ABRHS PHYSICS (CP) NAME: KEY

Newton's 2nd Law Review

Concepts:

1. Identify the following using the following terms: *weight, friction force, system, net force, normal force, applied force, mass, Newton's Second Law, Newton's First Law.*

   a. Net Force (ΣF) The "leftover" or "unbalanced" force that is acting on an object.

   b. system Two objects that are connected and have the same acceleration.

   c. N. 2nd Law $F_{net} = ma$

   d. normal Force For example, the force from the floor or a table that holds up objects.

   e. weight The force of gravity acting on an object.

   f. N. 1st Law Objects will maintain a constant velocity if and ony if all the forces on the object are balanced and therefore cancel out.

   g. friction The force that prevents objects from slipping.

   h. applied Force Some random force that is trying to move an object.

   i. mass This is always measured in kg.

2. What units are used to measure:

   a. inertia? kg b. force? N c. acceleration due to gravity? m/s^2

   d. mass? kg e. weight? N f. velocity? m/s

   g. tension? N h. normal force? N i. distance? m

3. Acceleration is always in the direction of the

   a. friction force. b. net force. c. weight. d. normal force. e. applied force.

4. If you are traveling to the right, and speeding up, what is the direction of your acceleration? → net force? →

5. If you are moving the right and slowing down, what is the direction of your acceleration? ← net force? ←

6. If you are moving to the right with a constant speed, what is the direction of your acceleration? 0 net force? 0

7. How can you tell the direction of the force of friction if something is moving?

   Friction always opposes motion. So opposite to velocity.

8. How can you tell the direction of the force of friction if something is at rest?

   Friction will try to keep things @ rest – so it will be opposite any forces trying to push or pull on something.

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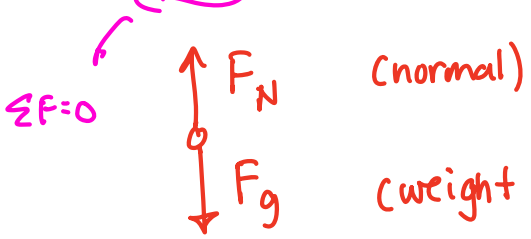
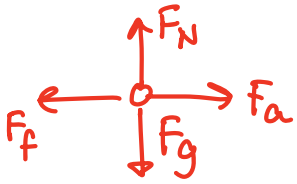
9. Draw and label a force diagram that would show all the forces acting on an object for the following:

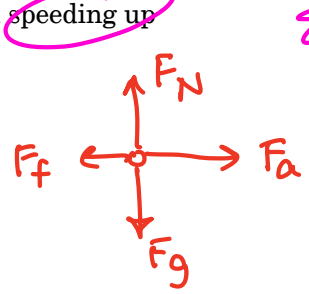
a. A block at rest on a lab table



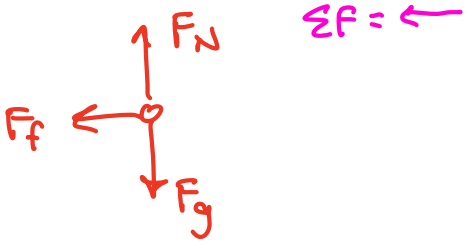
b. A block being pushed at constant speed on a rough, level surface



c. A block being pushed across a rough table and speeding up



d. A box sliding to a stop along the floor



10. If an object has zero acceleration, can you conclude that no forces are acting on the object? Explain.

No!! Just that the NET force is zero. There are probably multiple forces acting on the object – but they all cancel out if there is no acceleration.

11. A backpack with a mass of 12 kg is just sitting on the floor. What is the:

a. weight of the backpack?

$F_g = mg$ $F_g = (12)(10) =$ **120 N**

b. normal force on the backpack?

120 N it will cancel out gravity

c. net force on the backpack?

0 N it's @ rest

d. applied force on the backpack?

0 N there isn't one if backpack just sitting there

e. force of friction on the backpack?

0 N There doesn't need to be any, because nothing pulling it sideways.

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12. A car is driving down the road at a constant speed. The car weighs 25,000 N and there is an applied force of 1200 N pushing the car forward. What are
    a. normal force acting on the car?

25,000 N

    b. the mass of the car?

$F_g = mg$ $25{,}000 = m(10)$ $m = 2500$ kg

    c. the net force on the car?

0 N (constant speed so a=0)

    d. the force of friction on the car?

