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Chapter 1

Basic Forklift Knowledge

1 Forklift Definition (p.1)

1.1 Forklift definition

A forklift, also called a forklift truck, is a motorized loading, unloading, and transport machine with a “fork” that loads items and a “mast” mechanism that moves the fork up and down.

1.2 Using a forklift

Forklifts are widely used in industrial settings to save labor and improve the efficiency of loading, unloading, and handling work. However, the increased use of forklifts has also led to a higher number of forklift-related hazards and injuries. In order to prevent these problems, operators must have a basic understanding of forklift functions and operate forklifts properly.

The most common forklift-related hazards are:

- Tipping caused by overloading or sharp turns
- Collisions with objects or people caused by limited visibility due to the structure of the forklift
- Falling of items caused by unsafe loading methods, lack of driving experience, improper operation, etc.

Various standards and regulations, including the Industrial Safety and Health Law, related laws, forklift structural codes, and periodic self-inspection policies, have been established to help prevent these hazards from occurring.

2 Forklift Operation Qualifications (p.2)

Forklift operators/workers must have the following qualifications.

Table 1-1 Forklift Operation Qualifications

Qualifications/classification	Skill training course graduates	Special training graduates	Notes
Maximum load of 1 ton or more	○	-	Does not include driving forklifts on public roads
Maximum load of under 1 ton	○	○	

Those engaged in forklift operation work must carry the appropriate certificates and other qualifications. When driving a forklift on public roads, the forklift must be equipped with the safety parts required by the Road Transport Vehicle Act and the driver must have the appropriate driver's license.

(Note):

Maximum load refers to the maximum amount that can be placed on the rated load center based on the structure and material of the forklift.

3 Forklift Features (p.3)

A forklift can be used to load and handle items quickly and efficiently. Attachments such as rams and clamps have also been developed for different load types in order to improve the efficiency of loading and unloading work.

3.1 Basic forklift features

- A fork that can be raised and lowered from 2.5 to 6 meters off the ground (including the floor; the standard lifting height for regular forklifts is 3 meters)
- Front-wheel drive and rear-wheel drive turning type is commonly used
- A counterweight attached to the rear of the forklift frame to support the load on the front and ensure stability; thus, forklifts are relatively heavy vehicles
- Maximum velocity (speed) of approximately 10 - 20 km/h
- A head guard that helps to protect the operator from falling objects if a load collapses during lifting
- A backrest prevents the load from falling toward the operator when the load's center of gravity is high
- A compact structure that creates a small turning radius and enables the forklift to navigate narrow warehouse aisles
- The ability to stack and remove items within the fork's height range
- The ability to directly grasp and efficiently handle loads, using pallets for small items and objects with complex shapes and configurations

3.2 Battery forklift features

In addition to the basic features listed above, battery forklifts have unique advantages and disadvantages.

- As battery power does not generate any harmful exhaust gases, battery forklifts can be used relatively safely in poorly-ventilated warehouses and holds.
- Battery forklifts are quieter than engine forklifts, making them well-suited for operation in residential areas and at night. However, the electric motor, hydraulic pump, reduction gears, and other components do generate some drive noise.
- Driving forward/reverse, fast/slow can be changed easily with an electric switch.
- Battery forklifts have fewer maintenance items and require repairs less frequently than engine forklifts, keeping operation costs low.
- Due to limited battery capacity, working for extended periods of time requires battery charging equipment, backup batteries, and battery replacement equipment.

4 Forklift Types (p.4)

4.1 Power source (p.6)

Forklifts are generally categorized into an engine-powered group and a battery-powered group.

Engine forklifts (internal combustion)

Engine forklifts are categorized as follows according to fuel type.

		JIS symbol
a.	Diesel engine	(FD)
b.	Gasoline engine	(FG)
c.	LPG (liquefied petroleum gas) engine	(FL)
d.	CNG (compressed natural gas) engine	

Battery forklifts (rechargeable) (FB)

A battery forklift has an on-board battery that provides power for the electric motor that drives the vehicle.

Hybrid system

Lately, the hybrid power systems that utilizes two or more devices such as engine and electric motor or battery and capacitor are developed to improve the fuel consumption and to reduce the carbon dioxide emissions.

The capacitor is a device that stores electrical energy, and is capable to collect, charge and discharge the power efficiently due to low internal resistance.

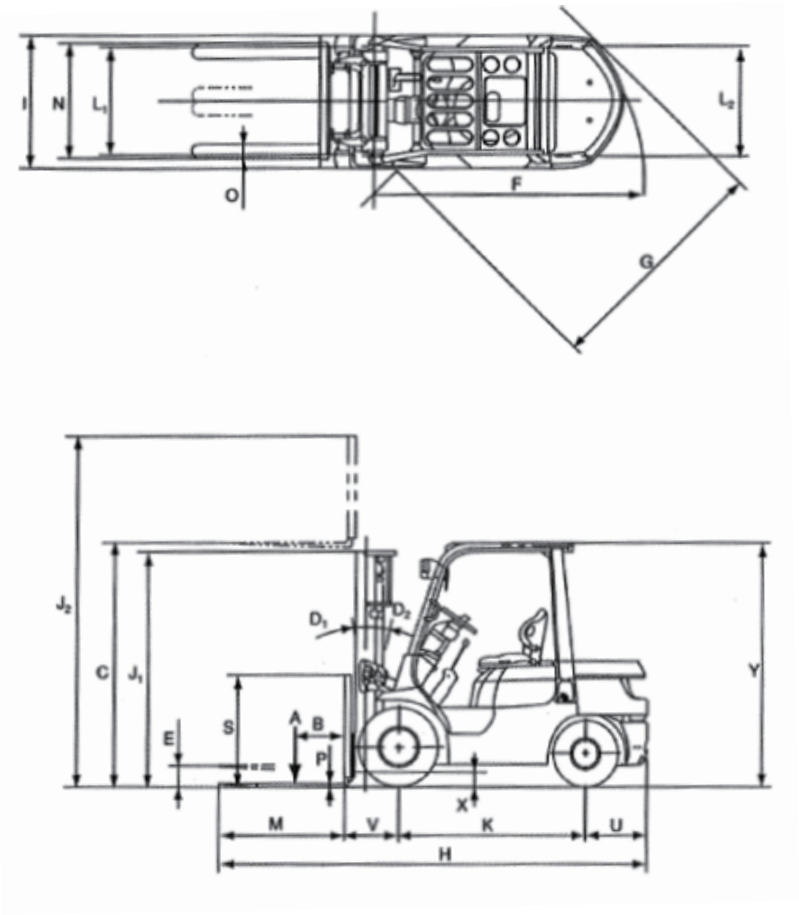
5 Terminology (p.10)

The following is a list of useful terminology often found in manufacturer catalogs, specifications, manuals, and other documentation.

5.1 Dimension terms (p.10)

Table 1-2 Dimension Terms

Term		Meaning
1	Overall length	The overall length of the forklift in standard non-loaded condition.
2	Length without fork arms	The length of the forklift excluding the fork and attachments.
3	Length to face of fork	The distance from the rear end to the vertical front face of the fork in a forklift in standard non-loaded condition.
4	Overall height	The height of the top of a forklift in a standard non-loaded condition while keeping the mast vertical and the fork at the lowest position. Based on vehicle specifications, may include mast height and/or head guard height.
5	Mast height	The height to the top of the mast in a standard non-loaded condition while keeping the mast vertical and the fork at the lowest position.
6	Head guard height	The height from the ground to the top of the head guard in a standard non-loaded condition.
7	Ground clearance	The height at the position where the distance from the ground is the minimum while traveling in the standard non-loaded condition, not including the area around the wheels.
8	Mast tilt angle	The maximum angle at which the mast can be tilted forward/backward from its vertical position.
9	Maximum lifting height	The height of the horizontal part of the fork from the ground when the fork is lifted up to the highest position in the standard loaded condition.
10	Free lift	The height of the horizontal part of the fork from the ground when the fork is lifted up to the highest position without changing the mast height from the lowest position while keeping the mast vertical in the standard non-loaded condition.
11	Fork length	The length from the vertical front face of the fork to the fork tip.
12	Fork thickness	A thickness of the fork normally defined according to the type of the maximum load.
13	Reach length	The maximum distance through which the fork or the mast moves back and forth or from side to side while the fork is kept horizontal.
14	Front overhang	The distance from the center of the front axle to the vertical front face of the fork.
15	Rear overhang	The distance from the center of the rear axle to the rear end of the forklift.
16	Load center	The distance from the center of gravity of the load that is laid on the fork to the vertical front face of the fork.
17	Standard load center	A load center that is listed in Table 1 of JIS D6001. See Fig. 1-2 and Table 1-3.
18	Wheel base	The distance between the centers of the front and rear axles.
19	Fork spread	The maximum and minimum adjustable distance between the outer edges of the left and right fork.
20	Minimum turning radius	The radius of the path that the outermost part of the body travels when traveling forward and steering to the maximum angle at the lowest speed in the standard non-loaded condition.
21	Minimum intersecting aisle	The theoretical minimum width of the right angle aisle where a vehicle that spreads the width of its fork to the maximum with/without a load on the fork can travel through in the standard non-loaded condition.
	Right angle stacking aisle	The theoretical minimum width of an aisle where a forklift with a certain load can turn 90 degrees on the straight aisle.



A: Maximum load
B: Standard load center
C: Maximum lifting height
D_1: Mast tilt angle (Forward)
D_2: Mast tilt angle (Backward)
E: Free lift
F: Minimum turning radius
G: Minimum intersecting aisle
H: Overall length
I: Overall width
J_1: Overall height (Mast is lowered)
J_2: Overall height (Mast is Lifted)
K: Wheel base
L_1: Front wheel tread
L_2: Rear wheel tread
M: Fork length
N: Fork spread (Outside)
O: Fork width
P: Fork thickness
S: Backrest height
U: Rear overhang
V: Front overhang
X: Ground clearance
Y: Head guard height

Fig. 1-1 Specifications of Forklift (Counterbalance type)

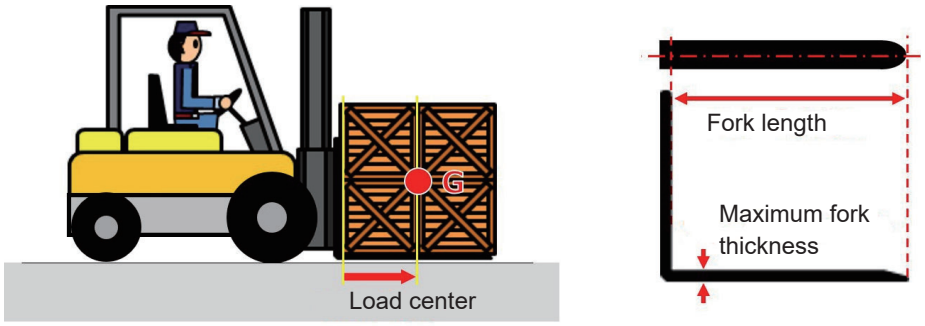


Fig. 1-2 Load Center and Fork length

Table 1-3 Standard Load Center

Rated load Q (kg)	Standard load center D (mm)				
	400	500	600	900	1200[a)]
<1000	○	○			
1000 - 4999		○	○		
5000 - 9999			○	○	
10000 - 19999			○	○	○
20000 - 24999				○	○
>25000					○

[a)]: Includes the distance of 1220 and 1250.

Table 1-4 Fork Length

Rated (maximum) load (t)		0.5	1	1.5	2	2.5	3	3.5	5	10
Standard fork thickness mm (maximum value)		30	40	40	50	55	60	65	80	90
Fork length (mm)	770	○	○							
	(850)	○	○	○						
	920	○	○	○	○	○				
	1,070	○	○	○	○	○	○	○		
	1,220		○	○	○	○	○	○	○	○
	1,370		○	○	○	○	○	○	○	○
	1,520			○	○	○	○	○	○	○
	1,670				○	○	○	○	○	○
	1,820						○	○	○	○
	1,970							○	○	○
	2,120							○	○	○
	2,270								○	○
	2,420								○	○

Fork length: The length from the vertical front face of the fork to the fork tip

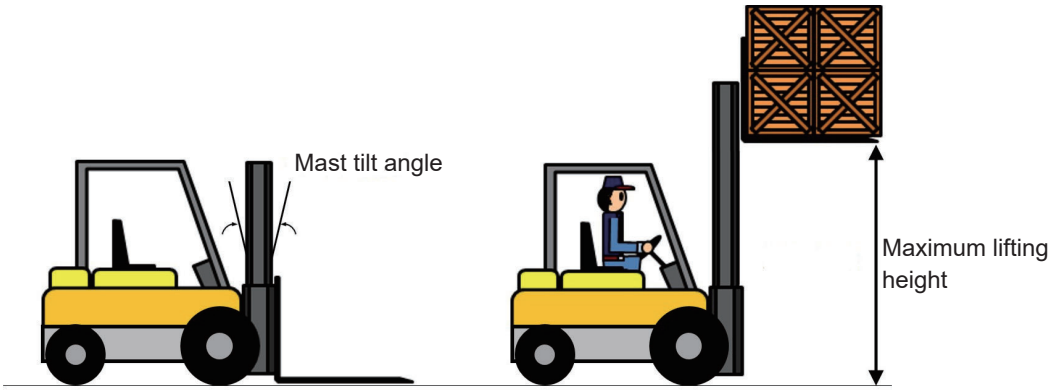


Fig. 1-3 Mast tilt angle and maximum lifting height

5.2 Terms related to load, performance, and status (p.14)

Table 1-5 Terminology Related to Load, Performance, and Status

Term	Meaning
Standard loaded condition	A condition where the maximum load is laid on the standard load center*1 of the forklift in standard non-loaded condition *2. *1: For sideloaders, a condition where the load is placed on the load platform and the top of the fork is aligned with the height of the platform (and any outriggers out) *2: For reach forklifts whose forks cannot be lowered to 300 mm off the ground, a condition where the fork is 150 mm above the top of the reach leg.
Allowable load	The specified load that can be laid on a load center. See Fig. 1-4.
Allowable load diagram	A diagram representing the relation between the load center and the allowable load (structural codes stipulate that the diagram must be placed in a location that is easily visible to the operator). See Fig. 1-5.
Maximum load	An allowable load that can be laid on the standard load* center. * According to Article 20, No. 11 of the Enforcement Order of Industrial Safety and Health Law, this term is defined as the maximum load that can be placed on the forklift, taking into account the structure and materials of the vehicle; equivalent to rated load."

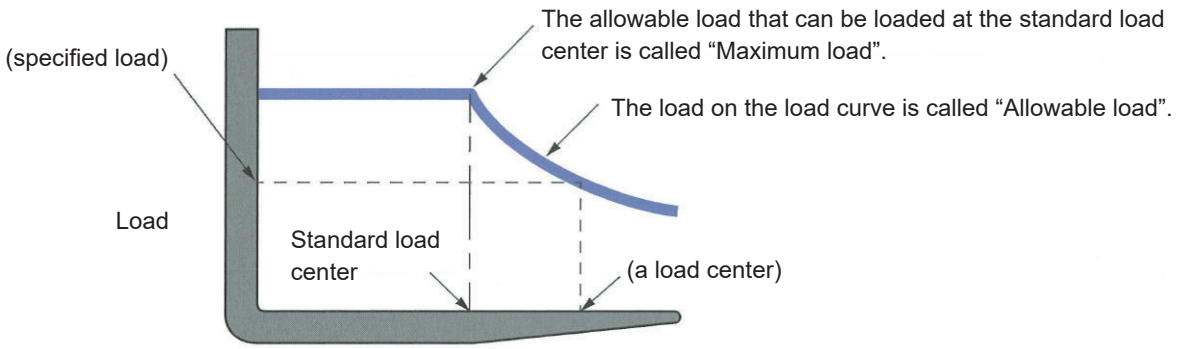


Fig. 1-4 Maximum Load and Allowable Load

The figure shows that if a load moves forward exceeding the standard load center, the allowable load decreases.

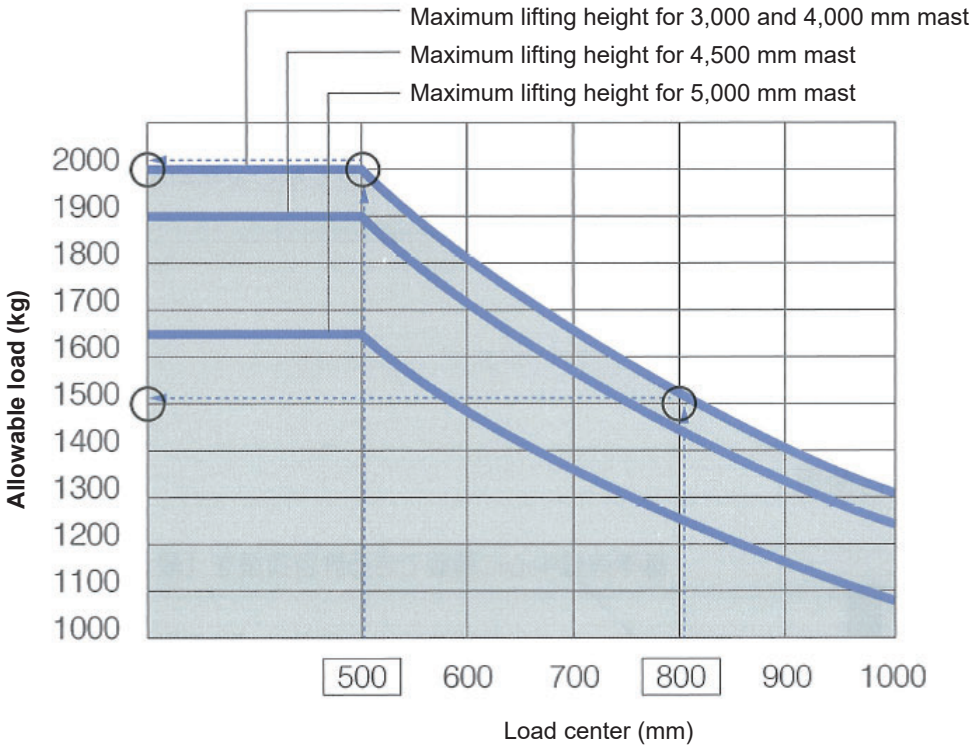


Fig. 1-5 Example of Allowable Load Diagram (Load Curve)

This figure above shows the example of allowable load diagram of the forklift with the rated load of 2 tons.

The load curve differs depending on the maximum lifting height. The higher the maximum lifting height is, the lower the allowable load becomes. (The allowable load is the same for the masts with the maximum lifting height up to 4,000 mm, however, the allowable load lowers if it exceeds 4,000 mm.)

Chapter 2

Motors

Forklifts are generally categorized into an engine-powered (internal combustion) group and a battery-powered (electric motor) group.

