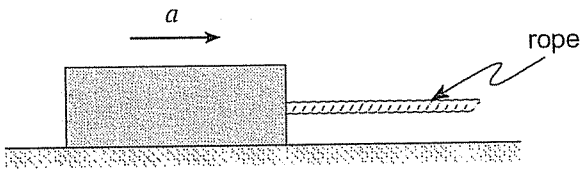
SOLUTIONS

Chapter 4 Government Exam Questions **Name:** _____

1. Basic. Free body diagrams

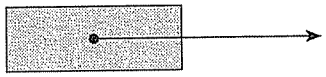
The block in the diagram below is being accelerated to the right across a rough surface by a force applied through the rope.

↳ implies we have friction.

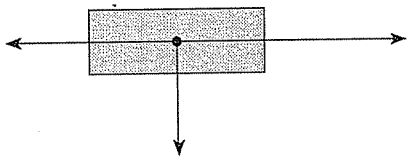


Which of the following best represents a free-body diagram for the block?

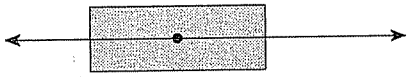
A.



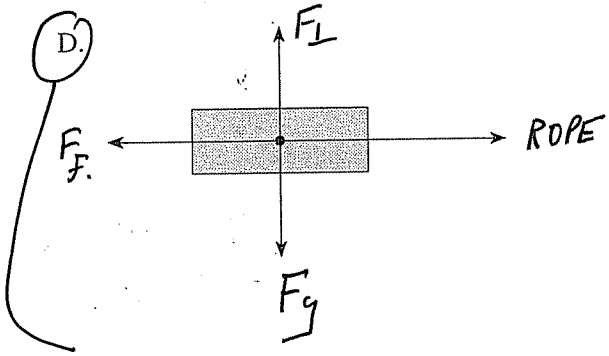
B.



C.



D.



2. A basic question, 1 mass problem

A 1200 kg vehicle is accelerated from rest to 15 m/s over a distance of 85 m. What is the net force on the car during this acceleration?

A. 1 600 N
B. 3 200 N
C. 6 800 N
D. 10 000 N

(1) $V_f^2 = V_i^2 + 2ad$.

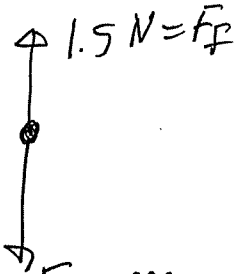
$\frac{V_f^2}{2d} = a = \frac{15^2}{2 \times 85} = 1.3235 \text{ m/s}^2$.

(2) $F = ma = (1200)(1.3235) = 1588$

3. Basic problem, 1 mass problem. Find F_{NET} then use it to calculate accel.

A falling 0.60 kg object experiences a frictional force due to air resistance of 1.5 N. What is the object's acceleration?

A. 2.5 m/s^2
B. 4.4 m/s^2
C. 7.3 m/s^2
D. 12 m/s^2



(1) $F_{NET} = 5.88 - 1.5$
$= 4.38 N$

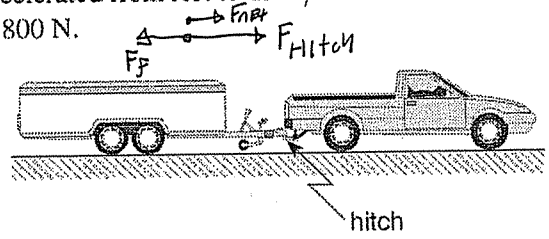
(2) $a = F/m = \frac{4.38}{0.6}$

$= 7.3 \text{ m/s}^2$

4. Basic. 1 Mass problem. Hint, pay attention to which mass or masses you need to use.

① $V_f = V_i + at$ $\quad \frac{V_f - V_i}{t} = a = \frac{15}{5} = 3\ m/s^2$

A 1200 kg trailer is accelerated from rest to 15 m/s in 5.0 s. The average force of friction acting on the trailer is 800 N.



