AP Physics B – Newton's Laws 80 min Test version: H Name Key Per___

1) A person weighing 490 newtons is standing on a bathroom scale in an elevator that is accelerating upward at a rate of 0.2 meter per second squared. What does the bathroom scale indicate the person's weight is?

(A) 480 N $N - mg = ma$
(B) 490 N
(C) 588 N
(D) 500 N
(E) 392 N

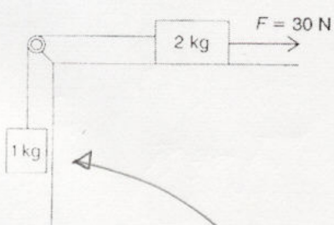
Each m/c is worth 2pts
m/c pts = 38
F/R pts = 42
total pts = 80
Students need 62.5% of this for a 100% or 50pts

2) A hockey puck with a mass of 0.2 kilogram is sliding along ice that can be considered frictionless with a velocity of 10 meters per second. The puck then crosses over onto a rough floor that has a coefficient of kinetic friction equal to 0.2. How far will the puck travel before friction stops it?

(A) 17.6 m $F_f = ma$
(B) 42.7 m $\mu mg = ma$
(C) 25.5 m $a = \mu g$
(D) 59.6 m
(E) 62.3 m $v^2 = v_0^2 + 2a(x - x_0)$

Questions 3 - 4) are based on the information and the diagram below:

Two masses are connected by a light string. The horizontal mass of 2 kilograms is being pulled to the right with a force of 30 newtons along a frictionless surface.



3) What is the magnitude of the tension in the connecting string?

(A) 16.5 N $T - mg = ma$
(B) 18.7 N
(C) 20 N
(D) 34.6 N
(E) 44.2 N

4) What is the magnitude of the acceleration of both masses? $F - mg = (m_1 + m_2)a$

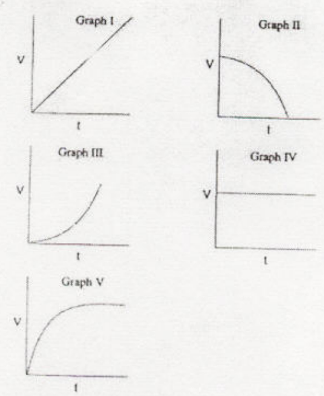
$30 - 10 = 3a$

(A) 3.5 m/s²
(B) 6.75 m/s²
(C) 8.25 m/s²
(D) 9.0 m/s²
(E) 10.3 m/s²

5) What braking force is applied to a 2500-kilogram car having a velocity of 30 meters per second if the car is brought to a stop in 15 seconds?

(A) 5000 N $\bar{a} = \frac{\Delta v}{\Delta t}$
(B) 6000 N
(C) 8000 N $F = ma$
(D) 10,000 N
(E) 12,000 N

QUESTIONS 6 - 7)



6) The graph that best describes the motion of a mass initially at rest and pulled by a constant force across a frictionless horizontal surface is

(A) Graph I.
(B) Graph II.
(C) Graph III.
(D) Graph IV.
(E) Graph V.

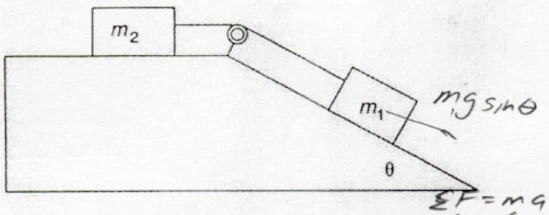
7) The graph that best describes the motion of a mass pulled by a force that is equal to the frictional force acting on it is

(A) Graph I.
(B) Graph II.
(C) Graph III.
(D) Graph IV.
(E) Graph V.

8) A 15-kilogram ball is suspended by a rope from the ceiling. The magnitude of the force exerted on the ball by the rope is most nearly

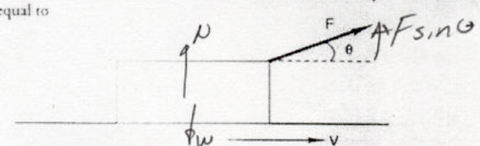
(A) zero
(B) 1.5 N
(C) 15 N
(D) 150 N
(E) 200 N

9) In the diagram below, two masses connected by a light string slide over frictionless surfaces. If the angle of the incline is θ, what is the acceleration of both masses?