1 Internal Combustion Engine (p.17)

1.1 Overview of internal combustion engine (p.17)

Internal combustion engines are categorized by fuel type into the diesel engine, gasoline engine, and LPG (liquefied petroleum gas) engine groups, each of which have different advantages, disadvantages, and areas of application. Medium- and large-sized forklifts normally use diesel engines, while smaller forklifts generally use gasoline engines.

Diesel engine

In a diesel engine, air is compressed in the cylinder and heated to around 600 °C. Fuel (either diesel fuel or fuel oil) is then sprayed into the compressed air in the cylinder and ignited by the heat. Power is generated via combustion.

Gasoline engine

In a gasoline engine, a mixture of gasoline and air is compressed and lit. The resulting explosive power is converted into rotational energy.

LPG engine

An LPG engine is a modified gasoline engine that uses LPG for fuel.

CNG engine

CNG (compressed natural gas) engine uses the compressed natural gas as fuel to exchange the heat obtained by the combustion of gas to the rotational energy. No much black exhaust smoke is emitted in this system.

Difference between Diesel Engine and Gasoline Engine

Diesel engines differ from gasoline engines in that they have:

- Cheaper operation costs
- Fewer breakdowns
- Greater force (turning force/torque)

Table 2-1 provides a comparison of the various features of diesel engines and gasoline engines.

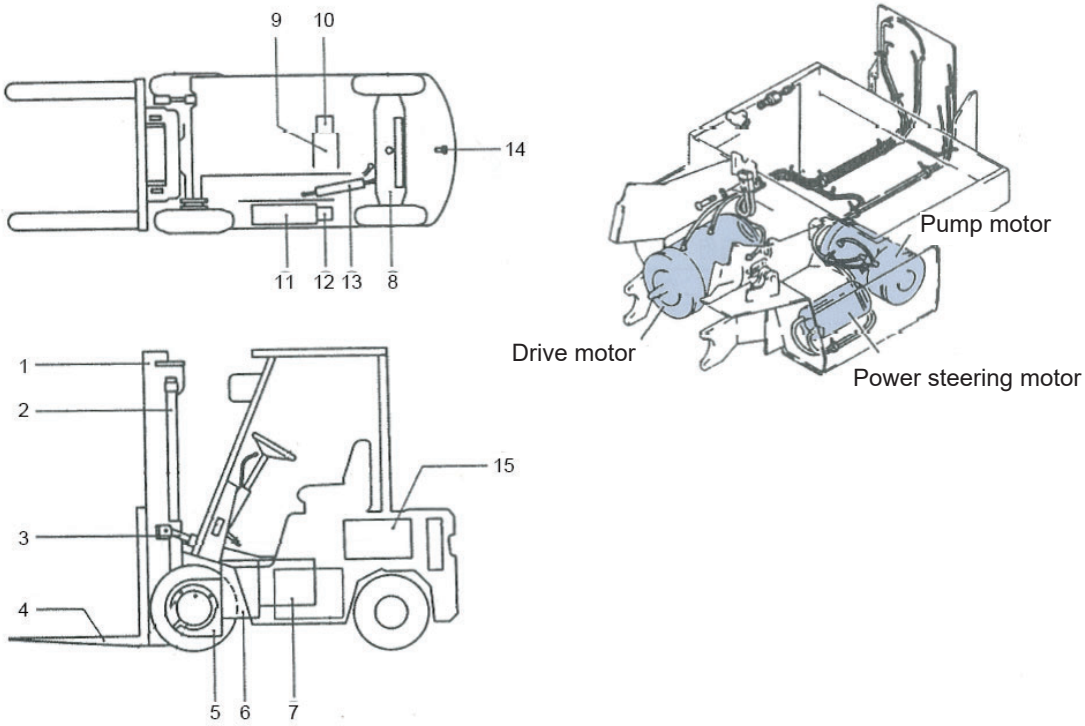
Table 2-1 A Comparison of Diesel Engines and Gasoline Engines

	Diesel engine	Gasoline engine
Fuel types	Diesel fuel (fuel oil)	Gasoline
Ignition or lighting	Ignited by the heat of compressed air	Lit by an electric spark
Mass per output	Heavy	Light
Cost per output	High	Low
Thermal efficiency	Good (30 - 40%)	Bad (20 - 26%)
Operating costs	Low	High
Fire safety	High	Low
Noise/vibration	High	Low
Startup during winter	Slightly bad	Good

2 Electric Motors (p.30)

2.1 The roles of electric motors (p.30)

Battery forklifts are powered by electric motors that use DC electricity from the battery. Engine forklifts use a single engine to power the hydraulic pumps for the wheel/operation system and the steering system, but battery forklifts rely on the following 3 types of electric motors.



1. Mast
2. Lift cylinder
3. Tilt cylinder
4. Fork
5. Differential
6. Reduction gear
7. Electric motor for traveling
8. Rear axle
9. Electric motor for loading/unloading
10. Hydraulic pump for loading/unloading
11. Electric motor for steering
12. Hydraulic pump for steering
13. Hydraulic cylinder for steering
14. Counter weight
15. Battery

Fig. 2-1 Components of a Battery-Powered Counterbalance Forklift

Important points to remember when using batteries

- Battery electrolyte consists of sulfuric acid diluted in water. Be careful not to get electrolyte on your hands or clothes. If electrolyte does get on your hands or clothes, wash it off immediately with water.
- Charge the battery when the specific gravity of the electrolyte falls to 1.20.
- Do not short-circuit the battery with a spanner or other metal object.
- Prevent loose connections by making sure that the battery terminals are firmly in place and free of corrosion.
- When removing battery terminals, remove earth (-) terminal first; when placing terminals on the battery, put the earth terminal on last.
- Do not over-discharge the battery.
- As the amount of electrolyte decreases over time, add distilled water up to the specified level.
- Keep the top of the battery clean (dust can lead to self-discharge).
- Keep the battery away from fire.

2.2 Battery chargers (p.33)

As a lead battery continues to discharge energy, the concentration of lead sulfate in the dilute sulfuric acid rises, interfering with chemical reactions and eventually preventing discharge. After a certain amount of discharge, the battery needs to be charged with a battery charger. There are two basic battery charger types: the on-board type and the stationary (installed separate from the vehicle) type.

To charge a forklift with an on-board battery charger, move the forklift to an appropriate location and connect the battery charger directly to an AC power source.

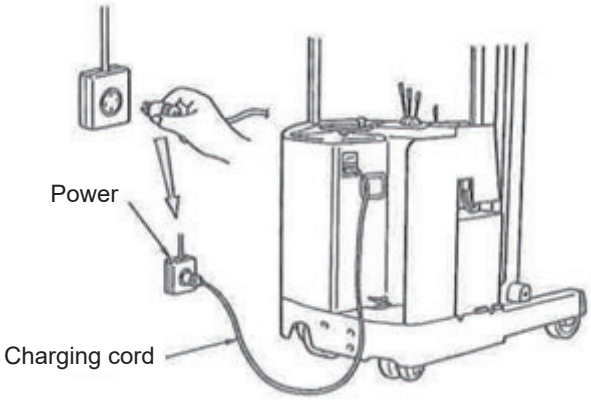


Fig. 2-2 Charging with an On-Board Battery Charger

To charge a forklift with a stationary battery charger, move the forklift to the battery charger and use the battery charger to connect the forklift to a DC power source.

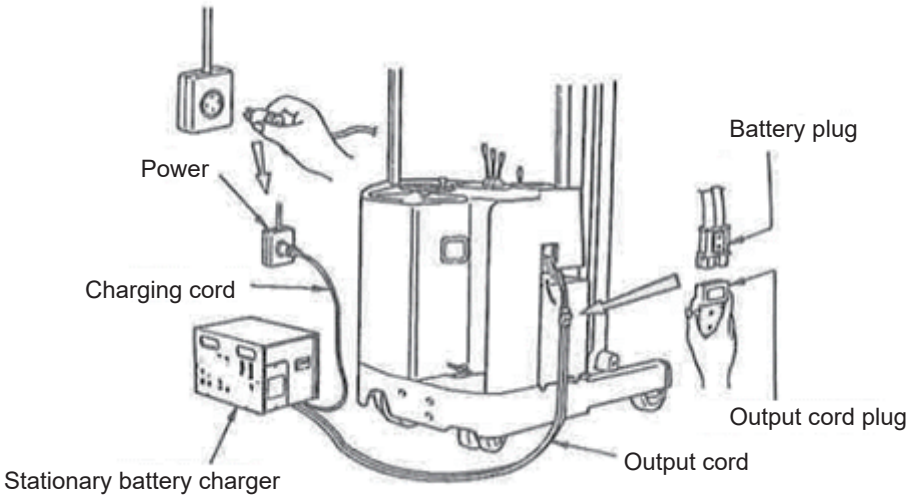


Fig. 2-3 Charging with a Stationary Battery Charger

2.3 Charging types (p.34)

There are 3 basic types of charging.

Normal charge

Normal charge refers to charging performed at the end of the work day. Charge time varies depending on the battery's discharge status and capacity.

Equalizing charge

Repeated normal charges can affect the specific gravities of the electrolyte solutions in the battery cells. "Equalizing charge" equalizes these specific gravities and needs to be performed once every two weeks.

Auxiliary charge

Auxiliary charge refers to charging during idle periods when a single charging prior to work is not enough to cover an entire day.

2.4 Important points to remember when charging battery (p.34)

A charging battery generates hydrogen gas and oxygen gas, and there is a risk of explosion. Accordingly, be sure to keep away from fire, and always perform ventilation while working indoors.

Chapter 3

Drive System Operations

To facilitate driving in warehouse aisles and other narrow spaces, forklifts have rear-wheel steering, unlike regular automobiles.

This section discusses standard forklift operations, but some operations may vary according to forklift manufacturer and model. Be sure to read the operation manual carefully before actually operating the forklift.

1 Engine Forklifts (p.57)

The following characteristics apply to engine forklift operations.

- Diesel vehicles and gasoline vehicles have different startup methods.
- Torque converter forklifts (hereinafter called “torque converter vehicles”) and clutch forklifts (hereinafter called “clutch vehicles”) have different pedal operations.
- Operations are basically the same as automobile operations, but there are some differences.

1.1 Engine startup procedure (See fig. 4-3, 4-4) (p.57)

(1) Make sure that the forward/reverse lever, high speed/low speed lever (for clutch vehicles only), and the fork operation lever are all in a neutral position.

(2) If the parking brake has a button, make sure that the button is in the on position. If the parking brake uses a lever, pull the lever all the way to ensure that the parking brake is on.

(3) Step on the inching pedal (for torque converter vehicles only) or the clutch pedal (for clutch vehicles only) with your left foot.

(4) Insert the key into the starting switch and turn the key.

- Diesel engines with no “preheat” position on the starting switch

  (a) Turn the key to the “on” position to turn on the preheat monitor light. Keep the key in the “on” position until the light goes off.

  (b) After the preheat monitor lamp goes off, step lightly on the accelerator with your right foot and turn the starting switch to the “start” position to rotate the starter and start the engine.

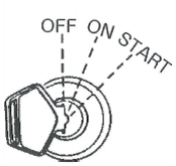


Fig. 3-1 No Preheat Position

- Diesel engines with a “preheat” position on the starting switch

  (a) Turn the key to the left to the “preheat” position and keep it there until the preheat monitor light turns red.

  (b) After the preheat monitor light turns red, step lightly on the accelerator with your right foot and turn the key to the “start” position to rotate the starter and start the engine.

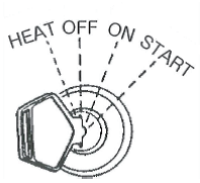


Fig. 3-2 With a Preheat Position

- Gasoline engines

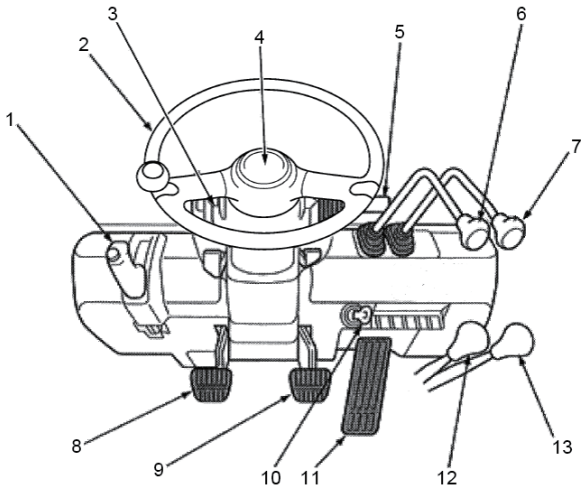
  (a) Step lightly on the accelerator with your right foot and turn the starting switch to the “start” position to rotate the starter and start the engine.

(5) Take your hand off the key as soon as the engine starts. A spring will automatically return the key to the “on” position. Turning the key to the “start” position while the engine is running causes the engine ring gear and the start pinion to hit each other, which may damage the gear teeth. Do not turn the key to the “start” position while the engine is running.

(6) Perform warm-up operations until the engine begins running smoothly.
Do not force the engine to rotate at a high speed immediately after startup.

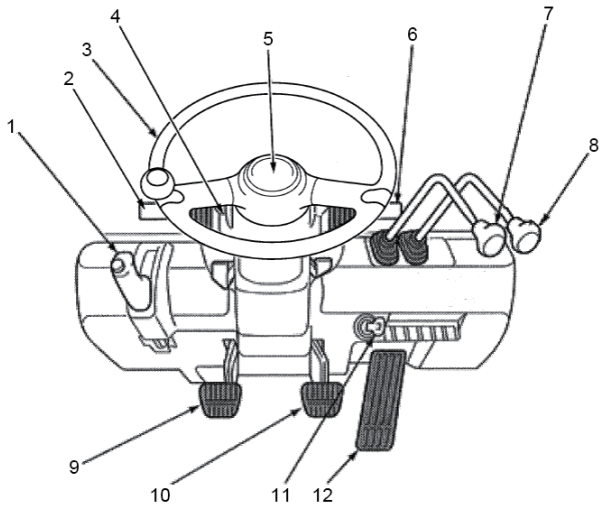
(Notes):

- Do not preheat for extended periods of time (preheat for less than 30 seconds).
- Do not use the starter for extended periods of time (keep starter use to 5 seconds, 10 seconds, or 20 seconds at a time).
- Wait (for 20 seconds, 2 minutes, etc.) before restarting the engine.



1. Parking brake lever
2. Steering wheel
3. Combination meter
4. Horn switch
5. Direction indicator/light switch
6. Lift lever
7. Tilt lever
8. Clutch pedal
9. Brake pedal
10. Starting switch
11. Accelerator pedal
12. High speed/low speed lever
13. Forward/reverse lever

Fig. 3-3 Clutch vehicle



1. Parking brake lever
2. Forward/reverse lever
3. Steering wheel
4. Combination meter
5. Horn switch
6. Direction indicator/light switch
7. Lift lever
8. Tilt lever
9. Inching pedal
10. Brake pedal
11. Starting switch
12. Accelerator pedal

Fig. 3-4 Torque converter vehicle

1.2 Initial driving procedure (p.60)

(1) The basic driving posture is to operate the steering wheel knob with your left hand and rest your right hand on your right thigh.

Fig. 3-5 Steering Wheel Operations with the Left Hand

(2) Pull the lift lever with your right hand to raise the fork 5 - 10 cm off the ground.

(3) Pull the tilt lever with your right hand to tilt the mast all the way back. (This will bring the bottom of the fork base 15 - 20 cm off the ground.)

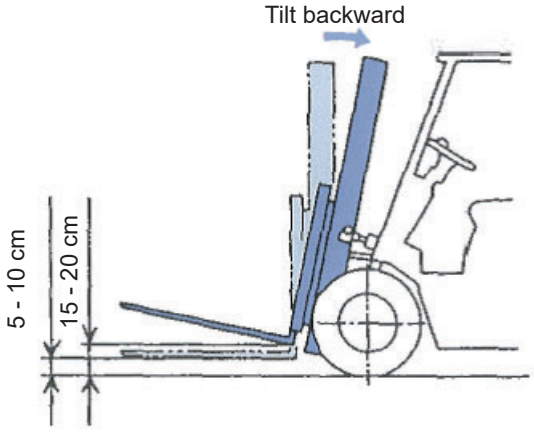


Fig. 3-6 Tilting the Mast Back

(4) Step on the inching pedal (or the clutch pedal) with pedal.

(5) Put the forward/reverse lever in the forward position right hand. When operating a clutch vehicle, also put the gear stick to the 1st speed position.

(6) After checking that you are traveling in the right direction and that the area is safe, push the parking brake lever down (or push in the parking brake lever button) to release the parking brake (OFF). Take your foot off the brake pedal.

(7) As you take your left foot slowly off the clutch pedal, step lightly on the accelerator with your right foot to move the forklift.

(a) Putting the inching pedal (or clutch pedal) in the half clutch position lets you move the vehicle at very low speed.

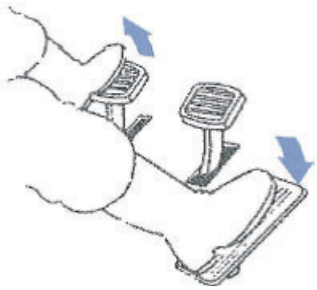
(b) Do not leave your foot on the inching pedal (or clutch pedal) or the brake pedal when it does not need to be there. Doing so can wear on the clutch friction plate and reduce the overall lifespan of the clutch.

(c) An empty forklift and a forklift carrying a load require different amounts of force on the accelerator to move. In a clutch vehicle, failing to apply enough force on the accelerator when the forklift is carrying a load can cause the engine to stall.

(d) When starting at an uphill, apply the accelerator pedal and remove your foot from the clutch pedal to move the forklift.

[Clutch vehicles]

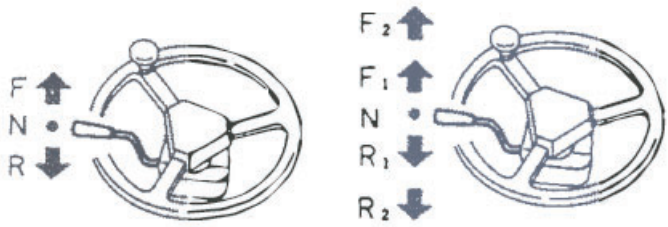
[Torque converter vehicles]



1.3 Acceleration/deceleration procedures (p.61)

Torque converter vehicles

In torque converter vehicles, you can change speeds with your foot on the accelerator by moving the gear stick to the desired position.



[1-speed torque converter vehicle] **[2-speed torque converter vehicle]**

Fig. 3-7 Torque Converter Vehicle Acceleration/Deceleration Operations

Clutch vehicles

(1) As you remove your foot from the accelerator, step on the clutch pedal.

(2) Move the gear stick to shift gears. After the stick is in position, slowly take your foot off the clutch pedal and step on the accelerator.

1.4 Forward/reverse switching operations (p.61)

To switch between forward and reverse, make sure that the vehicle is safely stopped and use the forward/reverse lever to select forward (F) or reverse (R). The vehicle must be stopped before switching between forward and reverse.