What is the pulling force applied to the trailer through the hitch?

A. 800 N
B. 2800 N
C. 3600 N
D. 4400 N

D

② $F = ma = (1200)(3) = 3600\ N$

③ $F_{NET} = F_{HITCH} - F_F$

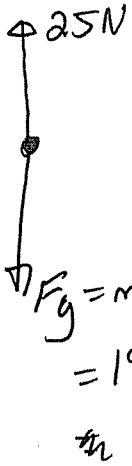
$3600 = F_{HITCH} - 800$

$F_{HITCH} = 4400$

5. Med to hard. 1 Mass problem. Hint, what is the net force on the 2 kg mass?

A 2.0 kg mass is suspended by a spring scale from the ceiling of an elevator. If the spring scale reads 25 N, then the acceleration of the elevator is

A. 2.7 m/s^2 upwards.
B. 2.7 m/s^2 downwards.
C. 13 m/s^2 upwards.
D. 13 m/s^2 downwards.



① $F_{NET} = 25 - 19.6$

$= 5.4\ N$ (up)

$F_g = mg = (2)(9.8)$

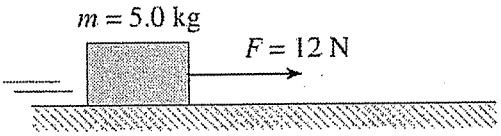
$= 19.6\ N$

② $a = \frac{F}{m} = \frac{5.4}{2}$

$= 2.7$ up

6. Medium, 1 Mass and Friction. Hint, what does the term constant force tell you?

A 5.0 kg object is pulled at a constant speed by a horizontal 12 N force as shown in the diagram below.

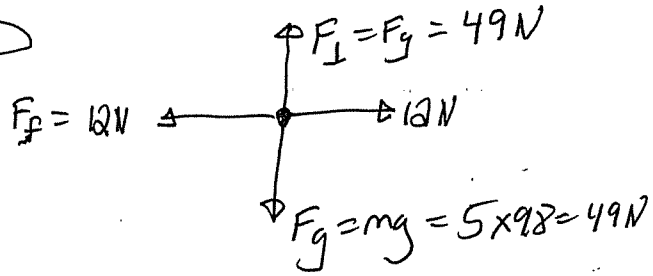


① means $F_{NET} = 0$

What is the coefficient of friction between the object and the surface?

② means $F_f = 12\,N$

A. 0.24
B. 0.42
C. 1.0
D. 2.4



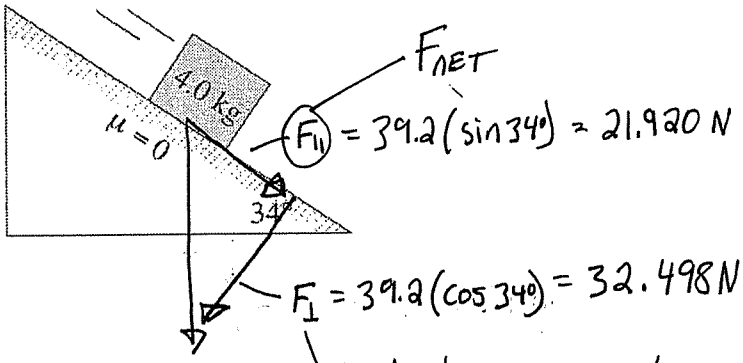
③ $F_f = \mu F_\perp$

$12 = \mu\, 49$

$\mu = 0.244$

7. Medium. Inclines, finding components. Hint: find the component of Fg parallel to the slope.

A 4.0 kg silver block is sliding down a frictionless inclined plane as shown below.



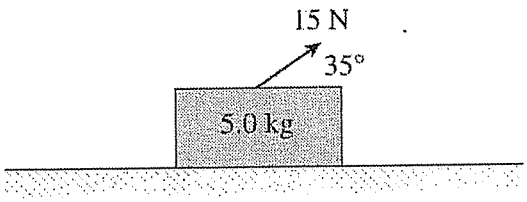
What is the block's acceleration?

