ABRHS PHYSICS (CP) NAME: KEY

Force Problems III

Numbers 1 to 7 refer to the diagram below, which shows a hand holding up a 4 kg mass by a string.

1. Imagine you pull up on the mass with a force of 40 N. (We would call this force the tension in the string).
   a. What is the weight of the mass?

   $F_g = mg$ $F_g = (4)(10) = 40\ N$

   b. So what is the net force on the mass?

   0 N → 40 N (you), 40 N (weight)

   c. So what is the acceleration of the mass?

   0 m/s^2

2. If you pull up on the mass with a force of 60 N, what is the acceleration of the mass? (Find the net force first.)

   60 ↑ 40 ↓

   $F_{net} = 60 - 40 = 20N$ up

   So $F_{net} = ma$

   $20 = (4)a$

   $a = 5\ m/s^2$

   It's up b/c 60 > 40

3. If you pull up on the mass with a force of 30 N, what is the acceleration of the mass? (Find the net force first.)

   30 ↑ 40 ↓

   So $F_{net} = 40 - 30 = 10N$ down

   So $F_{net} = ma$ $10 = (4)a$

   $a = 2.5\ m/s^2$ down

4. If the mass is accelerating <u>up</u>, what has to be true about the tension in the string?

   The net force has to be in the direction of the acceleration, so the tension would have to be bigger than the weight.

5. If the mass is accelerating <u>down</u>, what has to be true about the tension in the string?

   tension < weight

6. If the mass has a constant speed, what has to be true about the tension in the string?

   Constant speed means acceleration = 0, so $F_{net} = 0$, so tension = weight.

7. If the mass is accelerating up at 1.5 m/s^2, what is the tension in the string?

   F ↑ 40 ↓

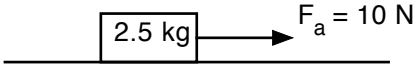
   $\Sigma F = ma$

   $\Sigma F = (4)(1.5) = 6N$

   $F - 40 = 6$

   $F = 46\ N$

Numbers 8 to 11 refer to the following diagram:



8. What is the force of friction if the acceleration of the block is 4 m/s^2?

   ? ← 0 → 10N

   $\Sigma F = ma$

   $\Sigma F = (2.5)(4)$

   $\Sigma F = 10N$

   Hey! That means NO friction! side 1

   * $10 - F_f = 10$

   $F_f = 0$

   $F_f = 0\ N$

Force Problems III

9. What is the force of friction if the acceleration of the block is 0 m/s²?

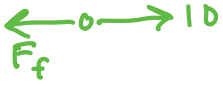
Since $a=0$, $\Sigma F=0$, which means friction has to cancel out all of the 10N → ∴ $F_f = 10\ N$

10. What is the force of friction if the acceleration of the block is 3 m/s²?

$\Sigma F = ma$

$\Sigma F = (2.5)(3)$

$\Sigma F = 7.5\ N$



So $10 - F_f = 7.5$

$F_f = 2.5\ N$

11. A 125 kg astronaut is at rest in outerspace. She then turns on the booster jets in her space suit and speeds up to 0.8 m/s in 2.5 seconds.

a. What was her acceleration?

$m = 125\ kg$

$v_i = 0\ m/s$

$v_f = 0.8\ m/s$

$t = 2.5\ s$

$a = \frac{v_f - v_i}{t}$ $a = \frac{0.8 - 0}{2.5}$ $a = \frac{0.8}{2.5}$ $a = 0.32\ m/s^2$

b. What was the net force on her?

$\Sigma F = ma$ $\Sigma F = (125)(0.32)$ $\Sigma F = 40\ N$

c. What was the force of the booster jets on her?

There are NO other forces in outerspace, 40 N

12. A 25 kg box initially at rest is pulled to the right with a constant force of 50 N. After 3 seconds, the box has traveled 7 meters.

a. What was the acceleration of the box?

$m = 25\ kg$

$v_i = 0\ m/s$

$t = 3\ s$

$d = 7\ m$

$F_a = 50N$

$d = \frac{1}{2}at^2 + v_i t$ $7 = \frac{1}{2}a(3)^2 + (0)(3)$ $a = 1.56\ m/s^2$

b. What was the net force on the box?

$\Sigma F = ma$ $\Sigma F = (25)(1.56)$ $\Sigma F = 38.9\ N$

c. Why is the net force less than the applied force of 50 N?

There must be some friction trying to stop the box.

d. What is the force of friction on the box?

Since $\Sigma F = 38.9\ N$ & $\Sigma F = 50 - F_f$

$50 - F_f = 38.9$

$F_f = 11.1\ N$

Force Problems III

13. Starting from rest, a 35 kg child is pulled with a constant force of 55 N for 5 seconds. There is also a constant frictional force of 40 N.

a. What was the net force on the child?

40N ⟵ 0 ⟶ 55 N

So $\Sigma F = 55 - 40 = 15\ N$

$m = 35\ kg$

$v_i = 0\ m/s$

$F_a = 55N$

$t = 5\ s$

$F_f = 40\ N$

b. What was the acceleration of the child?

$\Sigma F = ma \quad 15 = (35)a \quad a = 0.43\ m/s^2$

c. What was the final speed of the child?

$v_f = at + v_i \quad v_f = (0.43)(5) + 0$

$v_f = 2.14\ m/s$

Answers:

1.a) 40 N b) 0 N c) 0 m/s² 2) 5 m/s² up 3) 2.5 m/s² down 4) Tension > weight
5) Tension < weight 6) Tension = weight 7) 46 N 8) 0 N
9) 10 N 10) 2.5 N 11. a) 0.32 m/s² b) 40 N c) 40 N
12. a) 1.56 m/s² b) 38.9 N c) there must be friction d) 11.1 N
13. a) 15 N b) 0.43 m/s² c) 2.14 m/s

$1\ N = 1\ kg \cdot 1\ m/s^2$