1.5 Steering operations (p.61)

(1) When changing directions in an aisle or on a road, turn on the appropriate (L/R) turn signal before (about 3 seconds before) making the turn, check that your path is safe, and turn the steering wheel.

(2) Hold the steering wheel knob with your left hand and turn the vehicle in the intended direction.
Forklifts are steered by the rear wheels. Table 3-1 shows how steering a forklift is different than steering a regular automobile.

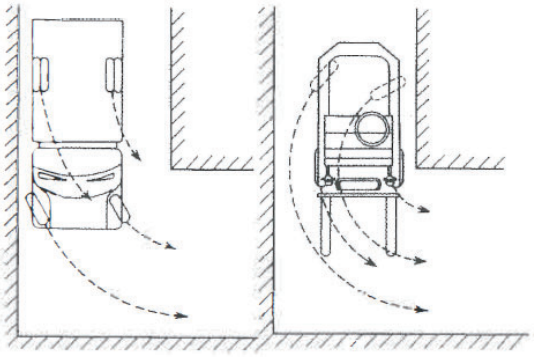
Table 3-1 Turning Differences

	Forward turns	Reverse turns
Forklift	Bring the vehicle to the inside of the corner. (This reduces the turning radius of the front wheels and makes the rear wheels swing outward).	Bring the vehicle to the outside of the corner. (The front wheels thus pass through the corner closer to the inside than the rear wheel trajectory).
Automobile	Bring the vehicle to the outside of the corner.	Bring the vehicle to the inside of the corner.

(3) After completing the turn, make sure that the turn signal has gone off.

[Points to note]

- Stop and wait for pedestrians or other vehicles attempting to turn.
- When turning, make sure that the outer edge of the counterweight and the rear tires do not hit other people or objects.
- Do not make sharp turns at high speeds or attempt turns on steep slopes.
- A power steering vehicle cannot be steered when the engine is stopped.
Never stop the engine on hills or slopes.



[Regular automobile] [Forklift]

Fig. 3-8 Cornering Differences

1.6 Braking/stopping/parking operating procedures (p.62)

Torque converter vehicles

(1) Take your right foot off the accelerator and step on the brake pedal.

(2) With your foot still on the brake pedal, pull the parking brake lever (or pull out the parking brake button) to apply the parking brake.

(3) Put the gear stick in neutral.

Clutch vehicles

(1) Take your foot off the accelerator and step on the brake pedal. Just before the vehicle stops, step on the clutch pedal.

(2) With your feet on the brake and clutch pedals, pull the parking brake lever (or pull out the parking brake button) to apply the parking brake.

(3) Put the forward/reverse lever in neutral.

[Points to note]

- When pulling over or parking, do so on a flat surface off the driving path.
- Do the following before leaving the vehicle.
  - Tilt the mast forward.

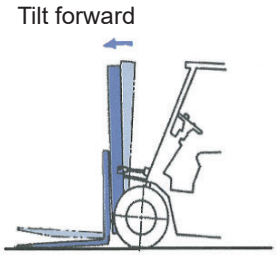


Fig. 3-9 Tilting the Mast Forward

  - Lower the fork so that the end touches the ground.
  - Stop the engine, turn the starting switch to “off,” and remove the key.
    (Note):
    When the engine is stopped, do not leave the key in the “on” position. Leaving the key in the “on” position causes the battery to discharge, making it more difficult to start the engine.
- Do not drive uphill or downhill with the engine off.
- Do not tow a power steering vehicle or a forklift with a brake servo system with its engine off.

1.7 Engine stoppage operating procedures (p.63)

To stop the engine, turn the starting switch key to the “off” position.

[Points to note]

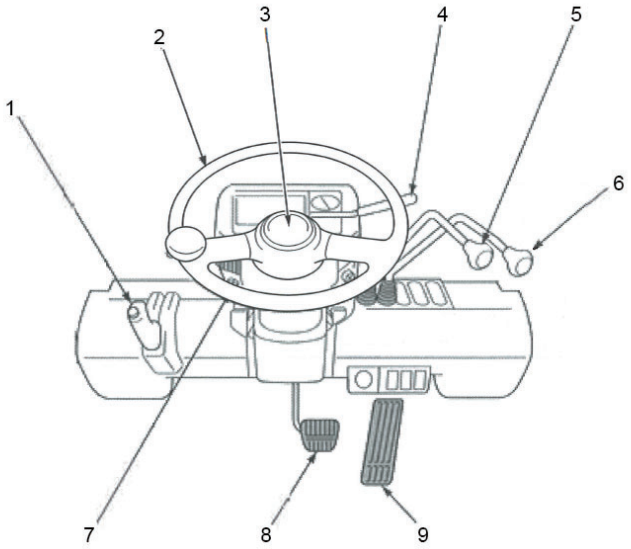
- Do not stop the engine immediately after finishing work. Let the engine idle for at least 30 seconds and turn it off once it cools down.

1.8 Points to note when driving/working (p.64)

- Do not stop the engine while driving or performing work with the forklift.
  - (a) Stopping the engine prevents the power steering system and brake servo system from working, which makes operations difficult and dangerous.
  - (b) If the engine stops while the vehicle is on an incline, follow the steps below to stop the vehicle as quickly as possible.
    - Step hard on the brake pedal to stop the vehicle.
    - Pull out the parking brake button to apply the parking brake.
- If the front visibility of the forklift is obstructed by a large load, transport it in reverse.

Fig. 3-10 Transport Large Loads in Reverse

2 Battery Counterbalance Forklifts (p.65)



1. Parking brake lever
2. Steering wheel
3. Horn switch display
4. Forward/reverse lever
5. Lift lever
6. Tilt lever
7. Light switch
8. Brake pedal
9. Accelerator pedal

Fig. 3-11 Battery-Powered Counterbalance Forklift Operator's Seat

2.1 Startup procedures (p.65)

(1) If the battery connector is disconnected, connect it.

(2) Put the forward/reverse lever in neutral and pull the parking brake lever all the way.

(3) Take your foot off the accelerator, put the key in the starting switch, and turn it to the "on" position. This will turn on a light indicating that the forklift is ready for operation.
Do not start driving immediately after the light comes on. First, check that the voltmeter is showing a normal value.

2.2 Initial driving and acceleration/deceleration procedures (p.65)

(1) Move the forward/reverse lever to either direction and step on the accelerator to start moving.
During initial movement, the driving motor will gradually increase its rotational speed no matter how hard you step on the accelerator, ensuring a smooth start.

(2) Apply different amounts of force to the accelerator to adjust the driving speed.

2.3 Forward/reverse switching procedures (p.66)

To switch driving directions, move the forward/reverse lever to the forward or reverse position. Unlike engine forklifts, battery forklifts do not need to be stopped before switching directions.

[Plugging operations]

In a battery forklift, when you use the forward/reverse lever to switch directions with your foot still on the accelerator, reverse rotation braking is applied to the driving motor and the vehicle slows down. This operation is called plugging. As reverse rotation braking takes effect and slows the vehicle down, you can achieve a complete stop by putting the forward/reverse lever in the neutral position just before the forklift stops. Once reverse rotation braking stops the vehicle, leaving the forward/reverse lever in the same position and continuing to step on the accelerator will move the vehicle in the opposite direction.

Applying different amounts of force to the accelerator lets you adjust how much reverse rotation braking force is applied to the driving motor.

(The harder you step, the more force is applied.) When the forklift is carrying a load, however, operate the accelerator carefully.

2.4 Points to note when steering, braking, stopping, and parking (p.66)

Refer to the points to note in the engine forklift (torque converter vehicle) section.

Make sure to disconnect the battery connector when leaving the vehicle parked for an extended period of time (for 1 month or more).

2.5 Stopping procedures (p.66)

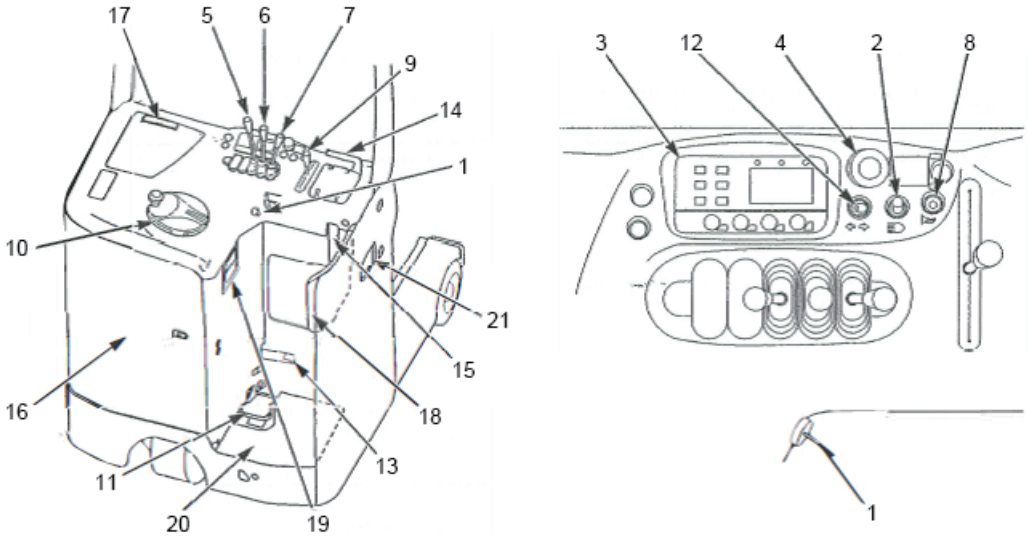
Apply the parking brake securely, move the forward/reverse lever to the neutral position, and lower the fork to the minimum height. Turn the key to the “off” position. And then, remove the key.

3 Reach Forklifts (p.67)

3.1 Startup procedures (p.67)

(1) If the battery connector is disconnected, connect it.

(2) Check that the accelerator lever and operation lever are in neutral, put the key in the starting switch, and turn it to the “on” position to ready the vehicle for operation.



1. Starting switch
2. Light switch
3. Meter panel (Battery capacity display, hour meter, malfunction code display, adjustment mode display)
4. Emergency power cut button
5. Lift lever
6. Tilt lever
7. Reach lever
8. Horn
9. Accelerator lever
10. Steering wheel
11. Brake pedal
12. Turn signal switch
13. Battery lock pedal
14. Assist grip
15. Hydraulic fluid level gauge
16. Back door
17. Note folder
18. Back support
19. Charging panel
20. Floor plate (Interlock plate)
21. Battery plug

Fig. 3-12 Stand-Up Reach Forklift Operator’s Seat

3.2 Initial driving and acceleration/deceleration procedures (p.67)

(1) Step on the brake pedal to release the brakes.

(2) Put the accelerator lever (which is combined with the forward/reverse lever) in the direction of movement to start moving.

(3) Control traveling speed by adjusting the tilt of the accelerator lever.

3.3 Forward/reverse switching procedures (p.68)

To switch between forward and reverse, push the accelerator lever (the forward/reverse lever) in the opposite direction.

[Plugging operations]

To plug, move the accelerator lever (forward/reverse lever) to the opposite direction while the forklift is moving. (See Forward/reverse switching procedures.)

3.4 Braking/stopping/parking operating procedures (p.68)

(1) Take your foot off the brake pedal to apply the brakes and stop the vehicle.

(2) Make sure to disconnect the battery connector when leaving the vehicle stopped for an extended period of time (for 1 month or more).

(3) For more operation procedures and points to note, refer to the engine forklift (torque converter vehicle) section.

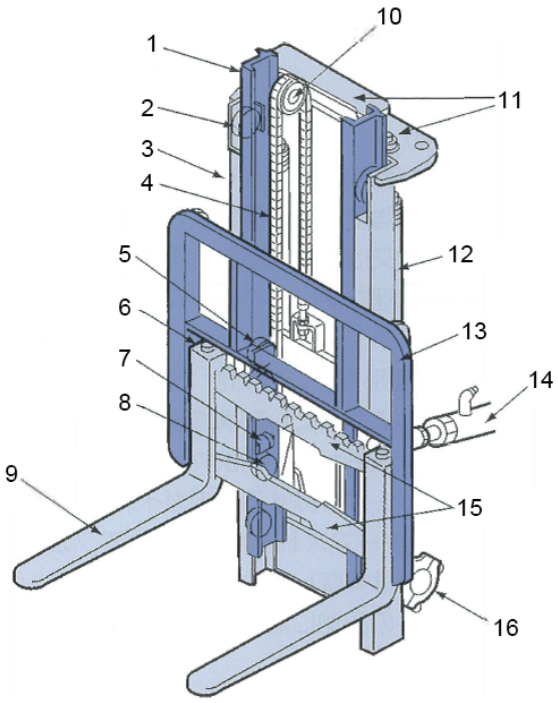
3.5 Important points to remember when operation the reach forklift (p.68)

- While carrying a load, tilt the mast and fork backward.
- The reach forklift can turn sharply since its steering angle is large. Decrease the travel speed and turn slowly. If the vehicle turns quickly at high speed, it may tip over and cause the load collapse.
- Do not put your foot outside of the vehicle through the step. Do not drive the vehicle while leaning out. You may crash into obstacles or being caught. Always drive the vehicle in proper position.
- Be sure to turn the starting switch to the “off” position and get off the vehicle before adjusting the loads. If you touch the operating lever by mistake, the mast operates and your body may be caught.
- Avoid driving on a wet road surface, slippery floor, or rough ground since the braking performance lowers due to sideways slip of the wheels.

Chapter 4

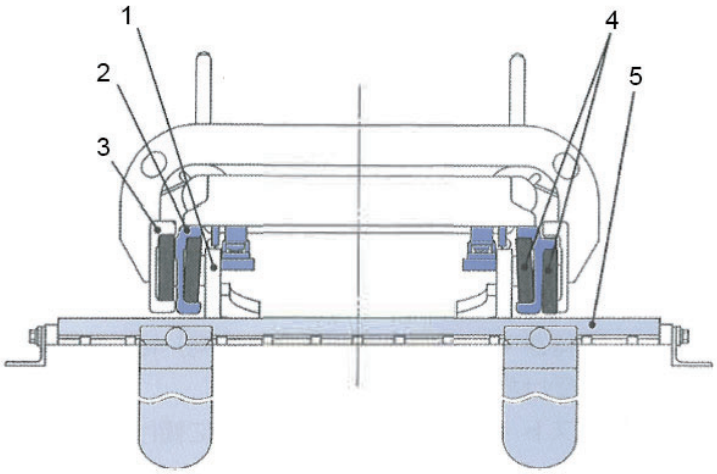
The Structures and Functions of Loading/ Unloading Devices

1 Part Names (p.69)



1. Inner mast
2. Lift roller
3. Outer mast
4. Lift chain
5. Lift roller
6. Fork stopper
7. Side roller
8. Lift roller
9. Fork
10. Chain wheel
11. Crossbeam
12. Lift cylinder
13. Backrest
14. Tilt cylinder
15. Finger bar
16. Mast support

Fig. 4-1 Loading/Unloading Device Part Names



1. Lift bracket
2. Inner mast
3. Outer mast
4. Lift roller
5. Finger bar

Fig. 4-2 From above the fork

2 Loading/Unloading Devices (p.70)

The loading/unloading device uses hydraulic pressure to raise the load to the target height, tilt it to the necessary angle, and perform other functions.

To move the fork up and down, the loading device expands and contracts the shift cylinders on both sides of mast, which functions as a guide rail, and maneuvers the lift bracket via the lift chain.

2.1 Loading/unloading device parts (See Fig. 5-1)

Fork

An L-shaped arm used for loading and unloading; forklifts normally have two forks. Forks, which must have a static strength safety factor of at least 3, are made of high-quality carbon steel or special steel to ensure sufficient strength, but are also prone to wear, bending, and breaking caused by prolonged or improper use.

Mast

The mast is a gate-shaped structure made up of two “J”-shaped heavy steel plates (one on each side) joined together at the top by a cross beam; built into the inner side of the outer mast, the inner mast serves as a guide rail for the lift bracket (finger bar) and its mounted fork when moving up and down. The inner mast moves up and down with the fork, using the outer mast (which does not move up and down) as a guide.

Lift cylinders

Hydraulic cylinders mounted along both sides of the outer mast; the lift cylinders move the fork bracket and inner mast up and down.

Lift chain

A chain that raises and lowers the fork as the chain wheel (pulley) on the top end of the lift cylinder moves up and down; to ensure that the fork moves up and down properly, it is important to make adjustments so that the left and right chains have the same tightness. The lift chain, which must have a safety factor of at least 5, can experience wear, stretching, and corrosion due to prolonged use. Daily inspections are required.

Lift bracket

The finger bar is welded in front of the lift bracket to install the fork, and the lift rollers are installed beside it. The lift brackets are suspended by the lift chains, and they raise and lower inside the inner mast. On the top of the finger bar, the notches are provided to fix the fork at the desired position.

Backrest

A frame equipped to prevent the load from dropping behind (toward) the mast.

Tilt cylinder

A hydraulic cylinder used to tilt the mast (and the fork) forward and backward.

3 Hydraulic System (p.73)

The hydraulic system, which operates the upper structure of the forklift, converts mechanical energy produced by the engine/motor to fluid energy, and then converts the fluid energy back to mechanical energy, which is used to conduct work. This system is based largely on Pascal's principle.

[Pascal's principle]

Pascal's principle states that "pressure exerted anywhere in a confined incompressible fluid is transmitted equally in all directions throughout the fluid."

Imagine a container combined with a cylinder having pistons of different sizes (10 cm^2 area and 1 cm^2 area), like the one shown in Fig. 4-3. When 100 N of force is applied to the piston with the smaller area (1 cm^2), the pressure of the liquid is 100 N/cm^2. The resulting force on the piston with the larger area (10 cm^2) is 1,000 N (10 cm^2 x 100 N/cm^2). Thus, the force on the piston with the smaller area is amplified in proportion to the area of the larger piston.

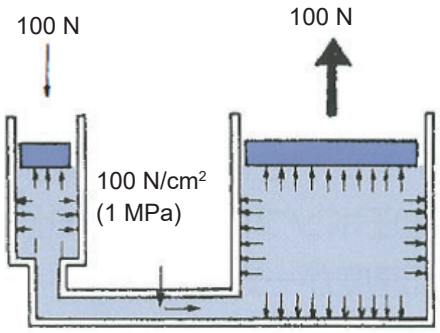


Fig. 4-3 Pascal's principle

Based on this principle, the hydraulic system applies pressure to the hydraulic fluid and uses hydraulically-driven devices, such as a hydraulic cylinder, to move the loading/unloading device.

The hydraulic system is made up of the following components.

- Hydraulic pressure generator
  Hydraulic pump, etc.
- Hydraulic drive
  Hydraulic cylinder; hydraulic motor
- Hydraulic control device
  Directional control valve (operation valve, etc.), pressure control valve (safety valve, etc.), flow control valve (metering valve, etc.)
- Ancillary equipment
  Hydraulic fluid reservoir, filter, pipe, joint, pressure gauge, etc.