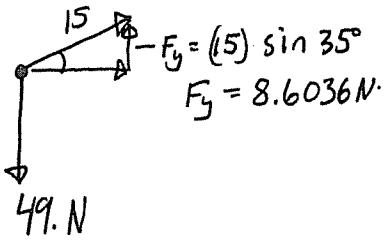
A. 2.5 m/s²
B. 5.5 m/s²
C. 6.6 m/s²
D. 8.1 m/s²

$$a = \frac{F_{NET}}{m} = \frac{21.920}{4} = 5.4800\ m/s^2$$

8. Basic. Normal forces. Hint, Find the Y component of the applied 15 N force.

A 15 N force is applied to a 5.0 kg block as shown.





What is the normal force on the block?

A. 37 N
B. 40 N
C. 49 N
D. 58 N

Forces up = Forces down (otherwise it would be accelerating)

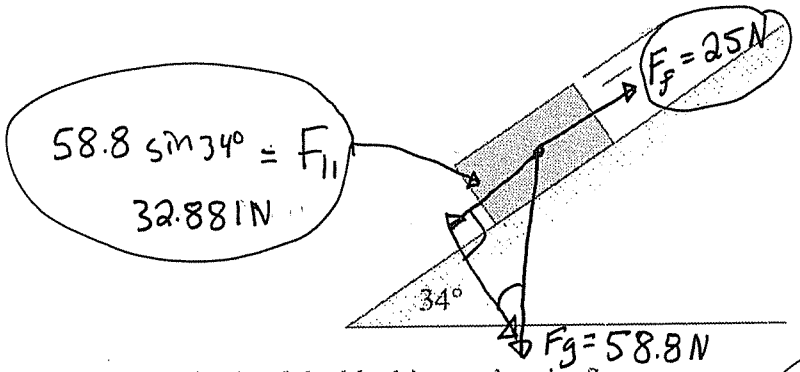
$F_y + F_\perp = F_g$

$8.6036 + F_\perp = 49$

$F_\perp = 40.396$ — B

9. Medium. Friction, inclines. Hint, find force of gravity parallel to surface a first step, then find F_{NET} (parallel to the slope).

A 6.0 kg block is on an incline. The friction force acting on the block is 25 N.



$58.8 \sin 34° = F_{||}$

$32.881 N$

$F_{NET} = F_{||} - F_f$

$= 7.8805$

What is the magnitude of the block's acceleration?

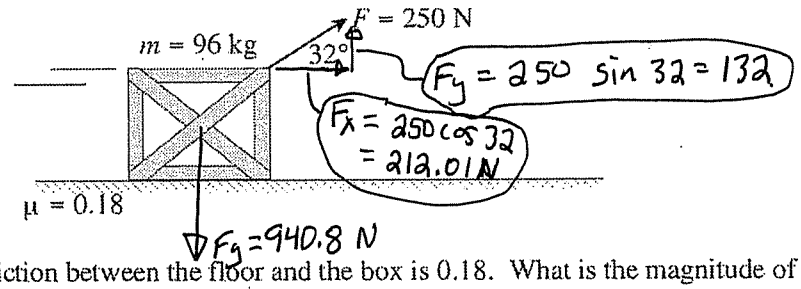
A. 1.3 m/s²
B. 2.0 m/s²
C. 4.0 m/s²
D. 5.6 m/s²

$a = \frac{F_{NET}}{m} = \frac{7.8805}{6}$

$= 1.3134 m/s^2$

10. Medium to hard. Friction, normal force, 1 mass problem. Hints, first find the x and y components of the applied force, then find the normal force taking into account the y component.

A 250 N force is applied at an angle of 32° above the horizontal to a 96 kg wooden box causing it to slide along a floor as shown.



The coefficient of friction between the floor and the box is 0.18. What is the magnitude of the net force on the wooden box?