1200 N (to cancel out applied force)

13. What net force is needed to accelerate a 1500 kg car at 3 m/s²?

$m = 1500$ kg, $a = 3$ m/s² $\Sigma F = ma$ $\Sigma F = (1500)(3)$ $\Sigma F =$ 4500 N

14. What net force is needed to accelerate a 12,000 N car at 2 m/s²? Careful!

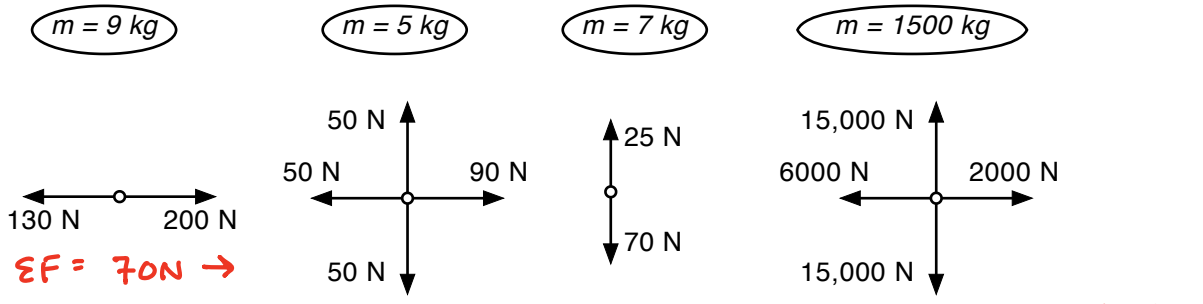
$F_g = 12{,}000$ N, $a = 2$ m/s² $F_g = mg$ $12{,}000 = m(10)$ $m = 1200$ kg $\Sigma F = ma = (1200)(2)$

$\Sigma F =$ 2400 N

15. What is the mass of an object if a net force of 100 N causes it to accelerate at 4 m/s²?

$\Sigma F = 100$ N, $a = 4$ m/s² $\Sigma F = ma$ $100 = m(4)$ $m = 25$ kg

16. For each of the following free-body diagrams, what is the acceleration of the mass? Give both the magnitude and the direction.



$\Sigma F = 70$ N → $\Sigma F = 40$ N → $\Sigma F = 45$ N ↓ $\Sigma F = 4000$ N ←

$\Sigma F = ma$: $70 = 9a$ $40 = 5a$ $45 = 7a$ $4000 = 1500a$

$a = 7.8$ m/s² → $a = 8$ m/s² → $a = 6.4$ m/s² ↓ $a = 2.7$ m/s² ←

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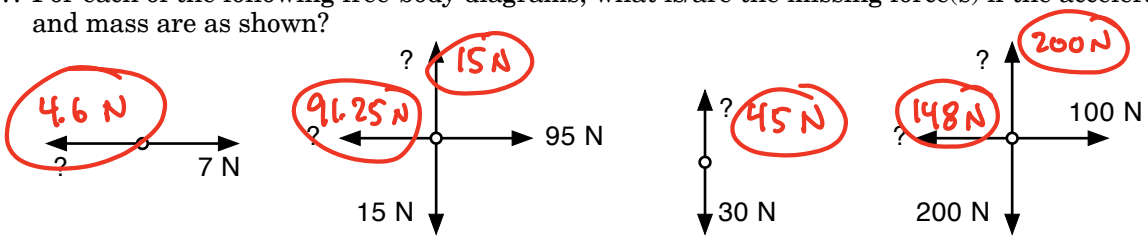
17. For each of the following free-body diagrams, what is/are the missing force(s) if the acceleration and mass are as shown?



m = 3 kg, *a* = 0.8 m/s²

$\Sigma F = (3)(.8)$

$\Sigma F = 2.4$ N

$7 - x = 2.4$

$x = 4.6$

m = 2.5 kg, *a* = 1.5 m/s²

$\Sigma F = (2.5)(1.5)$

$\Sigma F = 3.75$

$95 - x = 3.75$

$x = 91.25$

m = 3 kg, *a* = 5 m/s²

$\Sigma F = (3)(5)$

$\Sigma F = 15$ N

$x - 30 = 15$

$x = 45$

m = 15 kg, *a* = 3.2 m/s²

$\Sigma F = (15)(3.2)$

$\Sigma F = 48$ N

$x - 100 = 48$ N

$x = 148$ N

Problems:

18. What is the weight (on earth) of a 15 kg child?

$m = 15$ kg, $g = 10$ m/s²

$F_g = mg$ $\quad F_g = (15)(10)$ $\quad \boxed{F_g = 150 \text{ N}}$

19. What is the mass (on earth) of a 15 kg child?

$\boxed{15 \text{ kg}}$

20. What is the weight of a 30 kg object on the Moon (g = 1.6 m/s²)? What is the mass of a 30 kg object on Jupiter (g = 23 m/s²)?

on moon:

$F_g = mg$

$F_g = (30)(1.6) = \boxed{48 \text{N}}$

on Jupiter: mass is still 30 kg!

