CSEC Physics Handout

ACTION OF FORCE

OBJECTIVES (1.1-1.3)

Candidates should be able to:

1.1 recall that force can cause a change in the size, shape or motion of a body
1.2 identify situations in which gravitational, electric, magnetic or nuclear forces act
1.3 use the relationship: weight = mass x gravitational field strength i.e. W = mg

CONTENT

Forces can result from gravitational, electric, magnetic and nuclear actions. The force of gravity acts between bodies that may be close together or very far apart. For example, a gravitational force exists between a falling stone and the earth. And between distant objects like an artificial satellite and the earth. An electric force exists between charged bodies. This force depends on the distance between the objects and the amount of charge. A magnetic force can also be observed in situations of a wire carrying a current. A nuclear force exists between the protons and neutrons- particles in the atom.

EFFECTS OF FORCE

OBJECTIVE (1.4 – 1.8)

Candidates should be able to:

1.4 identify situations in which a turning effect on a body will result from the application of force
1.5 perform simple experiments to investigate the turning effects of forces on bodies in equilibrium
1.6 define the moment of force
1.7 state the principle of moments and the use it in solving problems on equilibrium
1.8 explain the action of common tools and devices as levers

Consider the following situation depicted in Figures 3.1 and 3.2

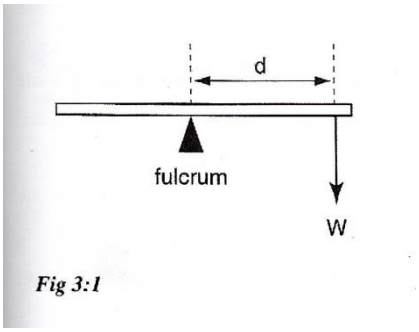

Fig 3:1

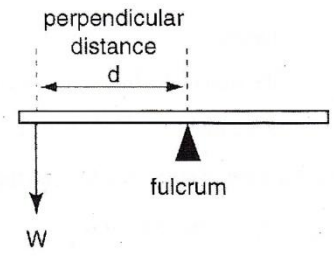

Fig 3.2

In both situations the force is causing the turning effect. In Figure 3.1 the turning effect is in a clockwise direction and in Figure 3.2 it is in an anticlockwise direction. The point about which the turning point takes place is the fulcrum or pivot.

You can calculate the moment of a force. The moment is given by the relationship:

Moment = Force x Perpendicular Distance from fulcrum to line of action of force

Force which produce turning effects in opposite directions can act together to give no motion, that is, a resultant moment of zero. Manipulation of the apparatus shown in Figure 3.3 could be used to demonstrate conditions under which equilibrium can be obtained.

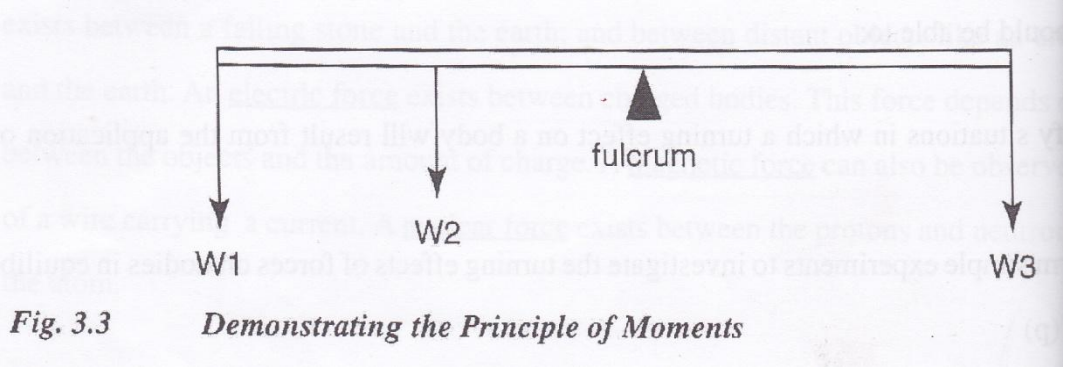

Fig. 3.3 ***Demonstrating the Principle of Moments***

Equilibrium can be explained by the following conditions for equilibrium.