A. 43 N
B. 67 N
C. 81 N
D. 210 N

$\Sigma F = 0$

OR

Forces up = Forces down (otherwise object would be accel up or down)

$F_\perp + F_y = F_g$

$F_\perp = F_g - F_y$

$= 940.8 - 132$

$F_\perp = 808.8\ N$

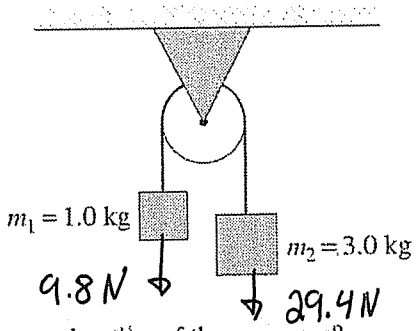
$F_f = \mu F_\perp = (.18)(808.8) = 145.58\ N$

$\leftarrow\rightarrow \quad F_{NET} = F_x - F_f = 212.01 - 145.58$

$F_{NET} = 66,426\ N$

11. Two mass problem, basic.

Two masses, one of 1.0 kg, the other of 3.0 kg. are suspended from the ends of a light string passing over a frictionless pulley.



What is the magnitude of the acceleration of these masses?

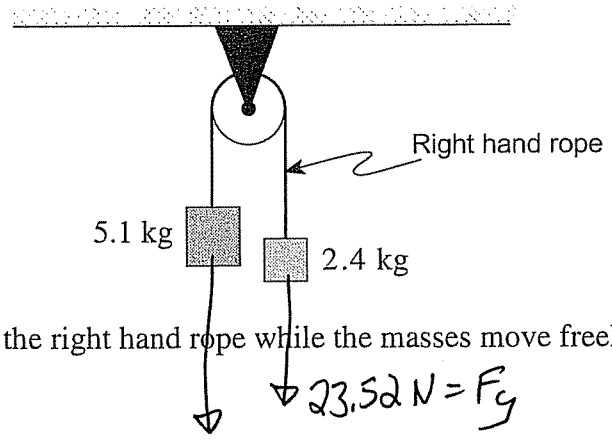
A. 2.5 m/s^2
B. 4.9 m/s^2
C. 7.4 m/s^2
D. 9.8 m/s^2

$F_{NET} = 19.6\ N$

$a = F/m = \frac{19.6\ N}{4} = 4.9\ m/s^2$

12. Medium. 2 Mass Problem. Hint, find acceleration of system first then solve for Tension.

A frictionless pulley is set up with two hanging masses as shown below.



What is the tension in the right hand rope while the masses move freely?

A. 8.5 N
B. 24 N
C. 26 N
D. 32 N

$F_g = 49.98\,N$

$23.52\,N = F_g$

$F_{NET} = 26.46\,N$

$a = \frac{F}{m} = \frac{26.46\,N}{7.5} = 3.528\,m/s^2$

Right Hand Mass

$= F_{NET} = ma = (2.4)(3.528) = 8.4672\,N$

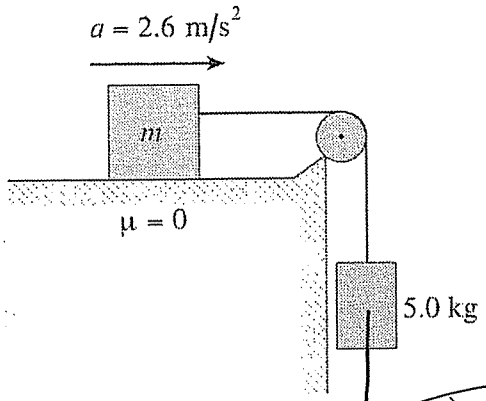
$F_{NET} = T - F_g$

$8.4672\,N = T - 23.52\,N$

$T = 31.987\,N$

13. Medium. 2 Mass problem. This is similar to 11 but your unknown is different. Hint, find Fnet on system and then find, then use that and the acceleration of system to find mass of system.

