AP Physics – Unit 2 – Dynamics - REVIEW   KEY

MULTIPLE CHOICE

1. You are standing in a moving bus, facing forward, and you suddenly fall forward. You can imply from this that the bus's
   a. velocity decreased
   b. velocity increased
   c. speed remained the same, but it's turning to the right
   d. speed remained the same, but it's turning to the left
   e. speed remained the same, but you have vertigo

2. A net force F acts on a mass m and produces an acceleration a. What acceleration results if a net force 2F acts on mass 4m?
   a. a/2
   b. 8a
   c. 4a
   d. 2a
   e. a

   $F = ma$

   $a = \frac{F}{m}$

   $= \frac{2F}{4m}$

   $a = \frac{F}{2m}$

3. If you blow up a balloon, and then release it, the balloon will fly away. This is an illustration of
   a. Newton's first law
   b. Newton's second law
   c. Newton's third law
   d. Galileo's law of inertia
   e. Ideal Gas law

4. Who has a greater weight-to-mass ratio, a person weighing 400 N or a person weighing 600N?
   F_1 F_2
   a. the person weighing 400 N
   b. the person weighing 600 N
   c. neither, their ratios are the same
   d. the question can't be answered with the information given
   e. the person eating the Fig Newtons

   $F = mg \leftarrow$ constant

5. A person standing on a horizontal floor feels two forces: the downward pull of gravity and the upward supporting force from the floor. These two forces,
   a. have equal magnitudes and form an action/reaction pair
   b. have equal magnitudes and but do not form an action/reaction pair - forces only act on 1 object
   c. have unequal magnitudes and form an action/reaction pair
   d. have equal magnitudes and do not form an action/reaction pair
   e. none of the above

6. If all of the forces acting on an object balance so that the net force is zero, then
   a. the object must be at rest no could have constant V, then $a = 0$ $\therefore \Sigma F_{net} = 0$
   b. the object's speed will decrease
   c. the object will follow a parabolic trajectory
   d. the object's direction of motion can change, but not its speed
   e. None of the above

7. A block of mass ***m*** is at rest on a frictionless, horizontal table placed in a laboratory on the surface of the earth. An identical block is at rest on a frictionless, horizontal table placed on the surface of the moon. Let ***F*** be the net force necessary to give the earth-bound block an acceleration of ***a*** across the table. Given that g_{moon} is one-sixth of g_{earth} and that air resistance is neglected, the force necessary to give the moon-bound block the same acceleration ***a*** across the table is
   a. ***F***/12
   b. ***F***/6
   c. ***F***/3
   d. ***F***
   e. 6***F***

$F = ma$

If frictionless, gravity does not affect horizontal motion

8. A crate of mass 100 kg is at rest on a horizontal floor. The coefficient of static friction between the crate and the floor is 0.4, and the coefficient of kinetic friction is 0.3. A force ***F*** of magnitude 344 N is then applied to the crate, parallel to the floor. Which of the following is true?
   a. the crate will accelerate across the floor at 0.5 m/s^2
   b. the static friction force will also have a magnitude of 344 N
   c. the crate will slide across the floor at a constant speed of 0.5 m/s
   d. the crate will not move
   e. none of the above

Check 1st is Force strong enough to over come F_s?

$F_s = F_N \mu_s$

$F_N = mg$

$= mg\,\mu_s$

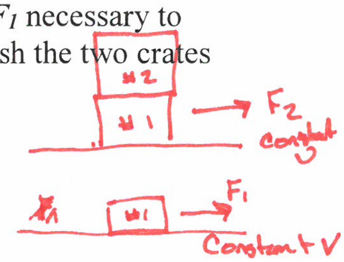
$= (100\,kg)(9.8\,m/s^2)(0.4)$

$F_s = 392\,N$ F is 344 N

So no movement

KEY

9. Two crates are stacked on top of each other on a horizontal floor; Crate #1 is on the bottom and Crate #2 is on the top. Both crates have the same mass. Compared to the strength of the force F_1 necessary to push Crate #1 by itself at a constant speed, the strength of the force F_2 necessary to push the two crates stacked together at constant speed is greater than F_1 because



a. the normal force on Crate #1 is greater

b. the coefficient of kinetic friction between Crate #1 and the floor is greater — U_k - mass not a factor

c. the force of kinetic friction, but not the normal force, on Crate #1 is greater — same! $F_k = U_k F_N \leftarrow F_N$!!