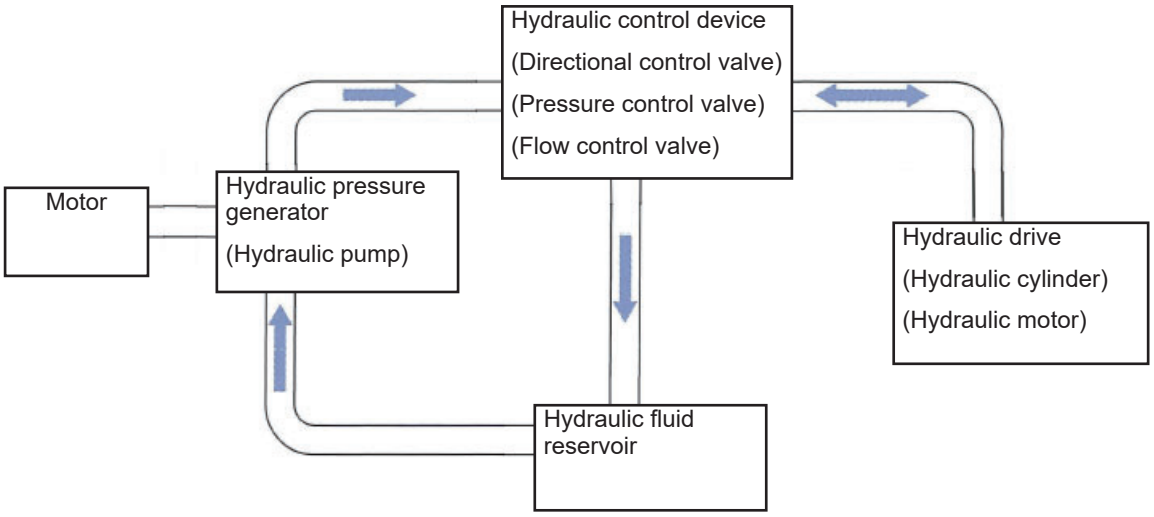
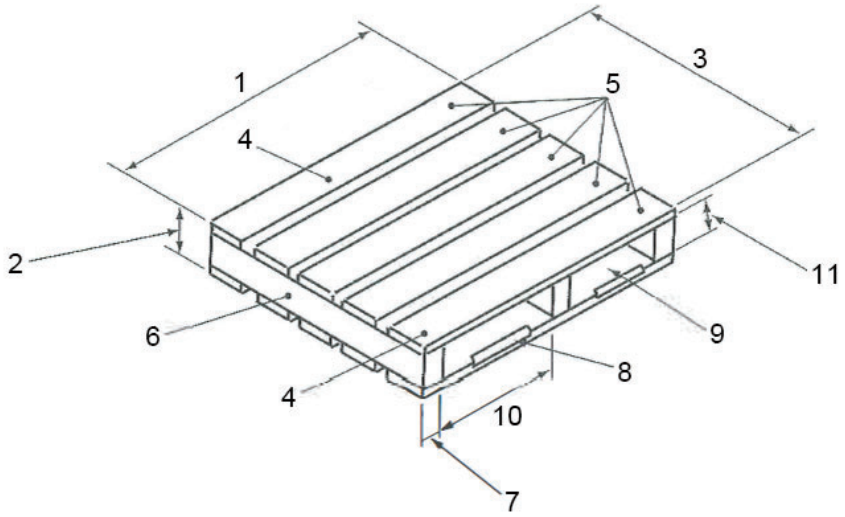


Fig. 4-4 Hydraulic System Structure

4 Pallets (p.85)

Pallets hold multiple load items and make loading/unloading, transport, and storage operations more efficient.

There are many types of pallets for different purposes. The most common pallets used with forklifts are flat pallets, box pallets, post pallets, and sheet pallets.



1. Pallet width
2. Pallet height
3. Pallet length
4. Edge board
5. Deck board
6. Stringer
7. Stringer width
8. Chamfer
9. Inserting opening
10. Inserting opening width
11. Inserting opening height (stringer height)

Fig. 4-5 Flat Pallet Part Names

4.1 Flat pallet (p.85)

A flat pallet is flat, has an insertion opening for a fork, and does not have posts or any other superstructure. Flat pallets made of wood are most common, but there are also metal and plastic types.

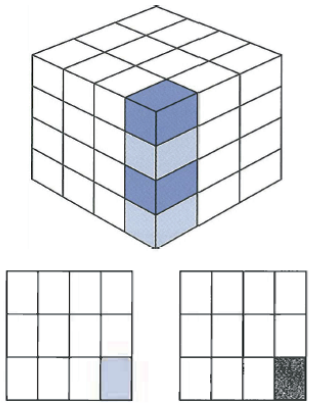
4.2 Stacking patterns on a pallet (p.88)

Loads must be stacked on a pallet safely and securely to prevent collapses.

As discussed below, there are 5 basic pallet stacking patterns. The most common patterns are alternate stacking and brick stacking.

Block stacking

In the block stacking pattern, all items are arranged in the same configuration, and each level in the same fashion. As this pattern generally increases the risk of collapse, items must be fastened down with bands and ties.

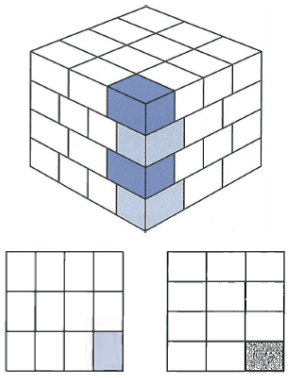


(Odd level) (Even level)

Alternate stacking

The alternate stacking pattern uses square pallets. All of the items on the same level are arranged in the same direction, with the levels rotated at right angles as they are stacked.

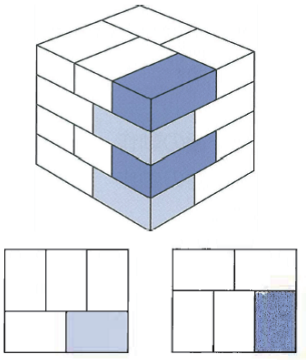
As long as the items on the pallets are not square, this pattern usually prevents breakage and also simplifies the stacking and banding processes.



(Odd level) (Even level)

Brick stacking

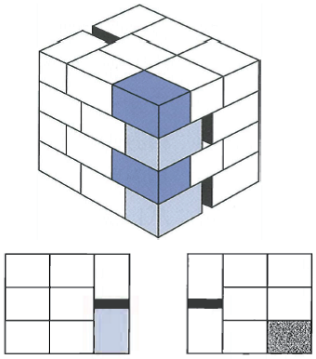
In the brick stacking pattern, each level has the same arrangement, but the levels are rotated by 180 ° as they are stacked so that the items alternate directions.



(Odd level) (Even level)

Split stacking

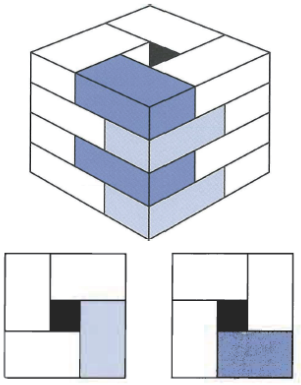
Split stacking is essentially the same as brick stacking with some space left open between items due to the shape of items.



(Odd level) (Even level)

Pinwheel stacking

In the pinwheel stacking pattern, items on the same level are arranged to form a pinwheel, with the levels switching directions in an alternating pattern. This pattern is also called the “windmill” pattern. In this pattern, non-square items are loaded onto square pallets.



(Odd level) (Even level)

Chapter 5

Loading/Unloading Device Operations

1 Loading/Unloading Terms (p.90)

Stationary swing	Turning the steering wheel to move the wheels while the vehicle is stopped
Lifting	Lifting the fork upward
Lowering	Lowering the fork downward
Tilting forward	Tilting the mast forward or the fork downward
Tilting backward	Tilting the mast backward or the fork upward
Contracting	Bringing the fork or mast in (perform a reach-in; used in reach forklifts and sideloaders only)
Extending	Putting the fork or mast out (perform a reach-out; used in reach forklifts and sideloaders only)
Pick-up	A series of actions performed when picking up a load with the fork
Loading	A series of fork actions performed when bringing down a stacked load
Unloading	A series of actions performed when bringing a loaded load to a specified location
Inserting	Inserting the fork into a pallet or similar object
Draw-back/pull-out	Pulling out the fork from a pallet or other place
Inching	Driving intermittently at a very slow speed when aligning the forklift with the specified position

2 Lever Operation Directions (Lift/Tilt Operation Levers) (p.91)

Fig. 5-1 illustrates lift/tilt lever operations and corresponding movements.

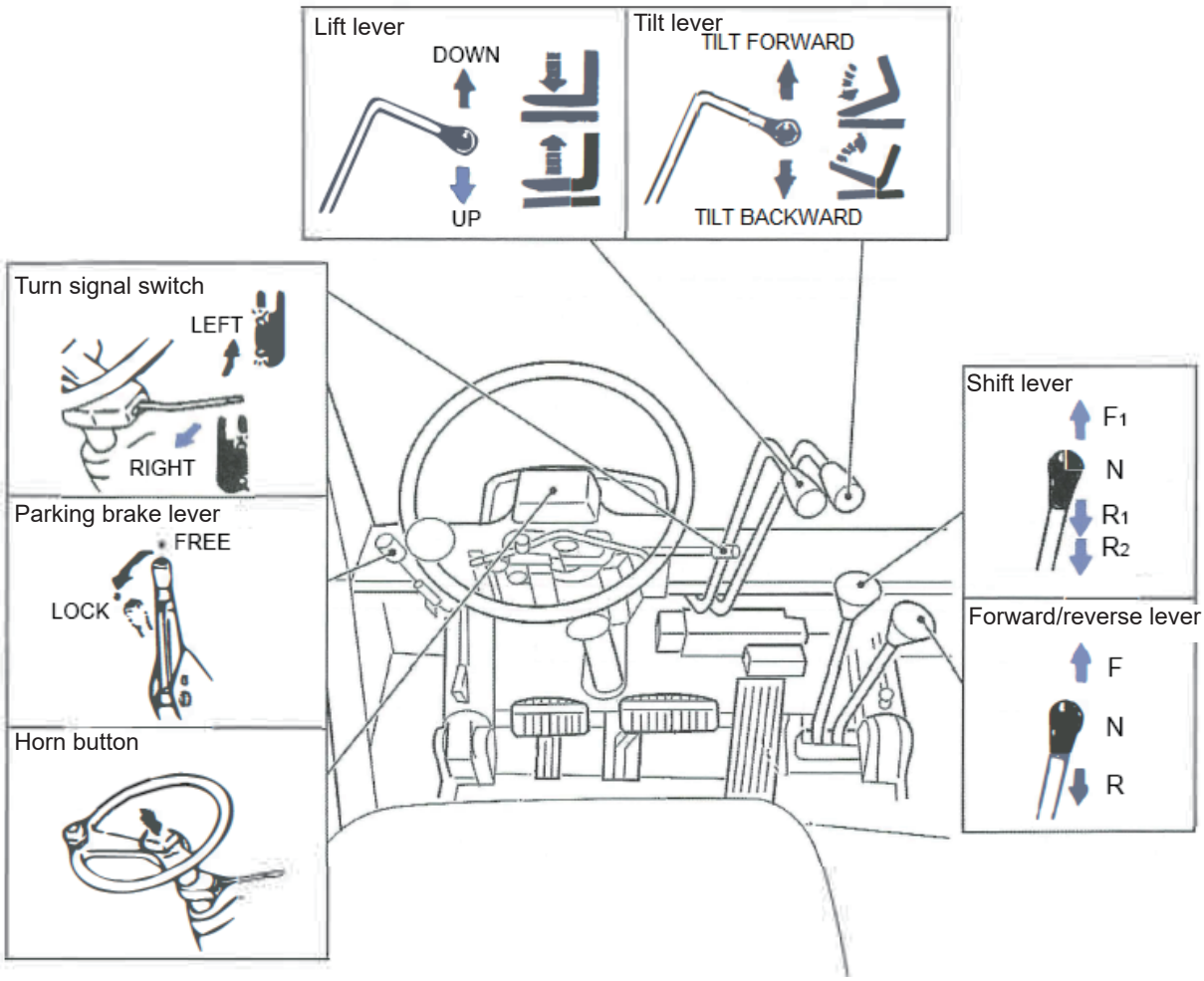


Fig. 5-1 Lever Operation (Ex.)

3 Loading/Unloading Operations (p.91)

3.1 Loading/unloading device operation method (p.91)

When performing loading/unloading work, stop the vehicle, apply the parking brake (as a general rule), and keep the forward/reverse lever in neutral.

- When loading, put the fork straight into the pallet opening.
- When unloading, perform a visual check for any cargo collapse, cargo damage, or other dangerous conditions.
- In order to keep the load from moving side to side and avoid unbalanced load conditions, the forks on both sides must be the same distance from the center of the vehicle and spaced so that 1/2 to 3/4 of the pallet width is between the forks.

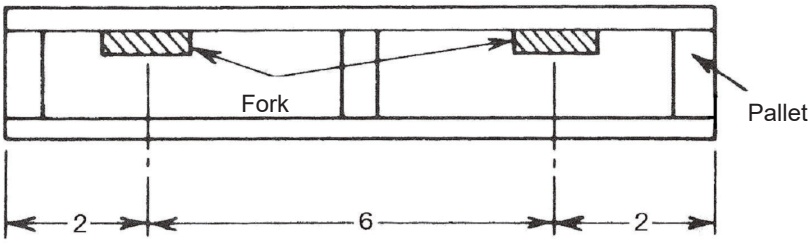


Fig. 5-2 Fork Separation

- When loading and unloading, make sure to insert the fork as far as possible into the pallet. Do not use the end of the fork to push loads or pallets.

3.2 Loading operating procedures (p.92)

When loading, follow the procedure below.

(1) Decelerate in front of the load.

(2) Approach the load and stop the vehicle.

(3) Check for any collapsed load or other possible hazards.

(4) Make the mast vertical and the fork horizontal and lift the fork up to the height of the pallet or skid.

(5) Make sure that the fork is in proper position and then slowly and gently move forward to insert the fork. When operating a reach forklift, slowly extend the mast and insert the fork.

(6) Once the fork is in the insertion opening, lift the fork a small amount (5 - 10 cm). Then move the forklift backward to pull the pallet or skid out 10 - 20 cm and lower the fork.

(7) Next, insert the fork all the way, gently bring the vertical front surface of the fork or the backrest against the load, and lift.

(8) After lifting, slowly move the forklift backward to a distance that makes it possible to lower the load safely. When operating a reach forklift, before moving backward, first retract the mast. Then move backward to a distance that makes it possible to lower the load safely.

(9) Lower the pallet or skid to a height 5 - 10 cm off the ground, tilt the mast backward to an appropriate angle, and move to the specified designation with the pallet or skid 15 - 20 cm off the ground. When operating a reach forklift, lower the pallet or skid to a height around 5 cm above the upper surface of the reach leg, tilt backward to appropriate angle, and move to the specified location.

3.3 Unloading operating procedures (p.92)

When unloading, follow the procedure below.

(1) Slow down as you move closer to the unloading location.

(2) Approach the unloading location and stop the vehicle.

(3) Check for any collapsed load, load damage, or other possible hazards in the unloading location.

(4) Make the mast vertical and the fork horizontal and lift the fork to a point that is slightly higher than the specified unloading point.

(5) Make sure that the fork is at the proper unloading point, slowly and gently move forward to the specified position, and lower the load. When operating a reach forklift, slowly extend the mast and lower to the specified position. In such cases, do not move the forklift forward.

(6) Slowly move backward to pull the fork out 10 - 20 cm, lift the fork again, proceed forward to a safe and appropriate unloading location, and lower the load. When operating a reach forklift, slowly retract the mast to pull the fork out 10 - 20 cm, lift the fork again, extend to a safe and appropriate unloading location, and lower the load. In such cases, do not move the forklift backward or forward.

(7) Once the load is stable, move backward, removing the fork, to a distance that makes it possible to lower the load safely. Lower the fork to a height 5 - 10 cm off the ground, tilt the mast backward to an appropriate angle, and begin driving with the fork 15 - 20 cm off the ground.
When operating a reach forklift, lower the fork to a height roughly 5 cm above the reach leg, tilt backward to an appropriate angle, and start moving.

3.4 Points to note when loading/unloading (p.93)

- When loading, do not recklessly tilt backward with the fork in its top position.
- Never get out of or leave the forklift with a load lifted.
- A person may not ride on the fork, a pallet, on top of a load, or any other location other than the operator's seat.

Fig. 5-3 No Riding

- As a general rule, use a forklift with a head guard.
- As a general rule, use a forklift with a backrest.
- Do not drive with a load lifted higher than 30 cm or with the mast vertical or tilted forward.

Fig. 5-4 No Driving with a Load Lifted

Chapter 6

Inspections and Maintenance

In order to run efficiently and safely, machines must be in good condition.

Many forklift-related accidents are caused by insufficient or improper daily inspections and maintenance. Thus, it is important to not only perform initial and periodic forklift inspections, but also stop and inspect the forklift whenever you suspect a possible problem.

Employers are required by law to perform the pre-work and periodic self-inspections listed in Table 6-1.

Fig. 6-1 Periodic Self-Inspection

Table 6-1 Forklift Inspection/Self-Inspection Regulations

Item	Inspector/qualifications	Notes
Pre-work inspections (The Ordinance on Industrial Safety and Health, Article 151, No. 25)	Inspector appointed by the employer (Operator)	Inspection timing: Before starting work
		Inspection records: (Should be kept as long as the forklift is in use)
Periodic self-inspections (The Ordinance on Industrial Safety and Health, Article 151, No. 22)	Inspector appointed by the employer (Operator)	Test timing: At least once a month
		Test records: Must be kept for 3 years
Specific self-inspections (The Ordinance on Industrial Safety and Health, Article 151, No. 21 and 24)	A worker with the qualifications stipulated by The Ordinance of Ministry of Health, Labour and Welfare Registered inspection agency	Test timing: At least once a year
		Test records: Must be kept for 3 years
		An inspection verification sticker indicating that inspections have been performed

1 Pre-Work (Initial) Inspections (p.99)

The item indicated with (E) applies only for engine forklift.

1.1 Pre-Work (Initial) Inspections

The employer must check the following matters before starting the work for the day: (Article 151-25 of the Ordinance on Industrial Safety and Health)

- Function of a braking device and a controlling device
- Function of a cargo handling device and a hydraulic system
- Abnormalities in a wheel
- Functions of front and rear lamps, a direction indicator and a warning device

Perform pre-work inspections at the following times.