A block of mass m on a frictionless surface is attached to a hanging 5.0 kg mass as shown below. The system accelerates at 2.6 m/s^2.



What is the mass of the block?

A. 1.3 kg
B. 14 kg
C. 19 kg
D. 24 kg

$F_g = 49\,N$

↳ This is also F_{NET} on system as $F_f = 0$.

For system.

$F = ma \rightarrow \quad m = \frac{F}{a} = \frac{49}{2.6} = 18.846\,kg.$

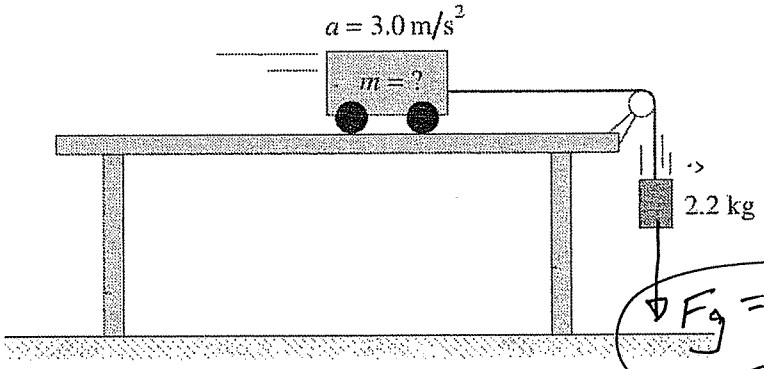
mass of system

$m + 5\,kg = 18.846$

$m = 13.8$

14. Medium. 2 Mass problem. This is the same problem as #13. Hint, find Fnet on system and then find, then use that and the acceleration of system to find mass of system.

A cart of unknown mass is attached to a 2.2 kg mass hanging over the edge of a table as shown. The cart accelerates at 3.0 m/s^2. (Ignore friction.)



$F_g = 21.56N$
$= F_{NET}$ of system

What is the mass of the cart?

A. 1.2 kg
B. 5.0 kg
C. 6.6 kg
D. 7.2 kg

For system $F = ma$.

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

$m = \frac{21.56}{3} = 7.186\ kg$

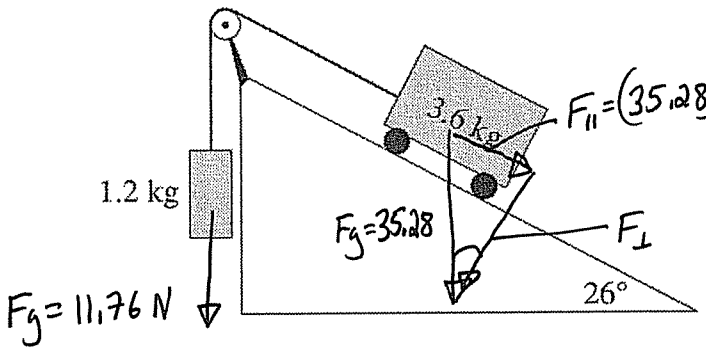
/ mass of system

$m + 2.2 = 7.186$

$m = 4.98 \approx 5\ kg$

15. Medium to Hard. 2 Mass problem. Hint, for 3.6 km mass, find component of Fg that acts parallel to slope.

A 1.2 kg mass is connected via a pulley to a 3.6 kg cart sitting on a frictionless incline as shown.



Which of the following is correct, if the 3.6 kg cart is allowed to move freely?

	MAGNITUDE OF ACCELERATION	DIRECTION OF ACCELERATION
A.	0.77 m/s^2	up the incline
B.	0.77 m/s^2	down the incline
C.	1.0 m/s^2	up the incline
D.	1.0 m/s^2	down the incline

$F_{NET} = 11.76 - 15.466$

$F_{NET} = 3.706\ N$ (− sign only indicates direction)

$a = \frac{F_{NET}}{m} = \frac{3.706}{4.8} = 0.77\ m/s^2$.

~~to the~~ down the slope