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WORK-POWER-TIME THEOREM

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Abstract- Work-Energy Theorem used to understand relation between work and energy. In this paper work-power-time theorem derived mathematically which explains relationship between work, power and time. Other than that power-time (PT), work-time (WT) and work-power (WP) equations are derived. It is useful to understand how they are related to each other and what will happen if any of them is constant.

Index Terms- Work, power, work-energy theorem, work-time equation, power-time equation, work- power equation.

1 INTRODUCTION

WHEN force is applied an object then object displace at some distance, the product of force and distance known as work and how quickly that work is done is known as power. Work-Energy theorem states that work done on object is equal to change in its energy but it does not tell about power and time. For example if two persons are lifting load from ground to known height then work done by both people is same and that work is store in the form of potential energy but what about power, how power for both people will vary it does not understand by work energy theorem. Same way same amount of power can generate by using different quantity of fuel but how it also can not explained by that theorem. In this paper work-power-time theorem derived which relates work, power and time. All the derivations are done by consideration that energy loss is zero.

2 DERIVATION OF THE WORK-POWER-TIME THEOREM

Fig.1. Work done on object

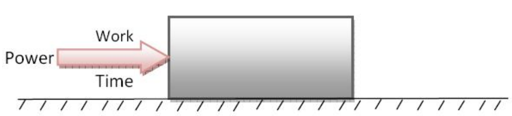
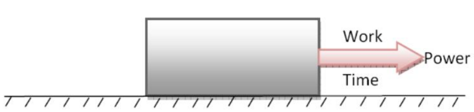


Fig.2. Work done by object



Let as shown in Figure 1 and 2, work is done on object or by object for known time then relation between work, power and time can show as,

$$\text{Power} = \frac{\text{Work}}{\text{time}} \qquad (1)$$

Where,

Work is in joules, Time in seconds and Power is in watt or joules per second.

If power is P, Work is W and Time is t then from equation (1),

$$P = \frac{W}{t} \qquad (2)$$

In above equation we having 3 variables power, work and time. If any of variable is constant then other will directly affected. The effect of all variables individually shown in bellow:

CONDITION 1

If work done is constant then equation (2) can write as;

$$P \propto \frac{1}{t} \qquad (3)$$

Let P_1 power is delivered to or by object for t_1 time and P_2 power is delivered to or by object for t_2 time then equation (3) can write as;

$$\frac{P_1}{P_2} = \frac{t_2}{t_1} \qquad (4)$$

This equation is *power-time (PT) equation.*

CONDITION 2

If rate of energy or work done is constant then from equation (2);

$$W \propto t \qquad (5)$$

Let W_1 work is done on or by object for t_1 time and W_2 work is done on or by object for t_2 time then equation (5) can write as;

$$\frac{W_1}{W_2} = \frac{t_1}{t_2} \qquad (6)$$

This equation is *work-time (WT) equation*.

CONDITION 3

If time or duration of work done is constant then from equation (2);

$$P \propto W \qquad (7)$$

Let P_1 power is delivered to or by object for W_1 work and P_2 power delivered to or by object for W_2 work then equation (7) can write as;

$$\frac{P_1}{P_2} = \frac{W_1}{W_2} \qquad (8)$$

This equation is *work-power (WP) equation.*

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3 RESULTS

From equation (3), (5) and (7) Work-Power-Time theorem composed of 3 theorems as;

Power-Time Theorem

"If work is constant then power delivered to or by object is inversely proportional to time at which work is done."

Work-Time Theorem

"If rate of work done or power is constant then work done on or by object is proportional time."

Work-Power Theorem

"If time or duration of power delivered to or by the object is constant then work is proportional to power."

4 DISCUSSIONS

As per *power-time theorem* when work is constant then power is inversely proportional to time that means value of power will change with respect to time. For example when a known load is lifted to known height then work done is constant whether that load is lifted by adult or by child only different is child will take more time then adult so from power-time theorem adult will more powerful then child. Now if adult is lifting load continuously but power is constant then energy used by object is depends on time as per *work-time theorem*. It can understand by simple example, if 1 KJ of work is done or energy is used in 1 second then in 5 second 5 KJ of energy will use. If duration of work done is constant then work done will depend on power of adult i.e. if power of adult is 1 KW then work done will 1 KJ and if power is 5 KW then work is also 5 KJ as per *work-power theorem.*

4 CONCLUSION

The Work-Power-Time Theorem derived successfully which composed of 3 theorems by using this theorems we can explains behavior of system or object in different condition like constant power, constant time and constant work.

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