d. the coefficient of static friction between Crate #1 and the floor is greater — movement! U_s not an Issue

e. the weight of Crate #1 is greater

$F_2 > F_1$ Because

10. The amount of force needed to keep a 0.2 kg hockey puck moving at a constant speed of 7 m/s on frictionless ice is

a. zero

b. 0.2 N

c. 0.7 N

d. 7 N

e. 70 N

Newton's 2nd Law
No opposing forces

11. Friction

a. can only occur between two surfaces which are moving relative to one another — No you have static f

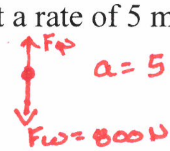
b. is equal to the normal force divided by the coefficient of friction — NO $F_f = U F_N$

c. opposes the relative motion between two surfaces in contact

d. only depends on one of the surfaces in contact

e. is always equal to the applied force — only Before movement

12. A person who weighs 800 N steps onto a scale that is on the floor of an elevator car. If the elevator accelerates upward at a rate of 5 m/s², what will the scale read? (use g = 10 m/s²)



$a = 5 m/s^2 \uparrow$ $g = 10 m/s^2$

$\Sigma F_x = F_N - F_w = ma$

$mg = F_w$
$m \cdot 10 = 800N$
$m = 80 kg$

$F_N = ma + F_w$
$= (80kg)(5m/s^2) + 800N$
$= 1200 N$

a. 400 N

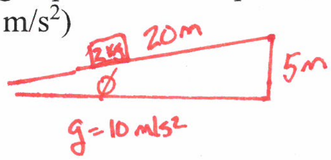
b. 800 N

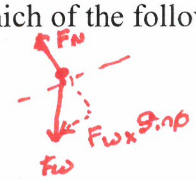
c. 1000 N

d. 1200 N

e. 1600 N

13. A frictionless inclined plane has a slant length of 20 m and a maximum vertical height of 5 m. If an object of mass 2 kg is placed on the plane, which of the following best approximates the net force it feels? (use g = 10 m/s²)





$\Sigma F_x = F_{wx} Sin ø = ma$
↑ only force in x-direction

a. 5 N

b. 10 N

c. 15 N

d. 20 N

e. 30 N

$F_{wx} Sin ø$
$Sin ø = \frac{5}{20}$
$F_{wx} = mg$

$F_{gx} = mg(\frac{5}{20})$
$F_{gx} = 2kg(10m/s^2)(\frac{5}{20})$
$= 5 N$

Key

14. A 20 N block is being pushed across a horizontal table by an 18 N force. If the coefficient of kinetic friction between the block and the table is 0.4, find the acceleration of the block. (use g = 10 m/s^2)

a. 0.5 m/s^2
b. 1 m/s^2
c. 5 m/s^2
d. 7.5 m/s^2
e. 9 m/s^2

18N, 20N, $u_k = 0.4$

F_n, F_A, F_k, F_w

$\Sigma F_x = F_A - F_k = ma$

$F_k = u_k F_n$

$\frac{F_A - u_k F_N}{m} = a$

$\frac{18 - (0.4)(20N)}{2kg} = a$

$= 5 m/s^2$

$\Sigma F_y = F_N - F_w = m\cancel{a}^0$

$F_n = F_w$

$= 20N$

$F_w = mg$

$20 = m(10)$

$m = 2kg$

15. The coefficient of static friction between a box and a ramp is 0.5. The ramp's incline angle is 30°. If the box is placed at rest on the ramp, the box will

a. accelerate down the ramp
b. accelerate briefly down the ramp but then slow down and stop
c. move with constant velocity down the ramp
d. not move
e. cannot be determined from the information given

$u_s = 0.5$

30°

F_n, F_s, $F_{wy}\cos\emptyset$, F_w, $F_{wx}\sin\emptyset$

$\Sigma F_x = -F_{wx}\sin\emptyset + F_s = ma$

$F_s = u_s F_N$

$-F_{wx}\sin\emptyset + u_s F_{wy}\cos\emptyset = \frac{mg}{m}a$

$F_w = mg$

$\Sigma F_y = F_N - F_{wy}\cos\emptyset = m\cancel{a}^0$

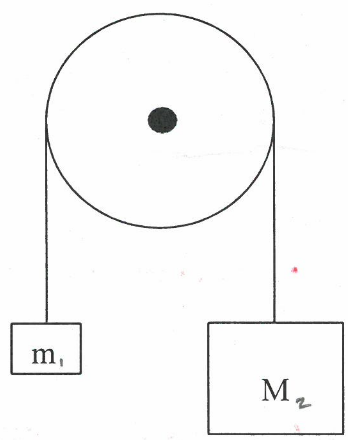
$F_n = F_{wy}\cos\emptyset$

$-\cancel{m}g\sin\emptyset + u_s\cancel{m}g\cos\emptyset = \cancel{m}a$

$-10\sin 30 + 0.5(10)\cos 30 = a$

$-5 m/s^2 + 4.33 m/s^2$

$-.67 m/s^2 = a$



$- a\uparrow$

x

y+

a+

16. Assuming the pulley above is frictionless and massless, determine the acceleration of the blocks once they are released from rest