- Before the engine has started (E) or when the starting switch is in the off position
- During warm-up operations after the engine has started (E) or when the starting switch is in the on position
- After starting to drive

Chapter 7

Safety Equipment and Safety Instructions

1 Safety Devices (p.106)

Forklifts must be equipped with the following safety devices (as stipulated by the Ordinance on Industrial Safety and Health, Article 27), and the safety devices must function properly. (The Ordinance on Industrial Safety and Health, Article 29)

1.1 Headlights and back lights

Headlights and back lights provide light in front of and behind the vehicle to ensure safe operations at night and in dark locations. A forklift must have headlights and back lights unless the work location “has enough brightness to ensure safe operations.” (The Ordinance on Industrial Safety and Health, Article 151, No. 16)

1.2 Head guard

The head guard is a sturdy frame placed over the operator’s seat to protect the driver from a falling load. A forklift must be equipped with a head guard of the required strength and size unless there is absolutely no chance of a load falling and endangering the driver. (The Ordinance on Industrial Safety and Health, Article 151, No. 17)

- The head guard strength must be able to withstand a static, uniformly-distributed load equivalent to twice the forklift’s maximum load (4 tons if the forklift’s maximum load is 2 tons or greater).
- Openings on the top of the head guard must be less than 16 cm long or less than 16 cm wide.
- In sit-down forklifts, there must be at least 95 cm between the upper surface of the operator’s seat and the bottom surface of the upper head guard frame.
- In stand-up forklifts, there must be at least 1.8 m between the floor of the operator’s seat and the bottom surface of the upper head guard frame.

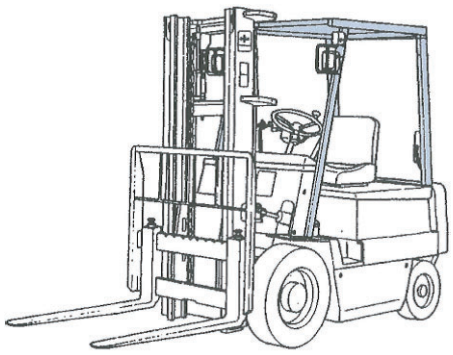


Fig. 7-1 Head Guard

1.3 Backrest

The backrest is a frame equipped to prevent a load from dropping behind the mast.

A forklift must be equipped with a backrest unless there is absolutely no chance of a load falling and endangering the driver. (The Ordinance on Industrial Safety and Health, Article 151, No. 18)

1.4 Brake system

The brake system is used to decelerate the vehicle and keep the vehicle stopped.

Brake systems must have the following performance. (The Structural Code, Article 4)

- A forklift traveling at 20 km/h under standard non-loaded conditions: brake to a stop within 5 m
- A forklift traveling at 10 km/h under standard loaded conditions: brake to a stop within 2.5 m

1.5 Turn signals

Turn signals show people and other vehicles in the area the direction one will turn. Except for small forklifts that travel at low speeds and have operator's seats outside the vehicle interior, a forklift must be equipped with turn signals on the left and right sides. (The Structural Code, Article 5)

1.6 Warning device

The warning device is a safety device used to alert people in the area while driving for performing operations. A forklift is required by law to have a warning device. (The Structural Code, Article 6)

Forklift warning devices include horns and buzzers that alert others, as well as warning buzzers and lights that notify operators of vehicle conditions.

1.7 Hydraulic system safety valve

The hydraulic system safety valve is a device used to prevent excess increases in hydraulic fluid pressure. A forklift is required by law to have a hydraulic system safety valve. (The Structural Code, Article 7)

1.8 Fall prevention equipment

A forklift with an operator's seat that moves up and down must have a handrail or similar device(s) in the operator's seat to help prevent workers from falling. (The Structural Code, Article 10)

1.9 Seat safety switch

The seat safety switch prevents the fork from moving up or down, the mast from tilting forward/backward, and the vehicle from moving (in torque converter vehicles) when the operator leaves the operator's seat, even when the loading/unloading lever is applied.

2 Understanding Operational Safety (p.108)

2.1 Overall operation instructions (p.108)

- Operation qualifications
  Only qualified, designated drivers may operate forklifts. People under the age of 18 are prohibited from performing loading/unloading work.

Fig. 7-2 Operation Qualifications

- Driving on public roads
  When driving a sha-ken-certified vehicle on public roads, the driver must have his/her driver's license as required by the Road Traffic Act and obey all traffic rules and regulations.
- Observe rules
  Observe workplace rules for prohibitions, precautions, work procedures, and others.
- Operation under overwork and drinking
  Never operate a forklift when you are fatigued or drunk.

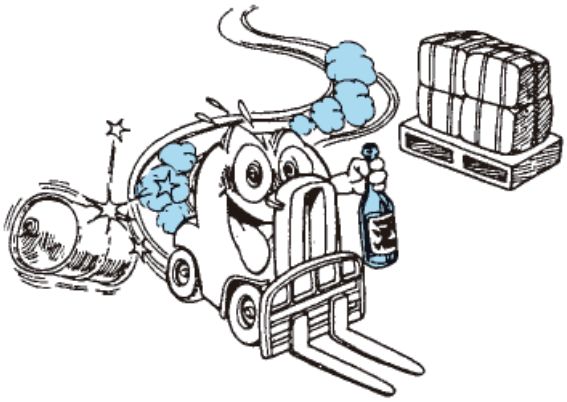


Fig. 7-3 Operation under Overwork and Drinking

- Keep the operator’s seat clean
  Operating levers and pedals with oily hands or shoes is extremely dangerous. Always keep the operator’s seat area clean.
- Work in the proper safety wear
  Use a helmet and protective footwear, fasten the chin strap, and wear work clothes that fit properly.

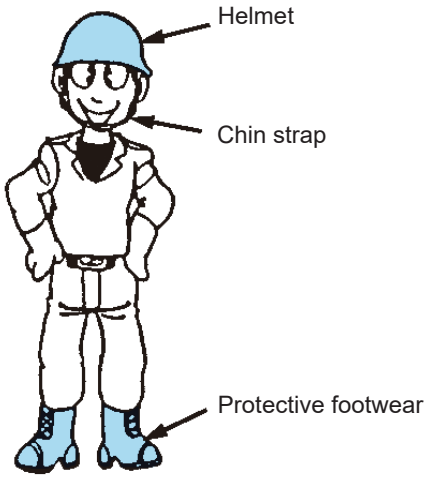


Fig. 7-4 Work in the Proper Safety Wear

2.2 Detailed operation instructions (p.110)

- Always perform pre-work (initial) inspections
  Do not operate the vehicle until the pre-work (initial) inspection is complete.

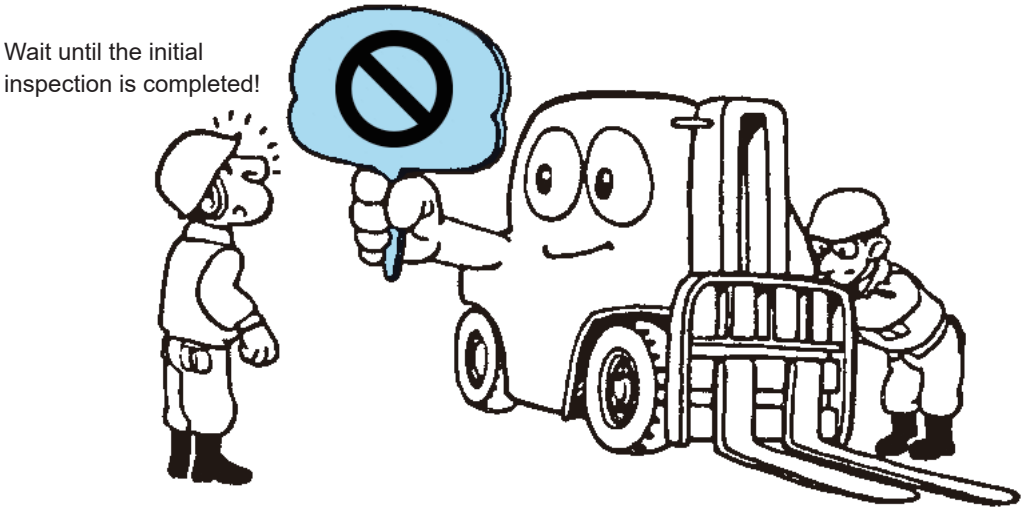


Fig. 7-5 Initial Inspection

- Embarking/disembarking the vehicle
  Use the handrail and steps when embarking and disembarking the vehicle. Do not embark or disembark the vehicle while holding the operation lever or steering wheel. Never jump into or out of the vehicle.

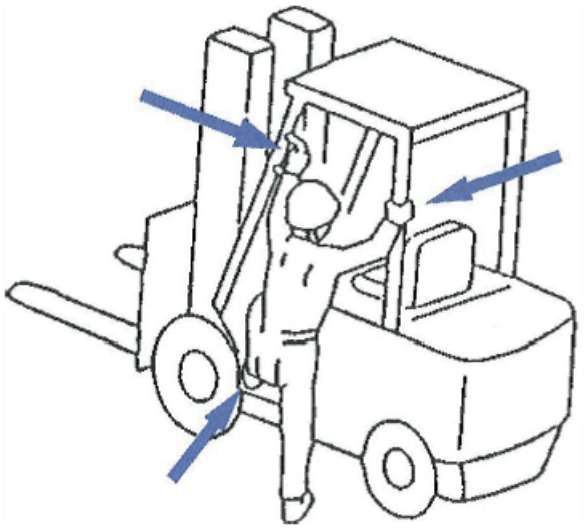


Fig. 7-6 Embarking/Disembarking the Vehicle

- Fasten the seat belt
  When driving the forklift, be sure to fasten the seat belt if equipped.
- Make sure the surrounding area is safe
  When starting the engine, moving the vehicle, and turning, make sure that the surrounding area (especially the area behind the forklift) is clear.
- Never drive the vehicle with the fork raised
  Never drive the vehicle with the fork raised (lifted).
  Bring the fork down to around 15 - 20 cm off the ground to lower the center of gravity and ensure that the vehicle is stable while moving. When operating a reach forklift, do not drive with the mast out (reached out).

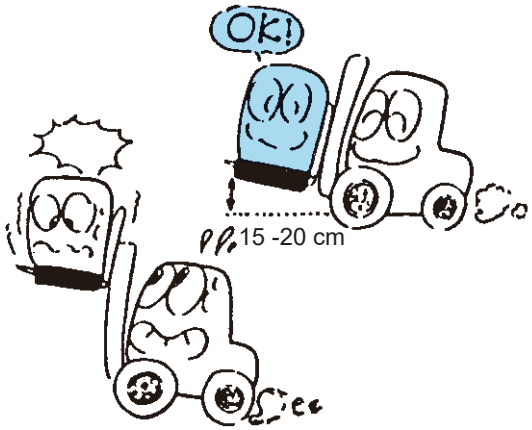


Fig. 7-7 Lower the Fork When Driving

- Loading/unloading large loads
  If a load obstructs visibility out of the front of the forklift, either transport the load in reverse or have another person guide you.
- Driving uphill/downhill with a load
  In order to ensure the safety of the vehicle when carrying a load, drive forward when going uphill and in reverse when going downhill.

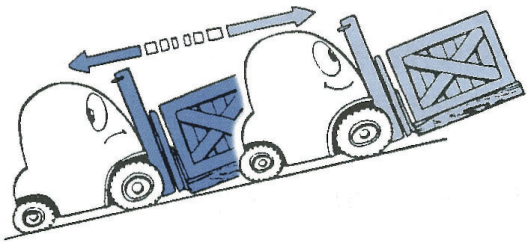


Fig. 7-8 Drive Forward Uphill and in Reverse Downhill

- Repair problems as soon as they are detected
  If you detect a problem while operating the forklift, immediately stop the vehicle in a safe location, identify the problem, and make the appropriate repairs.

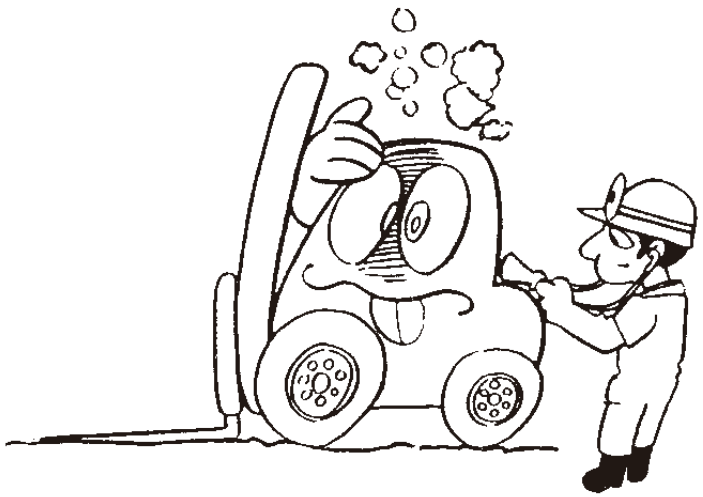


Fig. 7-9 Repair Problems Immediately

- Do not stop the engine while driving
  Do not stop the engine of a power steering vehicle (a vehicle with a steering servo system) or a vehicle with a brake servo system while driving. Doing so makes it difficult to turn the steering wheel and significantly reduces brake performance.

2.3 Loading/unloading instructions (p.113)

- Do not handle oversized loads
  Do not handle loads that exceed the allowable loads listed in the corresponding load tables.

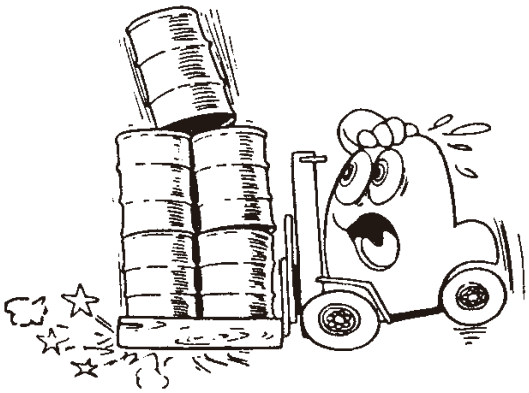


Fig. 7-10 Do Not Load Oversized Loads

- Follow instructions
  When having another person provide guidance, the operator should follow the guidance instructions given.
  The person providing guidance must be easily visible from the operator's seat.
- Never stand under a fork
  Never allow a person to stand under a fork or a load.

Fig. 7-11 Never Stand under a Fork

- Never Lift a Person with the Fork

Fig. 7-12 Never Lift a Person with the Fork

- Do not suspend loads from the fork with wires
  Do not hang wires on the fork to suspend loads.

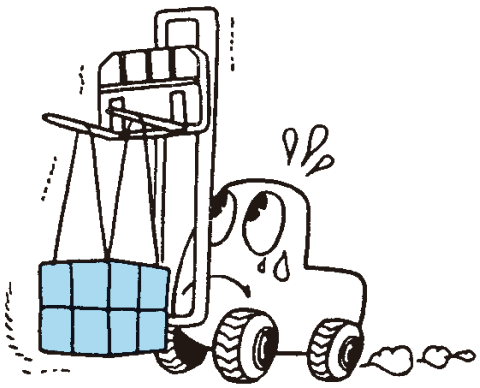


Fig. 7-13 Never Suspend Items from a Fork

- Never touch the mast during loading/unloading
  Placing your hand on the mast cross member and touch the load can cause the mast to drop. Never touch the mast during loading/unloading.

2.4 Charging instructions (p.116)

- Charge in a clean, well-ventilated place.

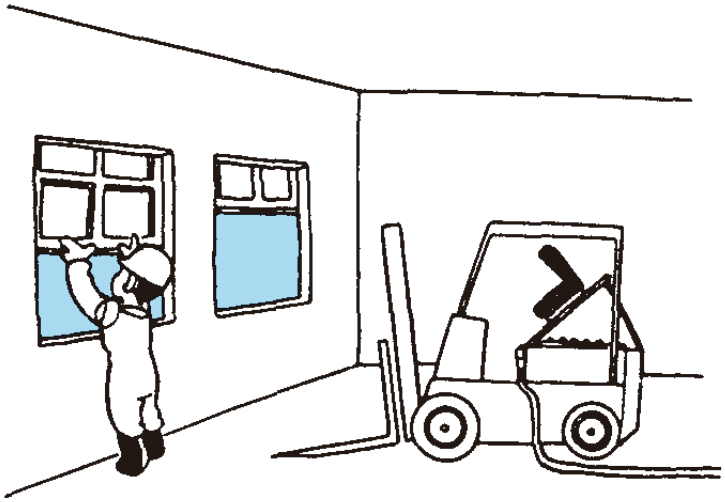


Fig. 7-14 Charge in a Well-Ventilated Place

- Open the battery cover.
  During charging, open the battery cover to improve air flow.

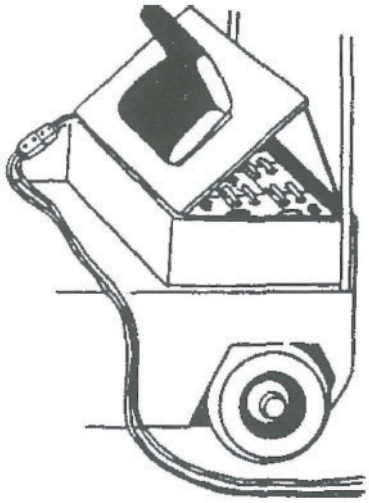


Fig. 7-15 Open the Battery Cover during Charging

- Keep fire away
  A charging battery generates hydrogen gas and oxygen gas. Keep away from fire. Do not spark/short.

Chapter 8

Basic Mechanics of Forklift Operation

All forklift maneuvers and loading/unloading operations are rooted in the principles of dynamics and mechanics. A firm grasp of the basic principles of dynamics helps you conduct loading and unloading work in a much safer, more efficient way. When you are confronted with balance and stability issues during actual forklift loading operations, you will see how much this basic knowledge can come in handy.

1 The Action of Force (p.120)

1.1 The three elements of force

Setting a stationary object in motion, changing the direction of a moving object, and changing the velocity of an object are all examples of force acting on an object. Every force has a direction, magnitude, and acting point. These are the “three elements of force,” which are represented by an arrow in Fig. 8-1.

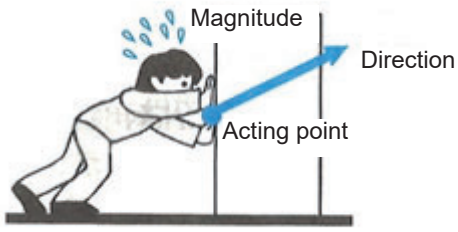


Fig. 8-1 Three Elements of Force

Vectors

Draw a straight line extending from the acting point A to B in the direction of force. The length of the force is proportional to the magnitude (for example, if you decide that 1 cm represents 1 N (newton), 5 cm would represent 5 newtons). The length of this straight line (AB) corresponds to the line of action of the force, and the arrow represents the direction of the force.

