac{2FD}{m}$ as $m\uparrow$ $V\downarrow$

$\therefore$ Lighter faster

Directions: For each of the following, two of the suggested answers will be correct. <u>Select the best two choices</u> to earn credit. No partial credit will be earned if only one correct choice is selected.

16. The following are characteristics of energy:

A. The amount of energy in an isolated system can be changed by an external force performing work on it.

B. Thermal energy can never be changed into mechanical energy. Steam engine

C. Mechanical energy can be changed into thermal energy.

D. Energy is only present in an object when it is moving.

17. A constant force, F, is applied to a block sitting on a bench. There could be other forces acting on the block at the same time. In which of the following cases is no work done on the block by F?

A. The force is applied to the block, and it moves in the same direction as the force.

B. The force is applied to the block, and the block moves in the opposite direction of the force.

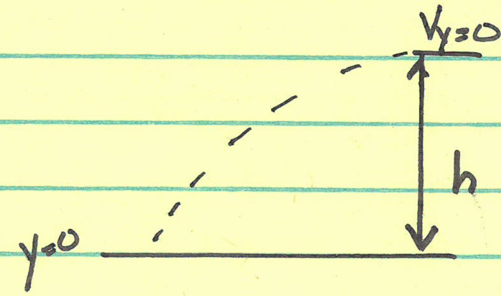
C. The block does not move.

D. The force is applied perpendicular to the block's motion.

AP Physics - Unit 4 - Pre-Exam - FRQ

KEY

① (A) $t = ?$ for Block to hit floor from Table height (h)



$$\cancel{y}^{\,0} = y_0 + \cancel{V_{y0}}^{\,0} t + \frac{1}{2} g t^2$$

$$0 = -h + \frac{1}{2} g t^2$$

$$+h = \frac{1}{2} g t^2$$

$$\boxed{t = \sqrt{\frac{2h}{g}}}$$

(B) $V_x = ?$

$$V_x = \frac{d}{t}$$

$$V_x = \frac{d}{\sqrt{\frac{2h}{g}}}$$

$$\boxed{V_x = d\sqrt{\frac{g}{2h}}}$$

(C) $W = ?$

$$W = \Delta KE$$

$$= KE_f - \cancel{KE_i}^{\,0}$$

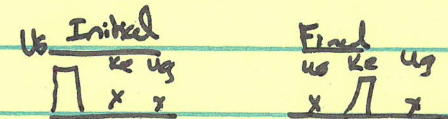
$$= \frac{1}{2} m v^2 \qquad v = d\sqrt{\frac{g}{2h}}$$

$$= \frac{1}{2} m \left(d\sqrt{\frac{g}{2h}}\right)^2$$

$$= \frac{1}{2} m d^2 \frac{g}{2h}$$

$$\boxed{W = \frac{m d^2 g}{4h}}$$

(d) $K = ?$



$$\cancel{\tfrac{1}{2}} K x^2 = \cancel{\tfrac{1}{2}} m v^2$$

$$K = \frac{m v^2}{x^2} \quad \left(v = d\sqrt{\frac{g}{2h}}\right)$$

$$K = \frac{m\left(d\sqrt{\frac{g}{2h}}\right)^2}{x^2}$$

$$K = \frac{m d^2 \frac{g}{2h}}{x^2}$$

$$\boxed{K = \frac{m d^2 g}{2 x^2 h}}$$

AP Physics - FRQ

Pre-Exam - KEY

$V_i = 25\ m/s$

2

a) $a = ?$

55m

$\Delta t = 3.0s$

$-a$ constant

$$x = \cancel{x_0}^{\,0} + v_x t + \tfrac{1}{2} \overset{?}{a} t^2$$

$x_0 = 0$

$v_{x0} = 25\ m/s$

$t = 3.0s$

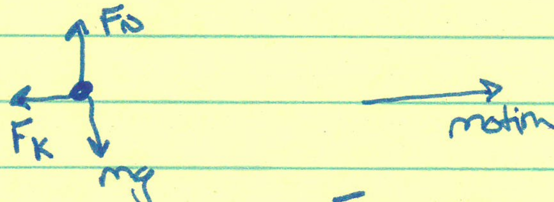
$x = 55m$

$$x - v_{x0}t = \tfrac{1}{2} a t^2$$

$$\frac{2(x - v_{x0}t)}{t^2} = a = \frac{2(55 - 25(3))}{3^2}$$

$$a = -4.4\ m/s^2$$

B



$F = ma$

$F_f = ma$

$= (900\ kg)(-4.4\ m/s^2)$

$F_f = 3960\ N$ static

$F_f = u_k F_N$

$$u_k = \frac{F_k}{F_N} = \frac{3960}{(900\ kg)(9.8)}$$

$\boxed{u_k\ .45}$

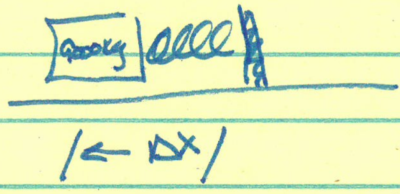
static

Pre Exam- Unit 4
KEY

$t = 10s$

(2) Cont: $V_i = 0$ $V_f = 25 m/s$

$K = 9200 \; N/m$



$\frac{1}{2}Kx$

KE   ug   us   KE   ug   us

$$V_{xf} = \cancel{V_{xo}}^{0} + at$$

$$a = \frac{V_y}{t} = \frac{25 m/s}{10 s} = 2.5 m/s^2$$

$$F = ma$$

$$F_{spring} = ma$$

$$\Delta Kx = ma$$

$$x = \frac{ma}{K} = \frac{(900 kg)(2.5 m/s^2)}{9200 N/m}$$

$$\boxed{x = .244 \; m}$$

(e) If the truck is moving at a constant speed the net force is zero. Since the only force acting directly on the crate is the spring force, the spring force must also become zero therefore the Δx would be zero and is **LESS** than before. Keep in mind the crate will stay on the frictionless truck bed because its inertia will keep it moving forward with the truck (remember you don't necessarily need forces to keep things moving)