a.
b.
c.
d.
e.

F_T, $m_1 g$, F_T, $M_2 g$

$-F_T + m_1 g = m_1 a$

$F_T = m_1 a + m_1 g$

$-F_T + M_2 g = M_2 a$

$F_T = -M_2 a + M_2 g$

$F_T = F_T$

$m_1 a + m_1 g = -M_2 a + M_2 g$

$m_1 a + M_2 a = M_2 g - m_1 g$

$a(m_1 + M_2) = g(M_2 - m_1)$

$a = g\left(\frac{M_2 - m_1}{m_1 + M_2}\right)$

17. A force of 26 N is needed to overcome a frictional force of 5 N to accelerate a 3 kg mass across a floor. What is the acceleration of the mass?

a. 4 m/s^2
b. 5 m/s^2
c. 7 m/s^2
d. 20 m/s^2
e. 60 m/s^2

5N, 26N, F_w, mg, m = 3kg

a = ?

$\Sigma F_x = ma$

$F_A - F_f = ma$

$26 - 5 = 3kg\, a$

$\frac{21}{3} = a$

$a = 7 m/s$

KEY

18. A force of 100 N directed at an angle of 45° from the horizontal pulls a 70 kg sled across a frozen frictionless pond. The acceleration of the sled is most nearly ?

a. 1 m/s^2
b. 0.7 m/s^2
c. 7 m/s^2
d. 35 m/s^2
e. 50 m/s^2

100 N, 45°, F_w, mg, $m = 70kg$

$F_{Ax}\cos\theta$

$F_{Ax}\cos\theta = ma$

$a = \frac{F_{Ax}\cos\theta}{m} = \frac{100N(\cos 45°)}{70kg}$

$a = 1\ m/s^2$

19. Two blocks of mass ***m*** and ***5m*** are connected by a light string which passes over a pulley of negligible mass and friction. What is the acceleration of the masses in terms of the acceleration due to gravity, g?

a. 4 g
b. 5 g
c. 6 g
d. ~~4/5 g~~
e. 2/3 g

m, $5m$, $-a\uparrow$, $-y\uparrow$, F_T, mg, $5mg$, $\downarrow +a$, $\downarrow y+$

$-F_T + mg = -ma$

$F_T = mg + ma$

$5m$: $-F_T + 5mg = 5ma$

$F_T = 5mg - 5ma$

$F_T = F_T$

$mg + ma = 5mg - 5ma$

$g - 5g = -5a - a$

$-4g = -6a$

$a = \frac{4}{6}g$

$a = 2/3\,g$

20. A 1-kg block rests on a frictionless table and is connected by a light string to another block of mass 2kg. The string is passed over a pulley of negligible mass and friction, with the 2 kg mass hanging vertically. What is the acceleration of the masses?

a. 5 g
b. 6.7 g
c. 10 g
d. 20 g
e. 30 g

1 Kg, 2 Kg, $+x \rightarrow$, $\downarrow y+$, $\therefore a+$

$a = ?$

1Kg: $\rightarrow F_T$, $F_T = m_1 a$

2Kg: F_T, $m_2 g$, $\downarrow y+$

$-F_T + m_2 g = m_2 a$

$F_T = m_2 g - m_2 a$

$F_T = F_T$

$m_1 a = m_2 g - m_2 a$

$m_1 a + m_2 a = m_2 g$

$a(m_1 + m_2) = m_2 g$

$a = \left(\frac{m_1 + m_2}{m_2}\right) g$

$= \frac{3}{2} g$

$= \frac{3}{2}(10)$

$a = 6.7\ m/s^2$

$F_T = m_1 a$

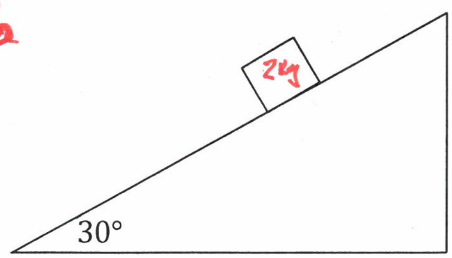
$= (1Kg)(6.7 m/s^2)$

$= 6.7 N$

21. A 2-kg wooden block rests on an inclined plane as shown below. The frictional force between the block and the plane is most nearly