A body is in equilibrium when:

1. The sum of the clockwise moments about the pivot of the forces equals the sum of the anticlockwise moments about the same pivot. This condition is known as the Principle of Moments
2. The sum of the forces on a body in any direction equals the sum of the forces in the opposite direction.

In a situation of static equilibrium there is:

(a) No rotation
(b) No translation

CENTRE OF GRAVITY

OBJECTIVES (1.9-1.10)

Candidates should be able to:

1.9 perform experiments to determine the location of the center of gravity of a body

1.10 Relate the stability of an object to the position of its center of gravity.

CONTENT

In everyday situations, every part of a body experience the earth's pull because gravitational influence cannot be screened. The overall or resultant of such forces acting on a body is commonly called its 'weight". The point where or through which (the line of action of) this overall force acts or passed is defined as the center of gravity of the body concerned. The position of the center of gravity in relation to its top, base, other parts and to the intended supports will largely determine:

(i) Whether or not the body be in equilibrium when we attempt to support it and

(ii) Even if there is equilibrium, whether the equilibrium is stable, unstable or neutral.

Stable equilibrium is said to exist when a body which is displace slightly and released, returns to its original position (often after oscillating a few times).

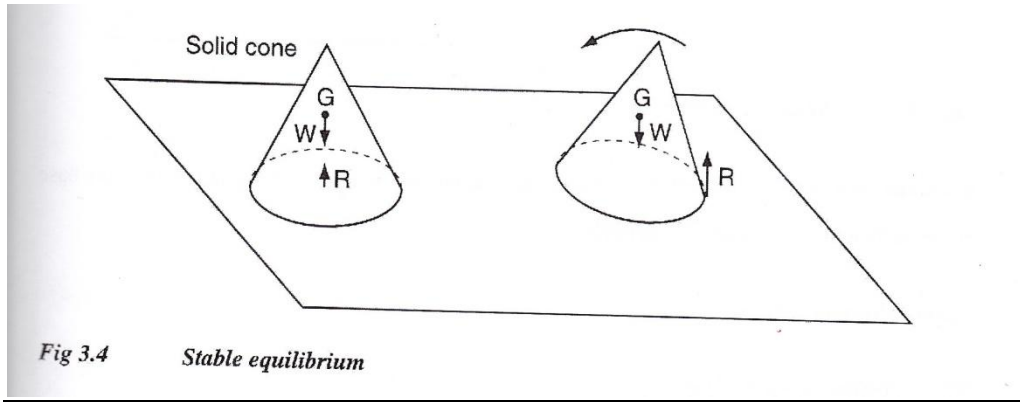

Fig 3.4 *Stable equilibrium*

Unstable equilibrium is said to exist when a body which is displaced and then released moves away from its original position and never returns to it.

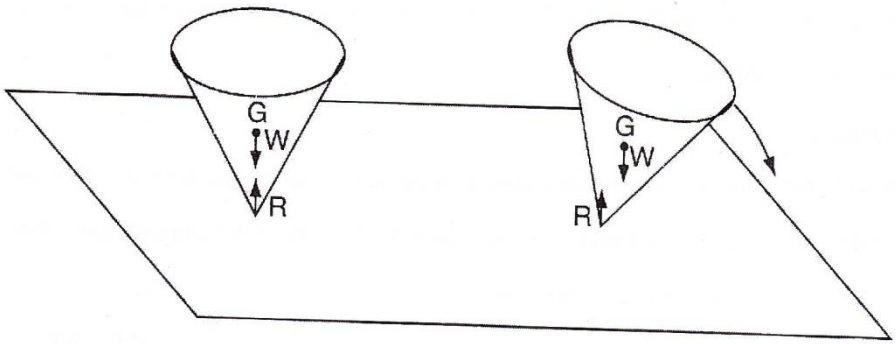

Fig 3.5 ***Unstable Equilibrium***

We say that neutral equilibrium exists when a body which is displaced remains in its new position.

