Unit 2

Forces, Equilibrium, Springs, and Newton's Second Law

SOURCE LOCK

Built from SPH3U video-distilled notes. Teacher moves, examples, and practice prompts are pulled from the local distilled packets.

Big idea

- Force questions are system questions: choose the object, draw all forces, then write the net-force equation in the useful direction.

Lesson map

- Force basics - 12 source lessons
- Springs and Hooke's law - 7 source lessons
- Equilibrium - 7 source lessons
- Newton's second law - 23 source lessons
- Friction and conveyor-belt contexts - 7 source lessons
- Simple multi-body Newton's law contexts - 5 source lessons

Core Notes

What to know

- A free-body diagram should show only forces acting on the chosen object.
- Net force is the vector sum of all forces and determines acceleration through Fnet = ma.
- Friction direction is decided from relative motion or tendency of relative motion.
- Spring force follows the source pattern of deformation and restoring force, commonly represented by F = kx in simple Hooke-law contexts.
- Equilibrium means the net force is zero; dynamic-equilibrium problems often become triangle or component problems.

Problem-solving workflow

- Choose the system or object first.
- Draw all real forces on that object.
- Choose axes that make components simple.
- Write Fnet = ma along each useful direction.
- Use constraints, friction direction, spring stretch, or equilibrium geometry only after the force diagram is clear.

Common traps

- Do not put forces exerted by the object on its own free-body diagram.
- Do not assume friction is always opposite the object's velocity; compare relative motion at the contact.
- Do not use F = ma before deciding which direction the equation describes.
- For multi-body systems, keep internal and external forces straight.

Teacher Moves

HOW TO THINK

These notes preserve the teacher's problem-solving moves: how to decide the model before calculating.

Move 1

- Draw the free-body diagram before writing force equations. | Source: L039 00:36:33, L041 00:00:33, L042 00:27:03.

Move 2

- For equilibrium, set net force to zero and use geometry or components. | Source: L039 00:24:18, L042 00:09:55, L043 00:05:30.

Move 3

- Decide friction direction from relative motion or tendency of relative motion. | Source: L041 00:00:47, L067 00:01:41, L069 00:12:52.

Move 4

- Set directions before assigning signs or writing equations. | Source: L039 00:04:50, L040 00:10:29, L041 00:09:30.

Move 5

- Connect spring force to deformation and restoring direction. | Source: L050 00:02:48, L051 00:11:47, L052 00:04:44.

Move 6

- Read the graph feature first: slope, area, intercept, or trend. | Source: L052 00:02:58, L053 00:05:33, L054 00:02:12.

Move 7

Move 7

- Combine forces into net force before applying Fnet = ma. | Source: L047 00:14:56, L048 00:02:41, L049 00:00:36.

Move 8

- Use Newton's second law only after the force diagram and axis choice are clear. | Source: L064 00:17:48, L065 00:00:03.

Move 9

- Use series-circuit rules only for elements on the same current path. | Source: L054 00:24:26.

Move 10

- Use parallel-circuit rules only after identifying shared endpoints. | Source: L054 00:01:26.

Worked Examples

Distilled example patterns

Newton's second law with direction (Unit 2 distilled pattern: write the equation after choosing the positive direction)

Choose right as positive.

A 3.0 kg object has a 12 N net force to the right.

Use $F_{net} = ma$.

$a = F_{net}/m = 12/3.0$.

Answer pattern: $a = 4.0\ m/s^2$ to the right.

Spring force reading (Unit 2 distilled pattern: spring force depends on deformation)

Identify how far the spring is stretched or compressed.

Use the simple Hooke-law pattern $F = kx$ when the problem states a linear spring.

If $k = 200$ N/m and $x = 0.050$ m, $F = (200)(0.050)$.

Practice prompts

- Draw a free-body diagram for a block on a horizontal surface.
- Use $F_{net} = ma$ to find acceleration from net force and mass.
- Explain the friction direction in a conveyor-belt context.

Source quality note

OCR review flags in this unit: 91 / 3876.

Printed slide text is usually reliable; dense handwritten equations should be verified against source frames.

This packet is polished for student reading, but it keeps the source trace instead of inventing missing formulas.