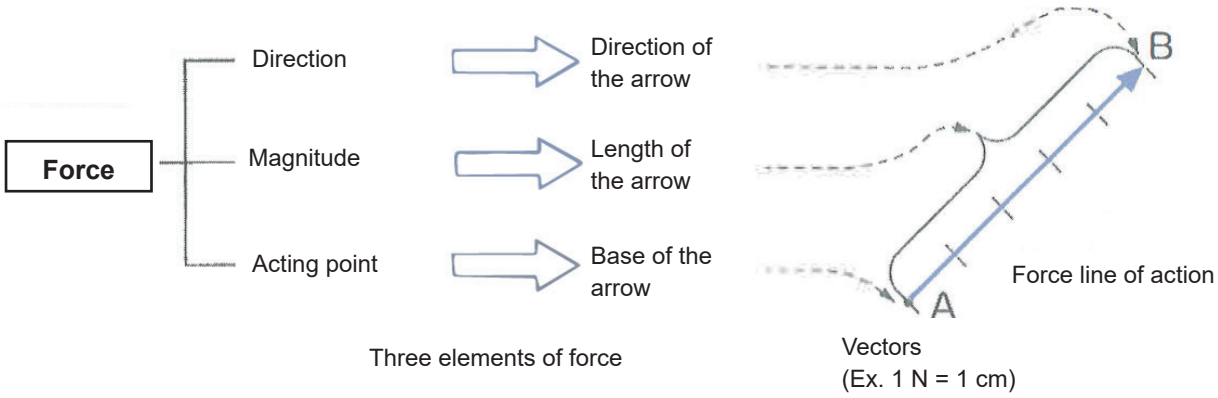


Fig. 8-2 Vectors

1.2 Composition and decomposition of forces (p.121)

Two or more forces acting on a single point can be “combined” into a single force with the same effect. This “combined” force is called the “resultant force.” The process of combining two or more forces into one resultant force is referred to as the “composition of forces.”

Composition of two forces

- Composition of force on a straight line
  Resultant force (R) is the sum of two forces (F1 and F2) operating in the same direction on a straight line. When the two forces are operating in opposite directions, the resultant force is the difference of the two forces.

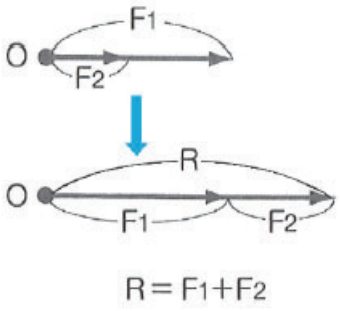


Fig. 8-3 Composition of Two Forces

- Composition of forces with different directions and orientations
  Fig. 8-4 illustrates how to find the s resultant force (R) of two forces (F1 and F2) operating in different directions on point O.
  Draw a parallelogram (OBDA), using F1 and F2 as sides. The diagonal line that connects point O to the other side of the parallelogram represents the resultant force (R).
  This way of finding the resultant force is called the “parallelogram law of forces.”

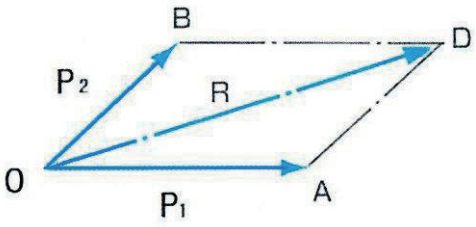


Fig. 8-4 Parallelogram Law of Forces

1.3 Decomposition of forces

As shown in Fig. 8-5, a ship is connected to the piles (A, B) at both banks of the river with ropes. The force to flow the ship is given as F, the forces applied to ropes are given as Fa and Fb.

To find a force applied to the ropes, the parallelogram law of forces shown in Fig. 8-4 is used in reverse sequence.

The force can be determined by drawing a parallelogram with the reaction force R for the force F as diagonal and ropes as its two sides. Fa and Fb represent the forces applied to the ropes.

The “decomposition of force” is the process of dividing a force working on an object into two or more forces. Each of force (Fa and Fb) is called a “component force”.

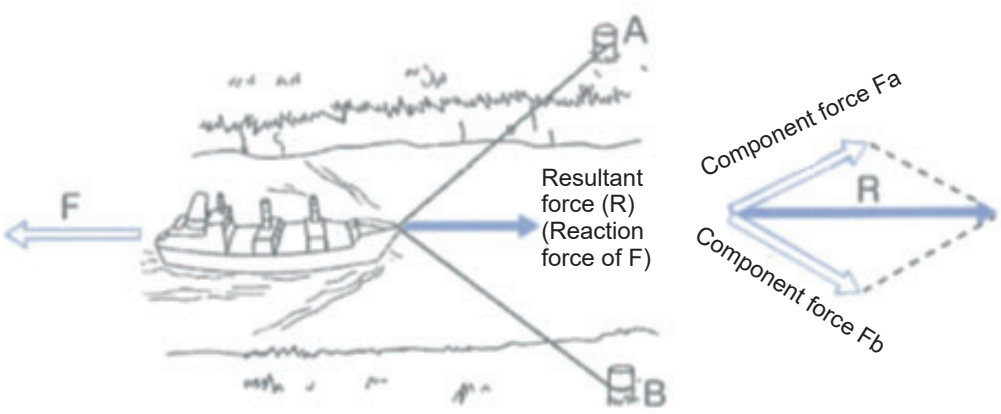


Fig. 8-5 Decomposition of forces (1)

Furthermore, even the load is pushed by the same force F as in Fig. 8-6, the magnitude of horizontal force F2 varies depending on the pushing angle.

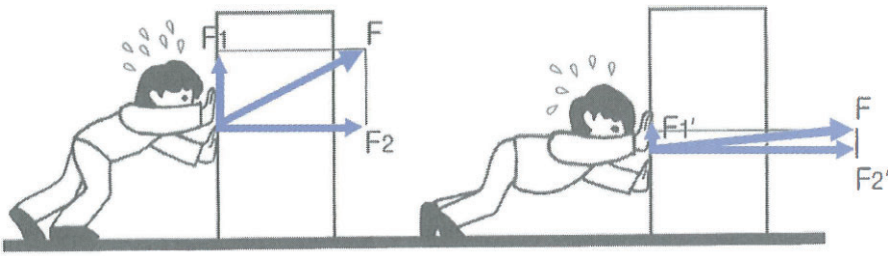


Fig. 8-6 Decomposition of forces (2)

1.4 Moment of force (p.123)

A “moment” is the tendency of a force to twist or rotate. Mathematically, a moment (M) is the product of the force (F) and its length (L) (the distance between the fulcrum and the force point).

Moment (M) = Force (F) x Length (L)

The “moment of force” is also called the “torque.”

Tightening force and moment

Essentially, if the resultant tightening forces (rotational moments) are equal, force Fa at point A, which is twice as far away from the axis as point B, is half of force Fb.

In this case, however, the force at point A has to move farther than the force at point B to tighten the nut. This means that the amount of work required to tighten the nut (force x distance) is the same for both point A and point B.

Ma = Fa x 2L

Mb = Fb x L

Fa x 2L = Fb x L

2Fa = Fb

Pa = Fb/2

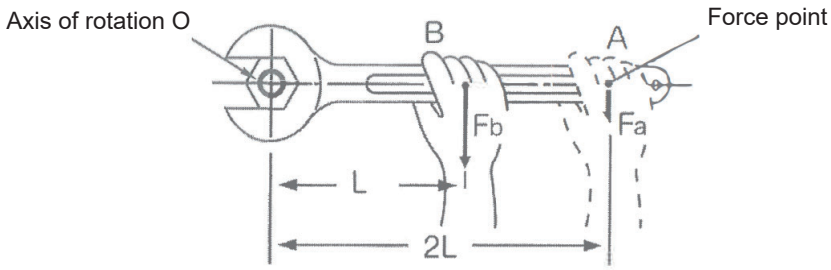


Fig. 8-7 Tightening Force and Moment

1.5 Balance of forces (p.125)

When there are multiple forces operating on a single object and the object is stationary, the forces are considered to be balanced.

For example, when a load is lifted with a rope, and the load is stationary, the upper force F that is equal to the gravity (W = mg) generated by the load weight is applied to a rope, and those forces are balanced.

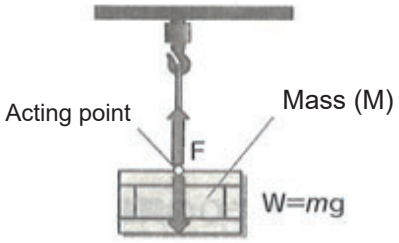


Fig. 8-8 Balance of forces on a single point

Balance of forces on a single point

The forces in Fig. 8-9 will be balanced and stationary if the resultant force F of the forces supplied by the two people (forces F1 and F2) is equal to the weight W of the load.

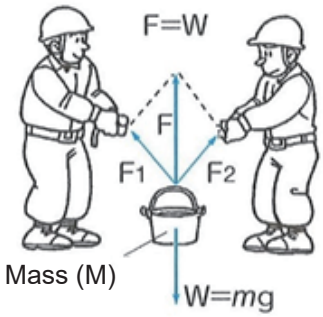


Fig. 8-9 Balance of forces on a single point

Balance of parallel forces

When the force applied to a pole is stationary in Fig. 8-10, the counterclockwise moment (Ma) is equal to clockwise moment (Mb) at the axis of rotation. Equation can be rewritten as:

Ma = Mb

Ma = Wa x a

Mb = Wb x b

Note that the person's shoulder supports the force P (Wa + Wb).

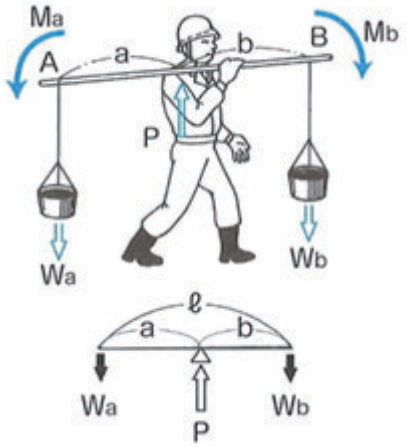


Fig. 8-10 Balance of parallel forces

Balance of forces in forklifts

Balance of stationary force

Let us consider the balance of forces of a loaded, stationary counterbalance forklift on level ground.

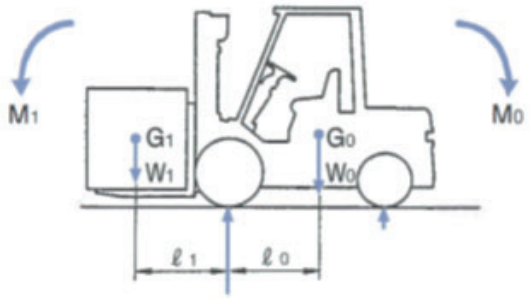


Fig. 8-11 Balance of Forces

If W0 is the vehicle mass, W1 is the load mass, L0 is the distance from the front wheel (fulcrum) to the vehicle's center of gravity, and L1 is the distance from the front wheel to the load's center of gravity, then:

Moment created by vehicle mass (stability moment): M0 = W0 x L0

Moment created by load mass (tipping moment): M1 = W1 x L1

This means that as long as stability moment M0 is larger than tipping moment M1, the total mass (W0 + W1) is supported by the wheels and the vehicle is stable. On the other hand, if tipping moment M1 exceeds stability moment M0, the vehicle will tip forward, lift the rear wheel off the ground, and make it impossible to operate the vehicle.

When a load is placed on the very end of the fork, L1 grows longer, increasing moment M1 on the load side and making the vehicle unstable. Tilting the forklift as shown in Fig. 8-12 moves the load's center of gravity (G1) further inward (G1'). The new L1 value (L'1) is shorter than the old value, thus reducing the tipping moment and stabilizing the vehicle.

Thus, forklifts have rated load center (see Table 1-3) and allowable load (see Fig. 1-5) specifications.

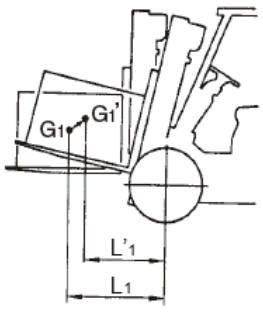


Fig. 8-12 Center of Gravity When Tilted

If a loaded forklift moves forward down a slope, as shown in Fig. 8-13, L'0 becomes shorter than L0 and L'1 becomes longer than L1 due to the heights of the respective centers of gravity in comparison with value on a flat surface. This makes the vehicle susceptible to tipping.

If the forklift goes down the slope in reverse, as shown in Fig. 8-14, L'0 grows longer than L0 while L'1 becomes shorter than L1, thus improving stability.

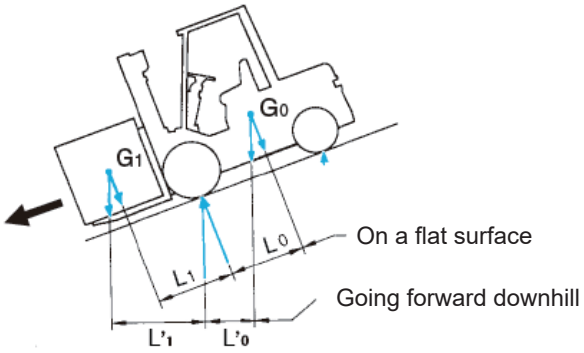


Fig. 8-13 Moving Forward Down a Slope

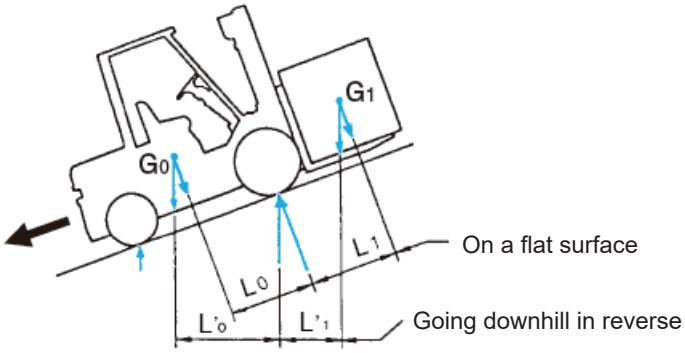


Fig. 8-14 Moving Down a Slope in Reverse

2 Mass and Center of Gravity (p.128)

2.1 Mass

Table 8-1 Density (Mass Per Unit Volume)

Material	Density (t/m³)	Material	Density (t/m³)	Material	Density (t/m³)
Lead	11.4	Concrete	2.3	Oak	0.9
Copper	8.9	Earth	1.8 - 2.0	Pine	0.5
Steel	7.8	Gravel/sand	1.5 - 2.0	Cedar/cypress	0.4
Cast iron	7.2	Coal	0.8	Paulownia	0.3
Aluminum	2.7	Coke	0.5	Water	1.0

2.2 Center of gravity (p.130)

Gravitational force acts on all parts of an object. An object's "center of gravity" is a point where gravity appears to be concentrated.

Position of the center of gravity

The position of the center of gravity (G) in an object with a simple shape is generally near the center of the object. No matter how the object is situated, the position of the center of gravity never changes.

Center of gravity and stability

The "stability" of an object is its ability to resist tipping. Stability is determined by whether the imaginary vertical line extending downward from the object's center of gravity passes through the bottom surface of the object or not.

If the vertical line passes through the middle of the bottom surface, the object is difficult to tip (has "good stability"); if the vertical line passes through the bottom surface near an edge, however, the object is easily tipped (has "bad stability") and will tip if the vertical line no longer passes through the bottom.

This is why an object that is tilted on its side or placed on an incline tips over easily. See Fig. 8-15. An object with a high center of gravity is also easily tipped over, even if the vertical line goes through the bottom of the object (ex.: a long, thin object standing on its end). Objects with large base area have good stability. See Fig. 8-16.

The vertical line from the center of gravity (G) passes through the bottom, making the object stable

The vertical line from the center of gravity (G) does not pass through the bottom, making the object unstable

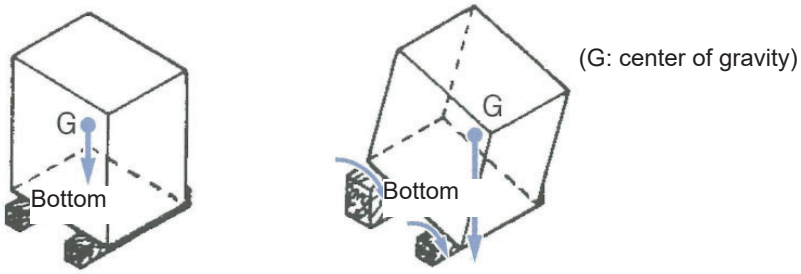


Fig. 8-15 Center of Gravity and Stability

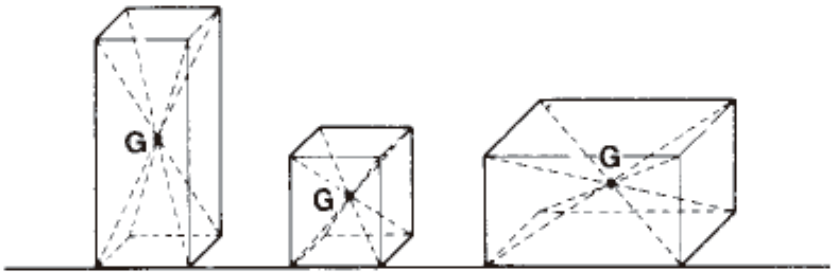


Fig. 8-16 Stability Comparison

The position of the center of gravity in a forklift and corresponding stability

When two objects are put together, the position of the combined center of gravity (G) is on a straight line between the centers of gravity for the two objects (G1 and G2). This is what happens when a forklift carries a load. Consider a loaded forklift. When the position of the combined center of gravity (G) is in front of the front wheels supporting the vehicle, the rear wheels are lifted off the ground, making the forklift more likely to tip over.

On the other hand, the vehicle is stable when the position of the combined center of gravity (G) is behind the front (supporting) wheels.

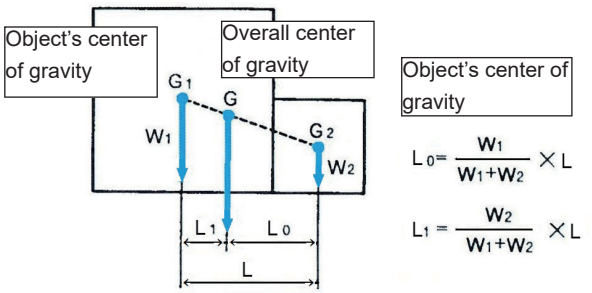


Fig. 8-17 Center of Gravity Position

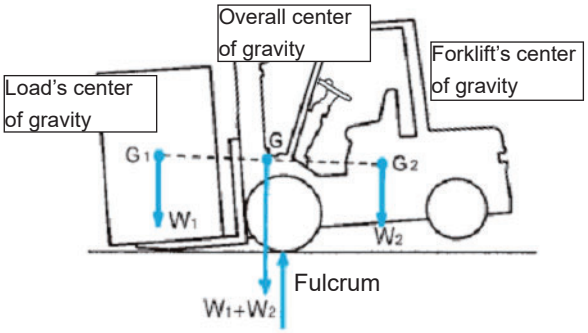


Fig. 8-18 A Center of Gravity that May Lead to Tipping

The higher a forklift lifts a load, the higher the position of the combined center of gravity moves. This reduces overall stability.