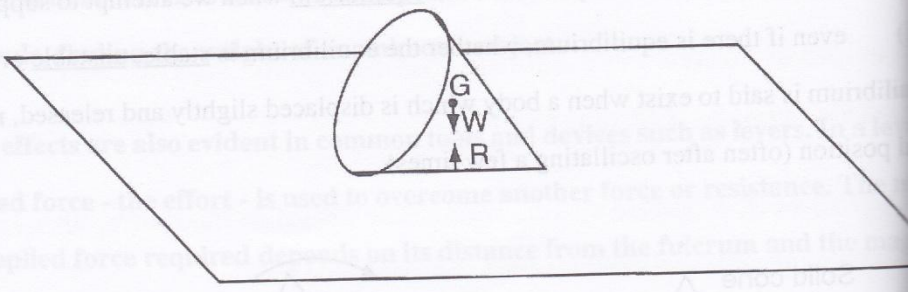

Fig 3.6 ***Neutral Equilibrium***

In a situation of stable equilibrium a vertical line through the center of gravity falls within the base of the body which is in stable equilibrium.

Factors affecting stability:

(a) Position of centre of gravity

A relatively low centre of gravity reduces the possibility of a body toppling over (see Figure 3.4). An example of an application of this principle is in the design of a bus. The centre of gravity of the bus is low since the base of the bus is heavier than the upper parts. This helps in preventing the bus from toppling over when it turns around a corner, or when for some reason it should tilt.

(b) Base Area

A wide base area improves the stability of an object. An example of an application of this concept is in the design and construction of a racing vehicle. A racing car has a low centre of gravity as well as a wide wheel base.

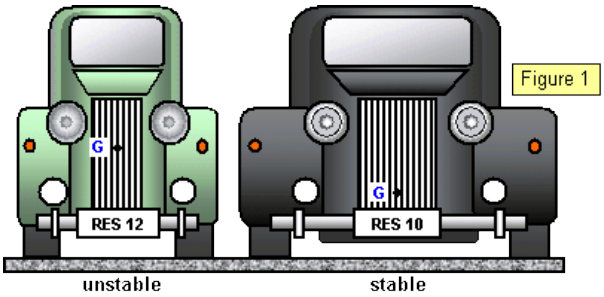

Figure 1

If an object is tilted it will topple over if the vertical line from its centre of gravity falls outside its base.

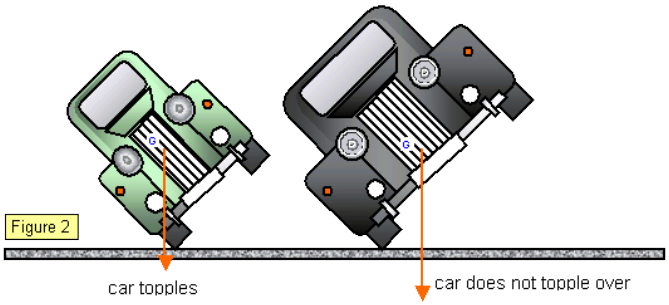

Figure 2

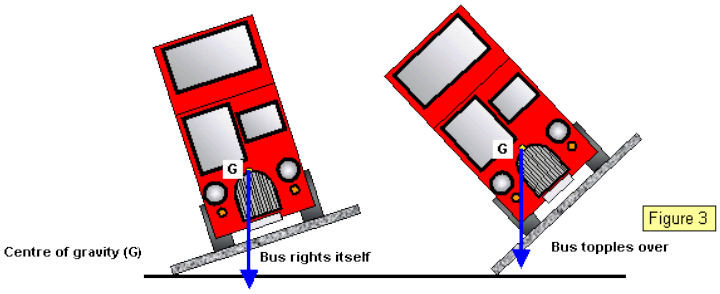

Figure 3