Dynamics Formula Overview

***I. Particles***

**Kinematics**

*One dimensional motion*

|  |  |
| --- | --- |
|  | *(1)* |
|  | *(2)* |
|  | *(3)* |

*Planar motion*

|  |  |
| --- | --- |
|  | *(4)* |
|  | *(5)* |

*Coordinate systems*

|  |  |
| --- | --- |
| Cartesian |  |
|  | *(6)* |
|  | *(7)* |
|  | *(8)* |
| Polar |  |
|  | *(9)* |
|  | *(10)* |
|  | *(11)* |
| Path |  |
|  | *(12)* |
|  | *(13)* |
|  | *(14)* |
|  | *(15)* |
|  | *(16)* |

**Kinetics**

*Newton’s second law*

|  |  |
| --- | --- |
|  | *(17)* |

*Work and energy*

|  |  |
| --- | --- |
| Work |  |
|  | *(18)* |
| Energy |  |
|  | *(19)* |
|  | *(20)* |
|  | *(21)* |
|  | *(22)* |
| Power |  |
|  | *(23)* |

*Impulse-momentum*

|  |  |
| --- | --- |
| Linear impulse-momentum |  |
|  | *(24)* |
|  | *(25)* |
|  | *(26)* |
|  | *(27)* |

|  |  |
| --- | --- |
| Angular impulse-momentum |  |
|  | *(28)* |
|  | *(29)* |
|  | *(30)* |
|  | *(31)* |

|  |  |
| --- | --- |
| One dimensional, central collision |  |
|  | *(32)* |
| Perfect elastic: e=1 Perfect plastic: e=0 | *(33)* |

***II. Systems of particles***

**Kinetics**

|  |  |
| --- | --- |
| General definitions |  |
|  | *(34)* |
|  | *(35)* |

*Equation of motion*

|  |  |
| --- | --- |
|  | *(36)* |

*Work and energy*

|  |  |
| --- | --- |
| Work |  |
| Including both external and internal forces | *(37)* |
| Energy |  |
|  | *(38)* |
|  | *(39)* |
| V includes both external and internet forces | *(40)* |

*Impulse-momentum*

|  |  |
| --- | --- |
| Linear impulse-momentum |  |
|  | *(41)* |
|  | *(42)* |
|  | *(43)* |
|  | *(44)* |

|  |  |
| --- | --- |
| Angular impulse-momentum |  |
|  | *(45)* |
|  | *(46)* |
| Special cases |  |
| About a fixed point O or the center of mass | *(47)* |
|  | *(48)* |

***III. Rigid bodies***

**Kinematics**

*General definitions*

|  |  |
| --- | --- |
|  | *(49)* |
|  | *(50)* |
|  | *(51)* |
|  | *(52)* |
|  | *(53)* |
|  | *(54)* |
|  | *(55)* |
| only valid for planar motion | *(56)* |
|  | *(57)* |
| only valid for planar motion | *(58)* |

**Kinetics***General definitions*

|  |  |
| --- | --- |
|  | *(59)* |
| for a homogeneous rigid body | *(60)* |
|  | *(61)* |
|  | *(62)* |

*Impulse-momentum*

|  |  |
| --- | --- |
| Linear impulse-momentum |  |
|  | *(63)* |
|  | *(64)* |
| Mass-moment of Inertia |  |
| About the center of gravity | *(65)* |
| About point A | *(66)* |
| Special cases |  |
| homogeneous rectangle about center of mass | *(67)* |
| slender bar about center of mass | *(68)* |
| slender bar about its endpoint | *(69)* |
| Homogenenous disk | *(70)* |

|  |  |
| --- | --- |
| Radius of gyration |  |
|  | *(71)* |
| Angular impulse-momentum |  |
|  | *(72)* |
|  | *(73)* |
|  | *(74)* |
|  | *(75)* |
| (scalar!)  h is the perpendicular distance between the line of action of Vg and point A | *(76)* |
|  | *(77)* |
| (scalar!)  d is the perpendicular distance between point A and the center of mass | *(78)* |
| For a point **fixed** to the rigid body | *(79)* |

*Work and energy*

|  |  |
| --- | --- |
| Work |  |
|  | *(80)* |
| Energy |  |
| pure translation of a rigid body | *(81)* |
| pure translation of a homogeneous rigid body | *(82)* |
| Pure rotation of a rigid body about the center of gravity | *(83)* |
| Total kinetic energy | *(84)* |
| Total kinetic energy about instantanious center of rotation | *(85)* |
|  | *(86)* |
|  | *(87)* |
|  | *(88)* |