$V = 0$

$\therefore a = 0$



F_f

F_P, F_s, F_w or mg, $m = 2kg$

$F_{Wy}\cos\theta$, $F_{Wx}\sin\theta$

a. 2 N
b. 10 N
c. 12 N
d. 17 N
e. 20 N

$\Sigma F_x = F_s - F_{wx}\sin\theta = m\cancel{a}^0$

$F_s = F_{wx}\sin\theta$

$F_{wx} = mg$

$= mg\sin\theta$

$= (2kg)(10 m/s^2)\sin 30°$

$= 10N$

KEY

22. A hockey puck with a mass of 0.3 kg is sliding along ice that can be considered frictionless. The puck's velocity is 20 m/s. The puck now crosses over onto a floor that has a coefficient of kinetic friction equal to 0.35. How far will the puck travel across the floor before it stops?

   a. 3 m
   b. 87 m
   c. 48 m
   d. 92 m
   e. 52 m

$x = ?$ $v = 20\,m/s$ 0.35 F_N F_f mg

$v = \frac{D}{T}$ $\cancel{V_f^2} = V_0^2 - 2ax$

$\Sigma F_x = -F_f = ma$

$F_f = u_k F_N$

$F_N = mg$

$-u_k \cancel{m} g = \cancel{m} a$

$a = -u_k g$

$= 0.35\,(10)$

$a = 3.5$

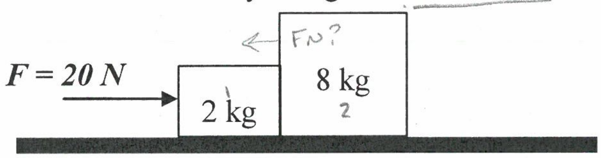
$2ax = V_0^2$

$x = \frac{V_0^2}{2a}$

$x = \frac{20^2}{2(3.5)}$

$x = 57.1$

23. A 20-N force is pushing two blocks horizontally along a frictionless floor as shown below



What is the force that the 8-kg mass exerts on the 2-kg mass?