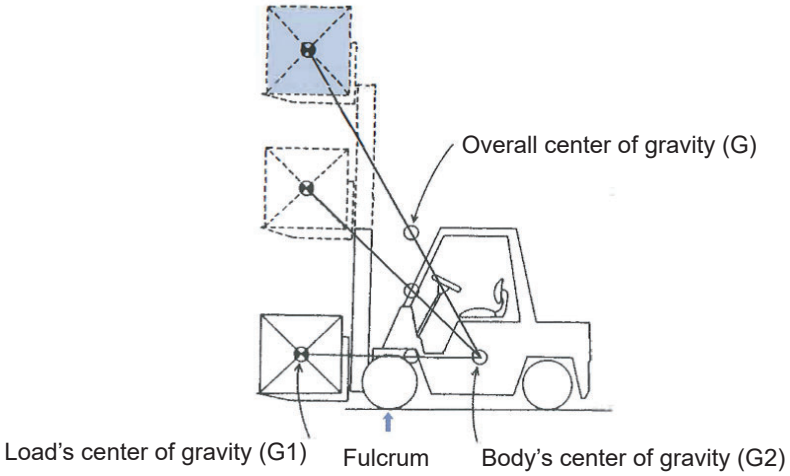


Fig. 8-19 Movement of Overall Center of Gravity

On uneven surfaces, forklifts are prone to tipping over to the side if the position of the combined center of gravity (G) is outside the front wheels to the right or the left.

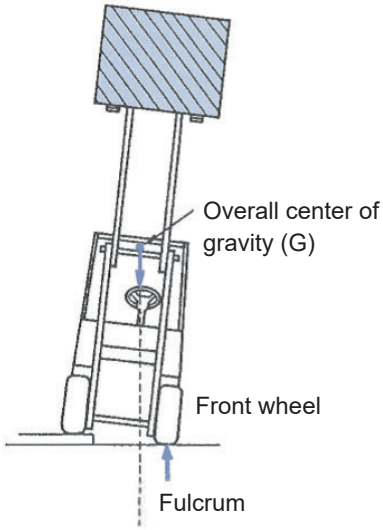
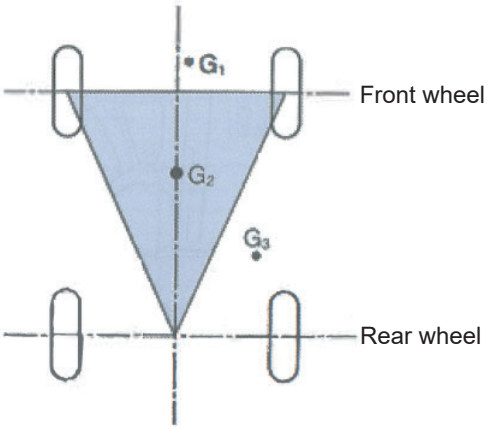


Fig. 8-20 The Dangers of Tipping on Uneven Surfaces

It is thus important to have the load in a low position when moving. When the fork is raised, it is extremely important to operate the forklift carefully to prevent tipping while driving and turning. Driving with one tire on a bump, into a hole, or on flat tires increases the risk of tipping.



Vehicle is stable when COG is at G2, however, it may tip over when COG is at G1 or G3.

Fig. 8-21 COG position of Forklift

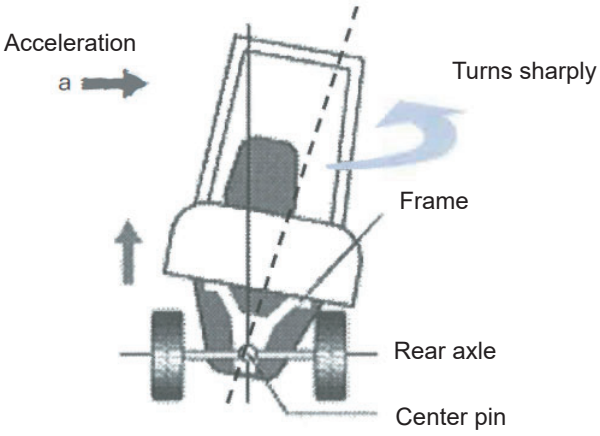


Fig. 8-22 When COG is not balanced

3 Motion (p.133)

3.1 Inertia and inertial force (p.134)

An object not acted upon by an external force has a tendency to remain at rest when stationary or in motion when moving. This is called “inertia.” The force that inertia appears to have on an object is called “inertial force.” Inertial force is proportional to mass and acceleration.

When you apply the emergency brake in a moving, loaded forklift, the load often collapses or jumps forward. This is because “inertia” tries to keep the load in motion as the forklift comes to a stop.

Sudden stops, therefore, are very dangerous.

Fig. 8-23 Forklift Inertial Force

3.2 Centrifugal force and centripetal force (p.134)

If you attach a weight to one end of a string, hold the other end, and swing the weight in a circle, your hand gets pulled toward the weight. Swinging the weight faster increases the pull on your hand. If you let go of the string, the weight flies away in an arc.

This outward force generated when an object is moving in a circular pattern is called “centrifugal force.” “Centripetal force” has the same magnitude as centrifugal force, but instead works inward, toward the hand supporting the weight.

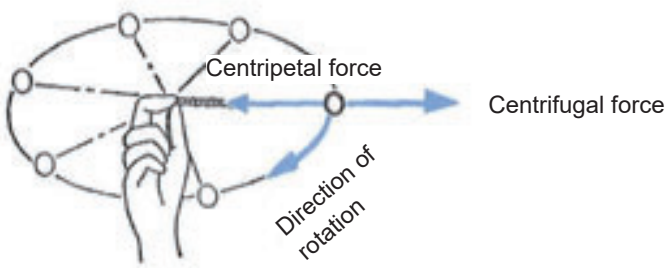


Fig. 8-24 Centrifugal Force and Centripetal Force

(Note):

Circumferential velocity refers to the distance traveled in a circle per unit of time.

When a loaded forklift traveling at a high speed makes an abrupt turn, centrifugal force acts on the vehicle and creates the risk of tipping. This is an extremely dangerous way of driving. It is extremely dangerous to turn a forklift carrying a load that elevates the overall center of gravity (G) to a high position, as doing so moves the line of action of the resultant force of the overall mass and centrifugal force outside the tire (fulcrum) and can thus lead to tipping.

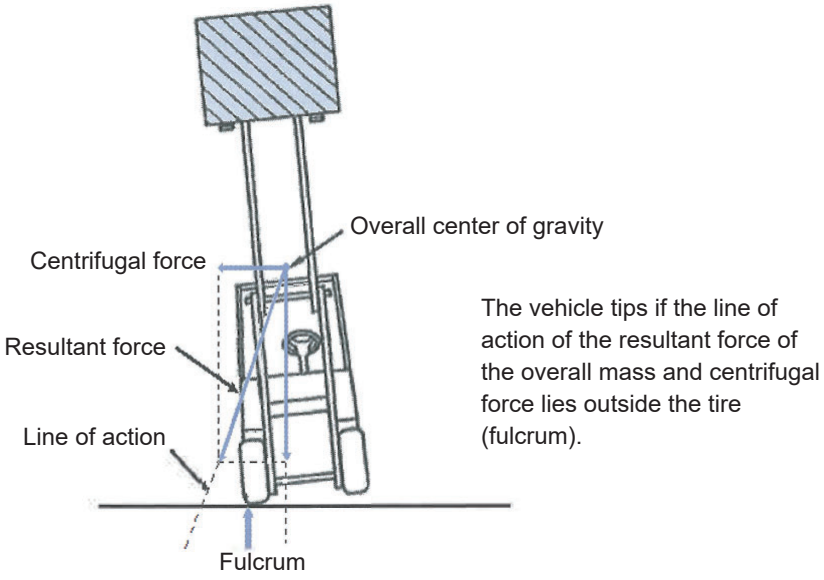


Fig. 8-25 Tipping due to centrifugal force

Chapter 9

Relevant Laws and Regulations

1 Law system regarding forklift (p.143)

As relevant laws required for operation of forklift, many laws and regulations have been established, such as laws including Industrial Safety and Health Law and other governmental and ministerial ordinances based the laws. In this text book, we refer to major laws and regulations out of them.

This law system can be classified as below:

(1) Management system and matters required to be managed when carrying out work using forklift

Management system and matters to be managed when carrying out the work using forklift (major matters required to be managed) are provided as follows and obliges the employer to comply with them.

(1) Work Plan (Article 151-3 of Ordinance on Industrial Safety and Health)
The employer must establish work plan in conformity with place pertaining to the work, type and capability of the forklift to be used, the type and shape of the cargo, and carry out the work according to the work plan.

- The work plan must include traveling route of the forklift and the method of work using the machine.
- The employer must make the established work plan known to the workers concerned.

(2) Operation leader (Article 151-4 of Ordinance on Industrial Safety and Health)
The employer must designate a leader for the work and have the leader direct the work based on the work plan.

(3) Speed Limit (Article 151-5 of Ordinance on Industrial Safety and Health)
The employer must set, in advance, the appropriate speed limit for the forklift corresponding to the landform and conditions of the ground of the place pertaining to the work and carry out the work by the speed limit.

(4) Prevention of Falling, etc. (Article 151-6 of Ordinance on Industrial Safety and Health)
The employer must take the following necessary measures for the traveling route of the forklift to prevent workers from dangers to workers due to overturning or falling of the forklift:

(a) Maintaining the necessary width.

(b) Preventing uneven settling of the ground.

(c) Preventing collapse of shoulders.

In case where the work is carried out at road shoulder or inclined place, and when it is liable to cause dangers to workers due to overturning or falling of the forklift, the employer must arrange a guide and have him/her guide the forklift.

(5) Prevention of Workers being Hit (Article 151-7 of Ordinance on Industrial Safety and Health)
The employer must not allow a worker to enter a place, which is liable to cause dangers to workers to being hit by the forklift or its cargo, except when arranging a guide and having him/her guide the machine.
Operator of the forklift must follow the instruction given by the guide.

(6) Signals (Article 151-8 of Ordinance on Industrial Safety and Health)
When placing a guide for the forklift, the employer set fixed signals and have the guide give signals.
The operator of the forklift must follow the signals given by the guide.

(7) Prohibition of Entry (Article 151-9 of Ordinance on Industrial Safety and Health)
As regards forklift, the employer must not allow a worker to enter the place under the fork, etc. or cargo supported by the forklift, except when repairing or checking works are carried out and when having the worker use a safety prop or safety block, etc.
The worker carrying out repairing or checking works must use safety prop or safety block, etc.

(2) Matters Required to be Managed during Operation of Forklift

Matters required to be managed by employer when carrying out work using forklift are provided as follows and the employer and the operator of the forklift are obliged to comply with them.

(1) Qualification for Operation (Articles 59 and 61 of the Industrial Safety and Health Law and Article 20 of the Enforcement Order of Industrial Safety and Health Act)
The employer must place a person who has finished special education for operation of forklift having a limited capacity of less than 1 ton.
The employer must place a person who has finished the skill training course for operation of forklift having a limited capacity of 1 ton or more.

(2) Loading of Cargo (Article 151-10 of the Ordinance on Industrial Safety and Health)
When loading cargo on the forklift, it must be loaded in a manner to prevent uneven loading.

(3) Measures to be taken in the Case of Leaving the Operating Station (Article 151-11 of the Ordinance on Industrial Safety and Health)
When the operator of a forklift leaves the operating station, the employer must have the operator take the following measures:

- Placing a cargo handling device such as a fork, etc. at the lowest descending position.
- Stopping a prime mover and taking measures of setting a brake securely to keep the forklift in stopped condition in order to prevent the forklift from breaking into run.

The forklift operator must take each of the above measures when leaving the operating station of the forklift.

(4) Transfer of forklift (Article 151-12 of the Ordinance on Industrial Safety and Health)
In the case where the forklift is loaded to a truck or unloaded from the truck using a loading plate or fills by self-propelling or towing for transferring the machine, the following provisions must be complied with in order to prevent dangers due to overturning or falling of the machine:

- Loading at a level and a firm place
- When using a loading plate, using one with a sufficient length, width and strength and fixing it securely with appropriate incline.
- When using fills or temporary stand, securing a sufficient width, strength and appropriate incline.

(5) Restriction on Ride (Article 151-13 of the Ordinance on Industrial Safety and Health)
The employer must not allow a worker to ride on places other than the seat of the forklift, except when having taken measures to prevent workers from dangers due to falling.

(6) Restriction on the Use for Other than Main Purpose (Article 151-14 of the Ordinance on Industrial Safety and Health)
Forklift must not be used for other than its main purpose of lifting a load, raising or lowering a worker, etc., except when it is unlikely to cause danger to workers.

(7) Repair, etc. (Article 151-15 of the Ordinance on Industrial Safety and Health)
When carrying out the work repairing forklift or fitting or removing its attachment, the employer must designate a person to direct the work and have the person carry out the following matters:

- Deciding a work procedure and supervising the work directly.
- Monitoring the use of a safety prop, safety block, etc.

(3) Matters regarding Structure and Functions of Forklift

In order to carry out works using forklift safely, it is necessary for forklift to be equipped with apparatuses required to prevent accidents. In this regard, the following provisions regarding structure and functions of forklift are provided for the employer and the employer must comply with them.

(1) Front and Rear Lamps (Article 151-16 of the Ordinance on Industrial Safety and Health)
The employer must not use any forklift without front and rear lamps, except where necessary illumination for carrying out the work safely is maintained.

(2) Head Guard (Article 151-17 of the Ordinance on Industrial Safety and Health)
The employer must not use any forklift without a head guard of the designated strength, except when it is unlikely to cause dangers to the operator of the forklift due to falling of cargo.

(3) Backrest (Article 151-18 of the Ordinance on Industrial Safety and Health)
The employer must not use any forklift without a backrest, except when it is unlikely to cause dangers to workers due to falling of cargo on the rear of the mast.

(4) Pallet, etc. (Article 151-19 of the Ordinance on Industrial Safety and Health)
Pallet or skid used in the material handling work by forklift must not be used, unless otherwise as prescribed below:

- They have sufficient strength corresponding to the cargo to be loaded.
- They are free from extreme damage, deformation or corrosion.

(5) Restriction of Use (Article 151-20 of the Ordinance on Industrial Safety and Health)
The employer must not use any forklift at conditions exceeding the allowable load (maximum load that can be burdened corresponding to its structure and material and the center of the gravity of the load to be loaded on the fork, etc.) and other capabilities.

(4) Matters regarding Self-inspection, etc. of Forklift

To use forklift safely, it is necessary to carry out checkups and periodical inspections and maintenance, and the matters regarding inspections which the employer must carry out are provided as follows and the employer must comply with them.

(1) Periodical Self-inspections (Articles 151-21 and 151-22)
The employer must carry out self-inspections of forklift for the designated matters once in a period not exceeding one month and once in a period not exceeding one year, except in the non-used period exceeding the above periods.

(2) Specified Self-inspections (Articles 151-24 and 151-21 of the Ordinance on Industrial Safety and Health)
As specified self-inspection, periodical self-inspection must be carried out once in a year.
Specified self-inspections must be carried out by a worker who has a qualification prescribed by the Ordinance of the Ministry of Health, Labor and Welfare.
When the specified self-inspection was carried out, an inspection sticker stating the specified self-inspection date should be affixed at a readily visible location of the forklift.

(3) Record of Periodical Self-inspections (Article 151-23 of the Ordinance on Industrial Safety and Health)
When having carried out self-inspections, the employer must record specified matters and keep the record for three years.

(4) Checkup (Article 151-25 of the Ordinance on Industrial Safety and Health)
The employer must check the following matters before starting the work for the day:

- Function of a braking device and a controlling device
- Function of a cargo handling device and a hydraulic system
- Abnormalities in a wheel
- Functions of front and rear lamps, a direction indicator and a warning device

(5) Repair, etc. (Article 151-26 of the Ordinance on Industrial Safety and Health)
When having found any abnormality in the self-inspection or checkup, the employer must repair the forklift or take necessary measures immediately.

(5) Effective Maintenance of Safety Device and Matters to be Observed by Workers

Safety Devices, etc. provided by laws and ordinances under the laws must be inspected and maintained by the employer in order to be used in an effective condition and matters to be observed by workers are also provided.

(1) Effective Maintenance of Safety Device, etc. (Article 28 of the Ordinance on Industrial Safety and Health)
The employer must carry out the checkup and maintenance for safety device, cover and enclosure, etc. (safety device, etc.) so that they may be used in effective conditions.

(2) Matters to be observed by workers (Article 29 of the Ordinance on Industrial Safety and Health)
Workers must observe the following matters regarding safety device:

- Not to remove the safety device, etc. nor to lose its function.
- When it is necessary to remove the safety device, etc. or to lose its function temporarily, to obtain prior permission by the employer.
- When having removed the safety device, etc. or lost its function by obtaining permission of the employer, to restore to its original condition immediately after the necessity is over.
- When having found that the safety device, etc. has being removed or lost its function, to report the fact immediately to the employer.

I. Knowledge of operations (15 questions)

[Question 1] Which of the following is NOT a correct description of the features of a forklift?

(1) For a forklift with a maximum load of 1 t or more, the maximum lifting height is 10 meters.

(2) Forklifts can be used to efficiently transport multiple cargo items at the same time.

(3) The body of a forklift is compact.

[Question 2] Which of the following is NOT a correct description of the features of a battery-powered forklift?

(1) The battery capacity is limited.

(2) It emits less noise than an engine-powered forklift.

(3) Since the power source is a battery, harmful exhaust gas is emitted.

[Question 3] Which of the following is NOT a correct description of the advantages of diesel engines over gasoline engines?

(1) Fewer breakdowns

(2) Less torque

(3) Lower operating costs

[Question 4] Which of the following is NOT a correct description of the differences between diesel engines and gasoline engines?

(1) Gasoline is used as fuel by gasoline engines.

(2) Diesel engines break down more frequently than gasoline engines.

(3) In diesel engines, the fuel is ignited by the heat of compressed air.

[Question 5] Which type of engine does the following statement describe?
“Air is compressed in the cylinder, causing it to heat up to approximately 600°C. Fuel is then sprayed into the cylinder and ignited by the heat, resulting in combustion.”

(1) Diesel engine
(2) Gasoline engine
(3) LPG engine

[Question 6] Which of the following is NOT a correct description of the precautions for handling batteries?

(1) Take care not to get any battery electrolyte on your hands or clothes.
(2) The amount of electrolyte decreases naturally, so it must be refilled when it is completely depleted.
(3) Keep batteries away from fire.