[weight would be $(30)(23) = 690$ N]

21. A small box weighs 100 N on Mars (g = 3.7 m/s²), how much would this box weigh on Earth?

$F_g = 100$ N, $g = 3.7$ m/s²

on Mars:

$F_g = mg$

$100 = m(3.7)$

$m = 27$ kg

on Earth:

$F_g = mg$

$F_g = (27)(10) = \boxed{270 \text{ N}}$

$g = 10$ m/s²

22. Imagine there is a 50 kg object with a force of 400 N trying to push it to the right and at the same time there is another force of 150 N trying to pull it to the left. What is the acceleration of the object?

150 N ← o → 400 N

$\Sigma F = 400 - 150$

$\Sigma F = 250$ N

$\Sigma F = ma$

$250 = (50)a$

$\boxed{a = 5 \text{ m/s}^2}$

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23. A 2500 kg car was traveling at 30 m/s when it skids to a stop in a distance of 120 meters.
    a. What was the net force on the car? (*Find acceleration first.*)

$m = 2500$ kg, $v_i = 30$ m/s, $v_f = 0$ m/s, $d = 120$ m

① $\bar{v} = \frac{v_i + v_f}{2} = \frac{30+0}{2} = 15$ m/s

② $\bar{v} = \frac{d}{t} \rightarrow 15 = \frac{120}{t}$ $t = 8$ s

③ $a = \frac{v_f - v_i}{t} = \frac{0-30}{8} = -3.75$ m/s²

④ $F_{net} = ma = (2500)(-3.75)$

$F_{net} = -9375$ N

    b. During this skid, there were three individual forces acting on the car. What were they?

① Friction stopping the car
② Weight (the earth pulling down on the car)
③ Normal Force (the road pushing up on the car)

these cancel!

24. Imagine you are pulling a heavy box across the floor with a force of 200 N. The box has a mass of 35 kg. The box started at rest, and sped up to 7.5 m/s in only 2.5 seconds. What was the force of friction acting on the box? (*Find acceleration first.*)

$F_a = 200$ N, $m = 35$ kg, $v_i = 0$ m/s, $v_f = 7.5$ m/s, $t = 2.5$ s

① $a = \frac{v_f - v_i}{t} = \frac{7.5-0}{2.5}$ $a = 3$ m/s²

② $F_{net} = ma = (35)(3)$

$F_{net} = 105$ N

③ $F_f \leftarrow \circ \rightarrow 200$ N

$\Sigma F = 105$ N →

$200 - F_f = 105$

$F_f = 95$ N

25. A small plane of mass 20,000 kg speeds up from 10 m/s to 50 m/s. It travels a ~~distance of 240~~ meters during this acceleration. If the force of friction on the plane during this was 50,000 N, how much force was generated by the engines? (*Find acceleration first.*)

$m = 20{,}000$ kg, $v_i = 10$ m/s, $v_f = 50$ m/s, $d = 240$ m, $F_f = 50{,}000$ N

① $\bar{v} = \frac{v_i + v_f}{2} = \frac{10+50}{2} = 30$ m/s

② $\bar{v} = \frac{d}{t} \rightarrow 30 = \frac{240}{t}$ $t = 8$ s

③ $a = \frac{v_f - v_i}{t} = \frac{50-10}{8} = 5$ m/s²

④ $F_{net} = ma = (20{,}000)(5) = 100{,}000$ N

50,000 ← ○ → F_a

$\Sigma F = 100{,}000$ →

⑤ $F_a - F_f = F_{net}$

$F_a - 50{,}000 = 100{,}000$

$F_a = 150{,}000$ N

26. Imagine you are pulling <u>up</u> on a book with a force of 20 N. The mass of the book is 1.2 kg. What is the acceleration of the book?

$m = 1.2$ kg, $F_a = 20$ N (↑)

① $F_g = mg = (1.2)(10)$

$F_g = 12$ N

② 20 N ↑, 12 N ↓ So $F_{net} = 8$ N ↑ (up)

③ $F_{net} = ma$

$8 = (1.2)a$

$a = 6.67$ m/s² up