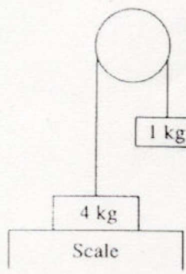


(A) $(m_1 + m_2)g \sin\theta$
(B) $m_2 g / (m_1 + m_2)$
(C) $m_1 g \cos\theta / (m_1 + m_2)$
(D) $(m_1 / m_1 m_2) g \sin\theta$
(E) $m_1 g \sin\theta / (m_1 + m_2)$

10) A block of weight W is pulled along a horizontal surface at a constant speed V by a force F, which acts at an angle θ with the horizontal, as shown below. The normal force exerted on the block by the surface is equal to



(A) $W - F \sin\theta$ (B) $W - F \cos\theta$.
(C) $W + F \sin\theta$ (D) $W + F \cos\theta$.
(E) W



11) The figure above shows a pulley system in equilibrium. What is the weight read by the scale? Assume that g = 10 m/s².

(A) 0 N
(B) 10 N
(C) 30 N
(D) 40 N
(E) 50 N

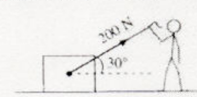
12) A box of mass 10kg slides on a frictionless surface at 30 m/s. How much force is needed to maintain this velocity?

(A) 0 N
(B) $\frac{1}{3}$ N
(C) 3 N
(D) 30 N
(E) 300 N

13) A 1 kg book is being pushed across a horizontal table with a force of 5 N. The coefficient of kinetic friction between the book and the table is 0.3. What is the acceleration of the book?

(A) 0 m/s²
(B) 2 m/s²
(C) 5 m/s²
(D) 8 m/s²
(E) 10 m/s²

Questions 14-15) refer to a mover pulling a 20-kilogram box along a frictionless surface using a rope that makes an angle of 30° with the horizontal. The mover pulls on the rope with a force of 200 N.
sin 30° = 0.500, cos 30° = 0.866

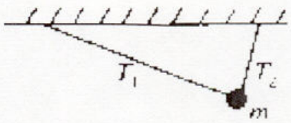


14) What is the acceleration of the box along the ground?

(A) 0 m/s²
(B) 5.00 m/s²
(C) 8.66 m/s²
(D) 10.0 m/s²
(E) 17.32 m/s²

15) What is the normal force exerted by the ground on the box?

(A) 27 N
(B) 100 N
(C) 200 N
(D) 300 N
(E) 373 N



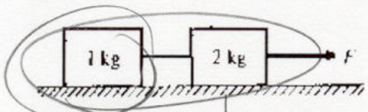
16) A ball of mass m is suspended from two strings of unequal length as shown above. The tensions T_1 and T_2 in the strings must satisfy which of the following relations?

(A) $T_1 = T_2$
(B) $T_1 > T_2$
(C) $T_1 < T_2$
(D) $T_1 + T_2 = mg$
(E) $T_1 - T_2 = mg$

19) Three forces act on an object. If the object is in translational equilibrium, which of the following must be true?

I. The vector sum of the three forces must equal zero.
II. ~~The magnitudes of the three forces must be equal~~
III. ~~All three forces must be parallel~~

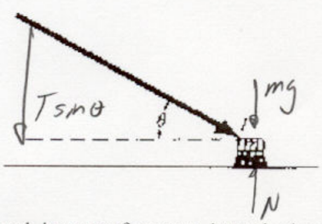
(A) I only
(B) II only
(C) I and III only
(D) II and III only
(E) I, II, and III



17) When the frictionless system shown above is accelerated by an applied force of magnitude F, the tension in the string between the blocks is

(A) $2F$
(B) F
(C) $\frac{2}{3}F$
(D) $\frac{1}{2}F$
(E) $\frac{1}{3}F$

$F = ma$
$F = 3a$
$a = F/3$
1/3 mass = 1/2 Force
$T = ma$
$T = 1(F/3)$



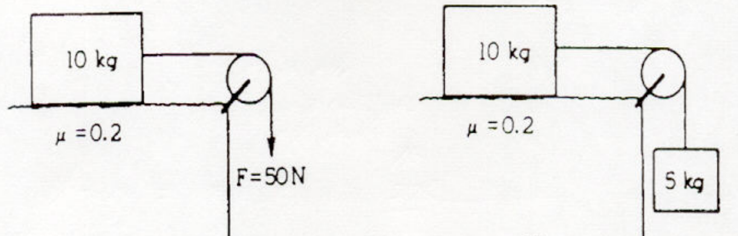
18) A push broom of mass m is pushed across a rough horizontal floor by a force of magnitude T directed at angle θ as shown above. The coefficient of friction between the broom and the floor is It. The frictional force on the broom has magnitude

(A) $\mu(mg + T\sin\theta)$
(B) $\mu(mg - T\sin\theta)$
(C) $\mu(mg + T\cos\theta)$
(D) $\mu(mg - T\cos\theta)$
(E) μmg

$F_f = \mu N$
$= \mu(mg + T\sin\theta$

15 pts

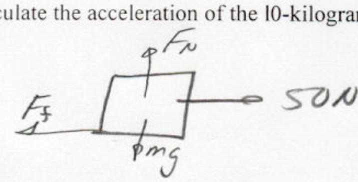
1979 PHYSICS B MECHANICS



Case I   Case II

A 10-kilogram block rests initially on a table as shown in cases I and II above. The coefficient of sliding friction between the block and the table is 0.2. The block is connected to a cord of negligible mass, which hangs over a massless, frictionless pulley. In case I a force of 50 newtons is applied to the cord. In case II an object of mass 5 kilograms is hung on the bottom of the cord. Use g = 10 meters per second squared.