   a. 4 N
   b. 8 N
   c. 16 N
   d. 20 N
   e. 24 N

2kg: F_B F_N F_{20} F_w mg $m = 2kg$

$\Sigma F_x = F_{20} - F_B = m_1 a$

$F_B = F_{20} - m_1 a$

8kg: F_N F_B mg $m = 8kg$

$F_B = m_2 a$

$am_2 = F_{20} - m_1 a$

$a(m_2 + m_1) = F_{20}$

$a = \frac{F_{20}}{m_2 + m_1} = \frac{20N}{8+2} = 2\,m/s^2$

$F_B = m_2 a$

$= 8\,kg\,(2\,m/s^2)$

$F_B\ 16\,N$

Check

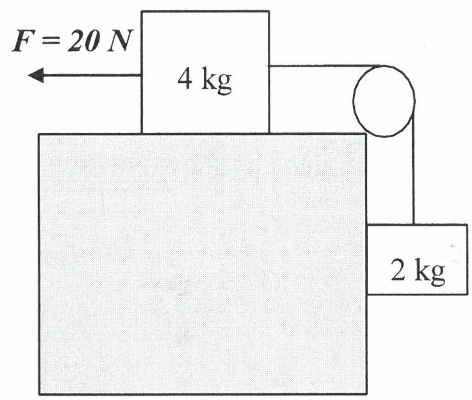
$F_B = F_{20} - m_1 a$

$= 20 - 2kg(2\,m/s^2)$

$= 20 - 4$

$= 16\,N$

24. According to the diagram below, what is the tension in the connecting string if the table is frictionless?



$\leftarrow a$ $+x \rightarrow$

   a. 6.4 N
   b. 13 N
   c. 20 N
   d. 25 N
   e. 32 N

$F_T = ?$

4kg: F_N F_{20} F_T mg

2kg: F_T $m_2 g$ $\uparrow y+$ $\uparrow a+$

$\Sigma F_x = F_T - F_{20} = -ma$

$F_T = -m_1 a + F_{20}$

$\Sigma F_y = F_T - m_2 g = m_2 a$

$F_T = m_2 g + m_2 a$

$F_T = F_T$

$-m_1 a + F_{20} = m_2 g + m_2 a$

$+m_1 a + m_2 a = -m_2 g + F_{20}$

$a(m_1 + m_2) = -m_2 g + F_{20}$

$a = \frac{-m_2 g + F_{20}}{m_1 + m_2}$

$a = .1$

$a = \frac{-(2\,kg)(9.8\,m/s^2) + 20\,N}{4 + 2\,kg}$

$= \frac{.4}{6}$

$a = 0.067\,m/s^2$

$F_T = 2kg(9.8) + 2kg(0.067)$

$= 19.7\,N$

$\approx 20\,N$

Check

$F_T = -m_1 a + F_{20}$

$= .4(0.067) + 20$

$= 19.7\,N \approx 20$

25. A mass M is released from rest on an incline that makes a 42° angle with the horizontal. In 3s, the mass is observed to have gone a distance of 3m. What is the coefficient of kinetic friction between the mass and the surface of the incline?

V_o t x $U_k = ?$

a. 0.8

b. 0.7

c. 0.6

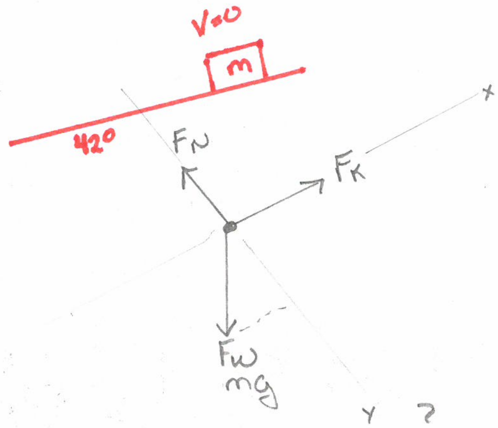
d. 0.5

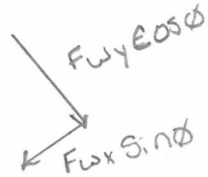
e. 0.3

$V_o = 0$

$t = 3s$

$x = 3m$





$\Sigma F_x = F_K - F_{wx}\sin\theta = m\overset{?}{a}$

$F_K = \overset{?}{u_k} F_N$

$\Sigma F_y = F_N - F_{wy}\cos\theta = m\cancel{a}^{0}$

$F_{wy} = mg$

$F_N = mg\cos\theta$

$-u_k F_N - mg\sin\theta = ma$

$-u_k \cancel{m} g\cos\theta - \cancel{m} g\sin\theta = \cancel{m}a$

$-\overset{?}{u_k} g\cos\theta - g\sin\theta = \overset{?}{a}$

$-u_k g\cos\theta = a - g\sin\theta$

$u_k = \dfrac{g\sin\theta - a}{g\cos\theta}$

$= \dfrac{(9.8\,m/s^2)(\sin 42°) - 0.67\,m/s^2}{(9.8\,m/s^2)(\cos 42°)}$

$= \dfrac{5.89\,m/s^2}{}$

$u_k = 0.808$

$x = \cancel{x_o}^{0} + \cancel{V_o t}^{0} + \frac{1}{2}at^2$

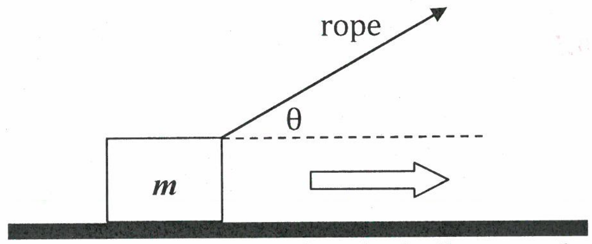
$x = \frac{1}{2}at^2$

$a = \dfrac{2x}{t^2} = \dfrac{2(3m)}{(3s)^2}$

$a = 0.67\,m/s^2$

FREE RESPONSE

26. This question concerns the motion of a crate being pulled across a rough, horizontal floor by a rope. In the diagram below, the mass of the crate is $\boldsymbol{m}$, the coefficient of kinetic friction between the crate and the floor is μ, and the tension in the rope is F_1.



   a. ***Draw and label (using the given variables) a free-body diagram showing all the forces acting on the crate.***

   b. ***Compute the normal force acting on the crate in terms of*** m, F_T, θ, ***and*** g.

   c. ***Compute the acceleration force of the crate in terms of m, F_T, θ, μ, and g***