[Question 7] Which of the following is NOT a correct description of the information related to charging batteries?

(1) Since harmful gas is generated when charging batteries, charging must be performed in a closed room so that the gas does not leak out into the surrounding environment.
(2) Normal charge refers to charging that is performed at the end of each work day.
(3) Equalizing charge refers to charging that equalizes the specific gravities of the electrolyte solutions in the battery.

[Question 8] Which of the following is NOT a correct description of the information related to charging batteries?

(1) Normal charge is a type of charging.
(2) To charge a forklift with a stationary charger, move the forklift to a location with an AC power source.
(3) Auxiliary charge refers to charging that is performed during an idle period such as a lunch break.

[Question 9] Which of the following is NOT a correct description of the abbreviation?

(1) (FB): Hybrid type

(2) (FD): Diesel engine type

(3) (FG): Gasoline engine type

[Question 10] Which of the following is NOT a correct description of the precautions when starting the engine?

(1) Do not use the starter continuously for a long time.

(2) Do not preheat for a long time. Preheat for less than 5 minutes.

(3) Wait for a specific amount of time before restarting.

[Question 11] Which of the following is NOT a correct description of the steering operations or precautions?

(1) Forklifts have front-wheel steering, so the vehicle must be brought outward away from the corner when turning.

(2) When turning a corner, stop and wait for pedestrians or other vehicles attempting to turn.

(3) A power steering vehicle cannot be steered when the engine is stopped.

[Question 12] Which of the following is NOT a correct description of the actions to perform when you temporarily leave the vehicle?

(1) Lower the fork to the ground.

(2) Tilt the mast backward.

(3) Stop the engine, turn the starting switch to the "off" position, and remove the key.

[Question 13] Which one of the choices below correctly replaces the [A] in the following sentence?

“When you temporarily leave the forklift, tilt the mast forward and [A]. Then, stop the engine, turn the starting switch to the "off" position, and remove the key.”

(1) lower the fork to about 20 cm off the ground

(2) raise the fork all the way up

(3) lower the fork so that the end touches the ground

[Question 14] Which of the following is NOT a correct description of the precautions when driving or operating a forklift?

(1) Do not stop the engine while driving or performing work with the forklift.
(2) If the engine stops while the vehicle is on an incline, step hard on the brake pedal and then apply the parking brake.
(3) Since it is dangerous to travel in reverse, travel forward even when transporting a large load that obstructs visibility in front of the forklift.

[Question 15] Which of the following is NOT a correct description of the precautions when operating a reach forklift?

(1) There is no risk of the vehicle tipping over when making a turn at high speed, so increase the speed.
(2) Leaning out of the forklift during operation could lead to an accident such as becoming crushed between the vehicle and another object.
(3) When adjusting a stacked load, turn the key switch to the "off" position before disembarking the vehicle and performing the work.

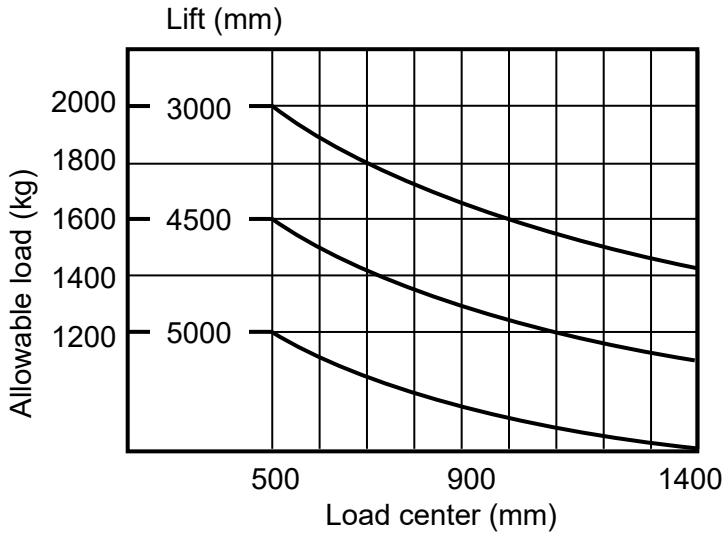
II. Knowledge of loading and unloading (15 questions)

[Question 1] For the forklift represented in the allowable load diagram below (with a rated load of 2 t), what is the allowable load at a load center of 500 mm when the lifting height of the mast is 4,500 mm?

(1) 1,800 kg

(2) 1,200 kg

(3) 1,600 kg



[Question 2] Which one of the choices below correctly replaces the [A] in the following sentence?

“Load center refers to the distance from the [A] of the load that is laid on the fork to the vertical front face of the fork.”

(1) mast

(2) center of gravity

(3) head guard

[Question 3] Which of the following is NOT a correct description of the basic features of a forklift?

(1) Pallets can be used to transport cargo efficiently.

(2) Items can be stacked or removed up to any height within the fork's height range.

(3) A counterweight is attached to the front of the forklift frame to balance the load on the rear.

[Question 4] Which of the following is NOT a correct description of the features of a battery-powered forklift?

(1) They have more maintenance items than engine-powered type forklifts.

(2) They are well-suited for operations in residential areas and at night.

(3) They can be used relatively safely in poorly-ventilated warehouses and ship holds.

[Question 5] Which one of the choices below correctly replaces the [A] in the following sentence?

“The L-shaped arms used for loading and unloading, which are called "forks", must have a static strength safety factor of at least [A].”

(1) 3

(2) 6

(3) 9

[Question 6] Which of the items below does the following sentence describe?

“This hydraulic cylinder is used to tilt the mast (and the fork) forward and backward.”

(1) Lift cylinder

(2) Tilt cylinder

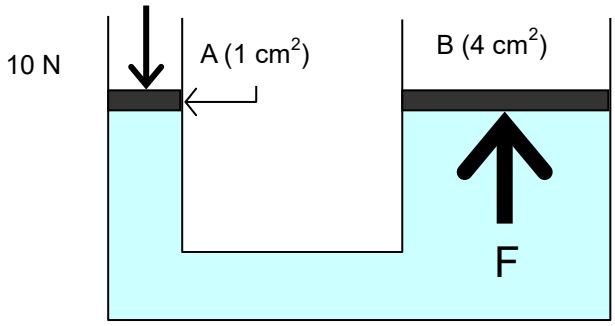
(3) Inner mast

[Question 7] If a force of 10 N is applied to A in the figure below, what is the force F that is transferred to B?

(1) 40 N

(2) 110 N

(3) 90 N



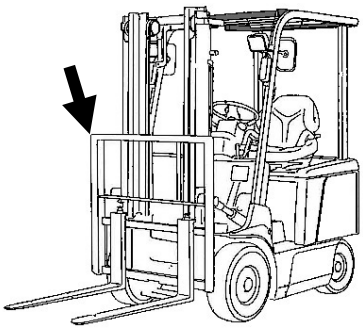
[Question 8] Which of the items below does the following sentence describe?

“This frame prevents the load from dropping toward the mast.”

(1) Lift cylinder

(2) Fork

(3) Backrest



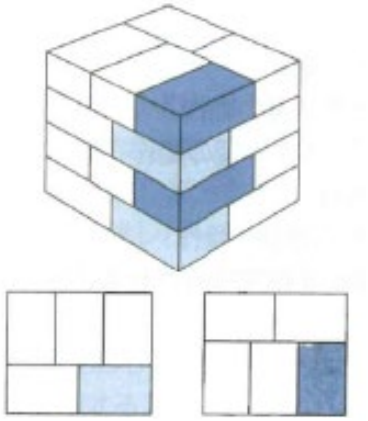
[Question 9] Which of the pallet stacking patterns does the following sentence describe?

“In this stacking pattern, all of the levels have the same arrangement, but each level is rotated by 180 degrees so that the items alternate directions.”

(1) Block stacking

(2) Brick stacking

(3) Pinwheel stacking



[Question 10] Which of the following is NOT the correct definition of a term related to the operation of the loading/unloading device?

(1) Stacking: Inserting the fork into a pallet or similar object

(2) Lifting: Lifting the fork upward

(3) Tilting backward: Tilting the mast backward

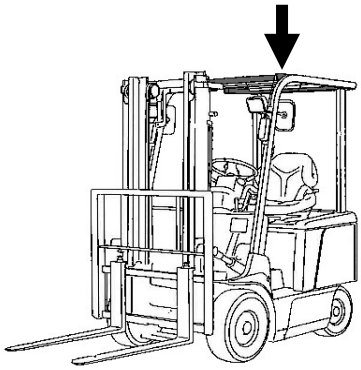
[Question 11] Which of the items below does the following sentence describe?

“This sturdy frame is placed over the operator's seat to protect the driver from a falling load.”

(1) Turn signal

(2) Fork

(3) Head guard



[Question 12] Which of the following is NOT a correct description of the information related to safety?

(1) Observe workplace rules.

(2) Wear the proper safety gear.

(3) If the pre-work inspection or periodical self-inspection has not been performed, operate the forklift carefully.

[Question 13] Which of the following is NOT a correct description of the operational safety information?

(1) When embarking/disembarking the forklift, grab the steering wheel or an operation lever, and quickly jump into or out of the vehicle.

(2) Never drive the vehicle with the fork raised to a high position.

(3) When starting the engine, moving the vehicle, or turning, make sure that the surrounding area (especially the area behind the forklift) is clear.

[Question 14] Which of the following is NOT a correct description of the operational safety information?

(1) Never drive the vehicle with the fork raised.
(2) Since it is dangerous to travel in reverse, travel forward even when transporting a large load that obstructs visibility in front of the forklift.
(3) Use the handrail and steps when embarking and disembarking the vehicle.

[Question 15] Which of the following is NOT a correct description of the safety information for driving and loading/unloading?

(1) Do not allow a worker to enter the space under the fork or under the cargo supported by the forklift.
(2) To ensure stability when the forklift is loaded, drive forward when going uphill, and drive in reverse when going downhill.
(3) If you detect a problem while operating the forklift, report it to your supervisor after your work is completed.

III. Knowledge of mechanics (10 questions)

[Question 1] Which one of the choices below correctly replaces the [A] in the following sentence?

“Every force has a [A], direction, and acting point. These are the three elements of force.”

(1) height

(2) weight

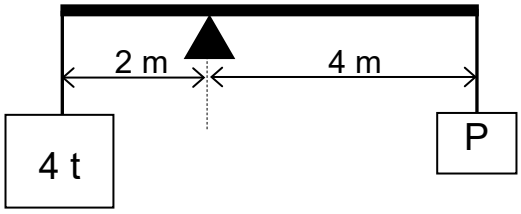
(3) magnitude

[Question 2] Which of the following is the mass P that is necessary to balance the left and right sides of the fulcrum (▲) of the scale shown below? For this problem, do not include the mass of the scale.

(1) 2 t

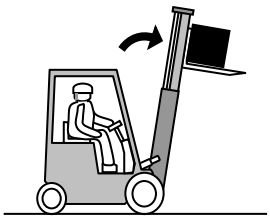
(2) 10 t

(3) 5 t

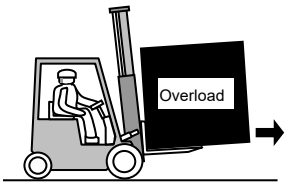


[Question 3] Which of the following actions is acceptable when operating a forklift?

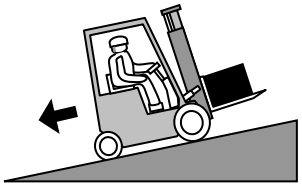
(1) Tilting the load forward while it is in a high position



(2) Traveling with cargo that exceeds the allowable load

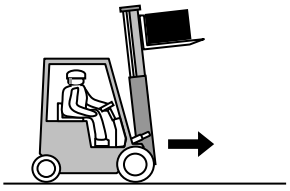


(3) Driving downhill in reverse

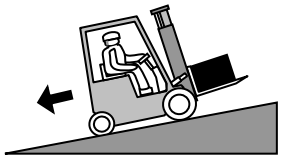


[Question 4] Which of the following actions is acceptable when operating a forklift?

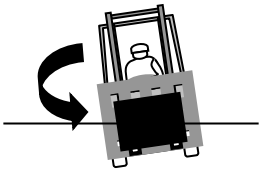
(1) Driving forward with the load in a high position



(2) Driving downhill in reverse



(3) Making a sharp turn



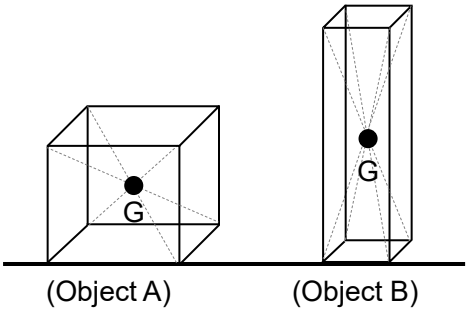
[Question 5] Which one of the choices below correctly replaces the [A] in the following sentence?

“Object A has better stability than object B because it has a larger base area and [A].”

(1) a higher center of gravity (G)

(2) a lower center of gravity (G)

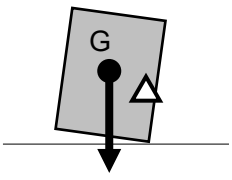
(3) no center of gravity (G)



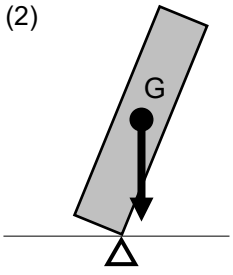
[Question 6] Which of the following illustrations shows an object that will tip to the right side of the fulcrum (Δ)?

* "G" represents the position of the center of gravity.

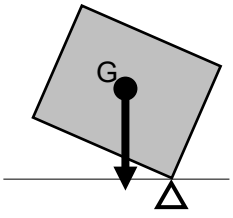
(1)



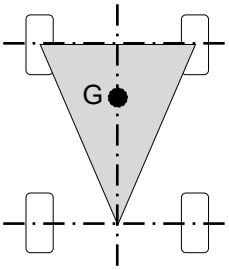
(2)

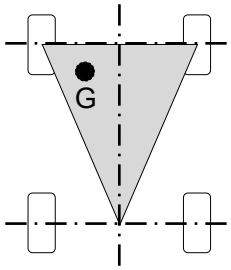


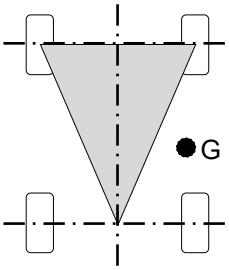
(3)



[Question 7] Point G represents the position of the center of gravity for the forklift and the loaded cargo. Which of the following illustrations shows a forklift that is in danger of tipping over?

(1) 

(2) 

(3) 

[Question 8] Which of the following is NOT a correct description of the information related to the center of gravity and stability of an object?

(1) Objects with a lower center of gravity are more stable.
(2) Objects with a larger base area are more stable.
(3) The position of the center of gravity for a object varies depending on how the object is placed.

[Question 9] Which one of the choices below correctly replaces the [A] in the following sentence?

“If you apply the emergency brake while a loaded forklift is moving, the load may collapse or jump forward. This is because [A] tries to keep the load in motion as the forklift comes to a stop.”

(1) wind pressure
(2) inertia
(3) gravity

[Question 10] Which one of the choices below correctly replaces the [A] in the following sentence?

“If you [A] while a loaded forklift is traveling at a high speed, centrifugal force acts on the vehicle and creates the risk of tipping.”

(1) make a sharp turn
(2) lower the load
(3) make a sudden stop

IV. Relevant laws and regulations (10 questions)

[Question 1] Which of the following is NOT a correct description of the rules that must be observed when using a forklift to perform work?

(1) Designate a leader for the work and have the leader direct the work based on the work plan.
(2) When a guide is used for the forklift, define the signals and have the guide give the signals.
(3) When a worker enters the space under the fork, make sure that an observer is present.

[Question 2] Which of the following is NOT a correct description of the measures that must be taken when the forklift operator leaves the operating station?

(1) Stop the engine and apply the parking brake.
(2) Lift the fork to the highest position.
(3) Take measures to prevent the forklift from rolling away.

[Question 3] Which of the following is NOT a correct description of the measures that must be taken when the forklift operator leaves the operating station?

(1) Leave the engine running.
(2) Move the fork down to the lowest position.
(3) Take measures to prevent the forklift from rolling away.

[Question 4] Which one of the choices below correctly replaces the [A] in the following sentence?

“The forklift must not be used for hoisting a load, [A], or any other purpose other than its main purpose.”

(1) transporting a load
(2) loading/unloading items from a truck
(3) lifting or lowering a worker

[Question 5] Which of the following items is required equipment for forklifts, to ensure that work is performed safely?

(1) Backrest
(2) Airbag
(3) Emergency stop button

[Question 6] Which of the following items is required equipment for forklifts, to ensure that work is performed safely?

(1) Front and rear lamps
(2) Airbag
(3) Emergency stop button

[Question 7] Which of the following is NOT a correct description of pallets?

(1) Pallets must be made of iron to ensure that they have sufficient strength.
(2) Pallets must be free from extreme damage or deformation.
(3) Pallets must be free from extreme corrosion.

[Question 8] Which one of the choices below correctly replaces the [A] in the following sentence?

“After performing periodical self-inspections, the employer must record the specified matters and keep the records for a period of [A].”

(1) 1 month
(2) 3 years
(3) 10 years

[Question 9] Which of the items below is NOT a matter that must be checked before starting the work for the day?

(1) Abnormalities in a wheel
(2) Function of the braking devices
(3) Abnormalities in the seat belt

[Question 10] Which of the following is NOT a correct description of the rules that must be observed by workers regarding safety devices?

(1) Do not remove safety devices without permission.
(2) If a safety device is found to have lost its function, remove the safety device and discard it.
(3) When it is necessary to remove the safety device temporarily, obtain prior permission from the employer.

Answers

I. Knowledge of operations (15 questions)

[Q1] (1), [Q2] (3), [Q3] (2), [Q4] (2), [Q5] (1),
[Q6] (2), [Q7] (1), [Q8] (2), [Q9] (1), [Q10] (2),
[Q11] (1), [Q12] (2), [Q13] (3), [Q14] (3), [Q15] (1)

II. Knowledge of loading and unloading (15 questions)

[Q1] (3), [Q2] (2), [Q3] (3), [Q4] (1), [Q5] (1),
[Q6] (2), [Q7] (1), [Q8] (3), [Q9] (2), [Q10] (1),
[Q11] (3), [Q12] (3), [Q13] (1), [Q14] (2), [Q15] (3)

III. Knowledge of mechanics (10 questions)

[Q1] (3), [Q2] (1), [Q3] (3), [Q4] (2), [Q5] (2),
[Q6] (2), [Q7] (3), [Q8] (3), [Q9] (2), [Q10] (1)

IV. Relevant laws and regulations (10 questions)

[Q1] (3), [Q2] (2), [Q3] (1), [Q4] (3), [Q5] (1),
[Q6] (1), [Q7] (1), [Q8] (2), [Q9] (3), [Q10] (2)