(4) (a) Calculate the acceleration of the 10-kilogram block in case I.



$\Sigma F = ma$ (1)

(1) $50 - F_f = ma$

$50 - \mu mg = ma$

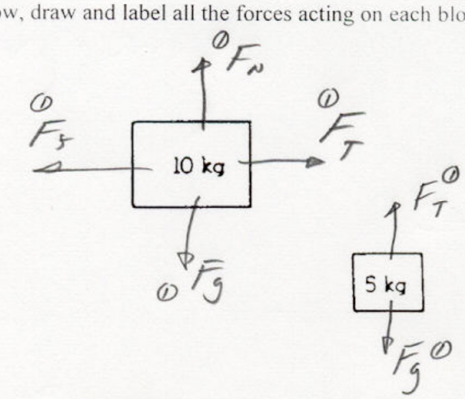
$50 - (0.2)(10)(10) = (10)a$

$50 - 20 = 10a$

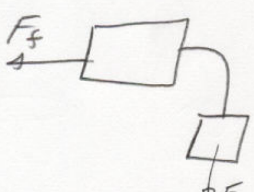
(1) $30 = 10a$

$a = 3\ m/s^2$ (1)

(6) (b) On the diagrams below, draw and label all the forces acting on each block in case II.



(5) (c) Calculate the acceleration of the 10-kilogram block in case II.



$\Sigma F = m_{total} a$ (1)

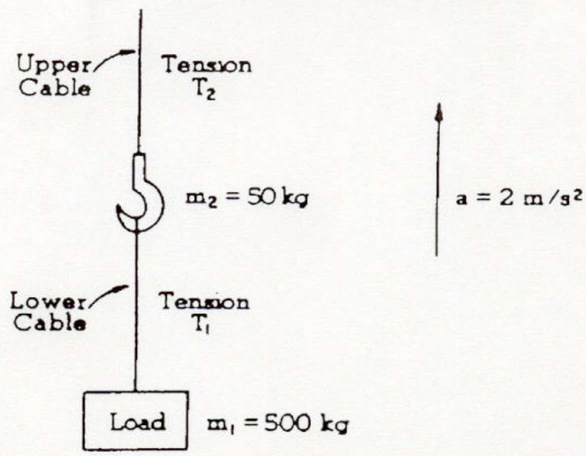
$F_g - F_f = m_{total} a$

(1) $m_5 g - \mu m_{10} g = (m_5 + m_{10}) a$ (1)

$5(10) - (0.2)(10)(10) = (15) a$ (1)

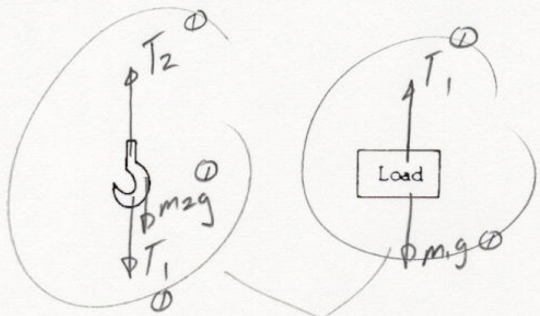
(1) $a = 2\ m/s^2$

15 pts



A crane is used to hoist a load of mass $m_1 = 500$ kilograms. The load is suspended by a cable from a hook of mass $m_2 = 50$ kilograms, as shown in the diagram above. The load is lifted upward at a constant acceleration of 2 m/s².

(6) (a) On the diagrams below, draw and label the forces acting on the hook and the forces acting on the load as they accelerate upward.



(9) (b) Determine the tension T_1 in the lower cable and the tension T_2 in the upper cable as the hook and load are accelerated upward at 2 m/s². Use g = 10 m/s².

$\Sigma F = ma$ ①

$T_1 - m_1g = m_1a$ ①

① proper substitution

$T_1 - 500(10) = (500)(2)$

① $T_1 = 6000\ N$

$\Sigma F = ma$ ①

$T_2 - m_2g - T_1 = m_2a$ ①

① proper substitution

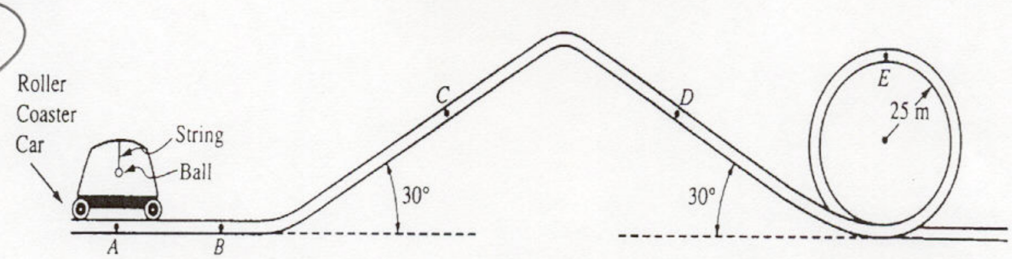
$T_2 - 50(10) - 6000 = (50)(2)$

① $T_2 = 6600\ N$

① Last point for units on both

12pts

1995 PHYSICS B MECHANICS



Note: Figure not drawn to scale.

3. Part of the track of an amusement park roller coaster is shaped as shown above. A safety bar is oriented length-wise along the top of each car. In one roller coaster car, a small 0.10-kilogram ball is suspended from this bar by a short length of light, inextensible string.

(a) Initially, the car is at rest at point *A*.

i. On the diagram to the right, draw and label all the forces acting on the 0.10-kilogram ball. (2)

ii. Calculate the tension in the string. (1)

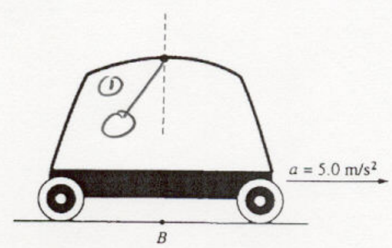
$F_g = mg \approx (0.1)(10) \approx \boxed{1\,N}$

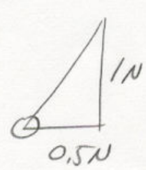
The car is then accelerated horizontally, goes up a 30° incline, goes down a 30° incline, and then goes around a vertical circular loop of radius 25 meters. For each of the four situations described in parts (b) to (e), do all three of the following. In each situation, assume that the ball has stopped swinging back and forth.

- Determine the horizontal component T_h of the tension in the string in newtons and record your answer in the space provided.
- Determine the vertical component T_v of the tension in the string in newtons and record your answer in the space provided.
- Show on the adjacent diagram the approximate direction of the string with respect to the vertical. The dashed line shows the vertical in each situation.

(b) The car is at point *B* moving horizontally to the right with an acceleration of 5.0 m/s².

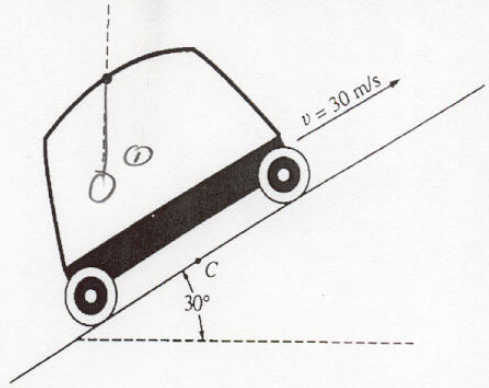
$T_h =$ 0.5 (1) N $\qquad T_v =$ 1 (1) N





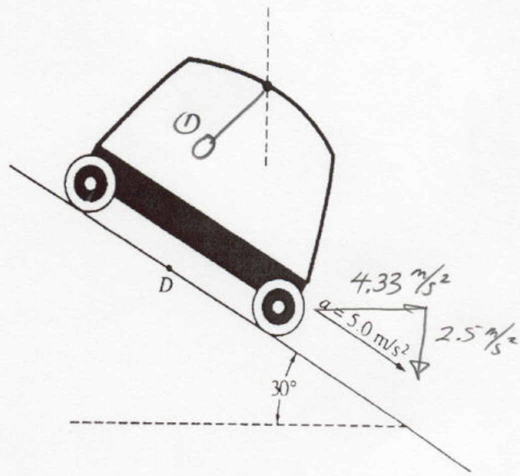
(c) The car is at point C and is being pulled up the 30° incline with a constant speed of 30 m/s.

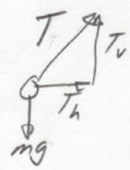
T_h = 0 N T_v = 1 N



(d) The car is at point D moving down the 30° incline with an acceleration of 5.0 m/s^2.

T_h = 0.433 N T_v = 0.75 N





$\Sigma F_h = ma$

$\xrightarrow{+}$ $T_h = (0.1)(4.33\ \text{m/s}^2) =$

$+\downarrow$ $\Sigma F_v = ma$

$mg - T_v = ma$

$T_v = mg - ma$

$= m(g-a)$

$= (0.1)(10-2.5)$

$= 0.75\ \text{N}$