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Motion transformation systems

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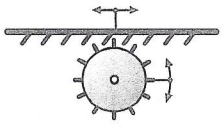
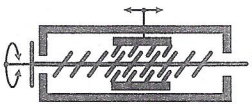
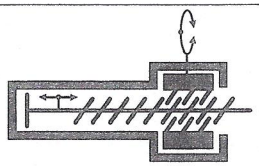
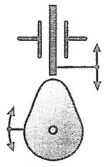
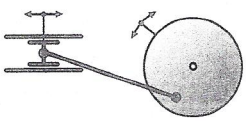
CONCEPT REVIEW 59
Complete this concept review handout and keep it as a record of what you have learned.

Definition

- Motion transformation is *the mechanical function of relaying a motion from one part to another while altering the nature of the motion.*

Characteristics of motion in the most common motion transformation systems

System		Possible transformations	Reversibility
Rack and pinion system		*Rotation → Translation or Translation → Rotation*	*Yes*
Screw gear system, type I		*Rotation → Translation*	*No*
Screw gear system, type II		*Rotation → Translation*	*No*
Cam and follower system		*Rotation → Translation*	*No*
Slider-crank mechanism		*Rotation → Translation or Translation → Rotation*	*Yes*

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Elements to consider when building motion transformation systems

System	Elements to consider
Screw gear system, type I Screw gear system, type II	1. In type I, the nut must be connected to the screw in such a way that the nut cannot rotate. 2. In both system types, the threads of the screws and nuts must match. 3. In type II, the nut must be fixed in such a way that its only possible motion is rotational.
Rack and pinion system	1. The teeth on the rack and on the pinion must be identical. 2. The system requires frequent lubrication. 3. The greater the number of teeth on the pinion, the slower its rotation.
Cam and follower system	1. The follower must be guided in its translational motion. 2. The shape of the cam determines how the follower will move. 3. A device (return spring) is usually necessary to keep the follower in continual contact with the cam.
Slider-crank mechanism	1. The connecting rod contains two bushings to attach it to the crank and piston. 2. A slider must guide the part moving in translation. 3. The system requires frequent lubrication.

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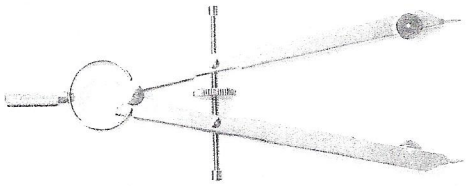
INTEGRATION QUESTIONS

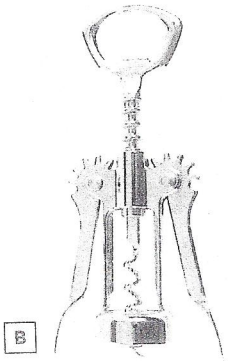
Motion transformation systems

1. Identify the motion transformation systems illustrated.



A

Screw gear system, type I.



B

Rack and pinion system.

2. True or false?

a) Only screw gear systems are not reversible. *False.*

b) In the first type of screw gear system, the screw is the driver. *True.*

c) Slider-crank mechanisms create a back-and-forth motion. *True.*

d) A pinion is a toothed gear. *True.*

e) Cam and follower systems sometimes use eccentrics. *True.*

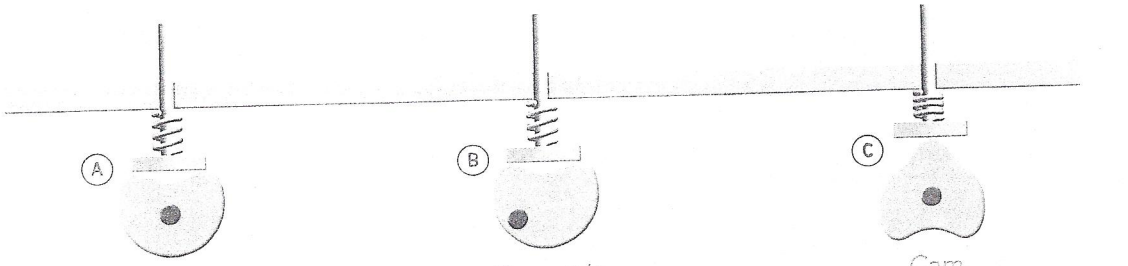
3. You want to build a system that will transform rotational motion into translational motion. You do not need the system to be reversible, but you do not want to have to lubricate it and the motion created must not be back-and-forth. Which system is best?

A screw gear system.

4. Proud of your first creation, you start building a second system that will be part of a motor. This system will be reversible and perform rapid motions. Which system is it?

A slider-crank mechanism.

5. a) Identify the cams and eccentrics.



Cam. *Eccentric.* *Cam.*

b) In which of these systems will the rod rise the highest? *B*

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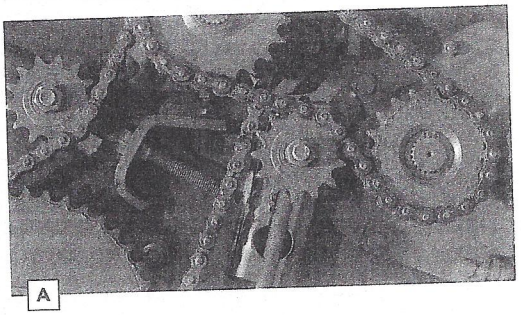
ADDITIONAL QUESTIONS

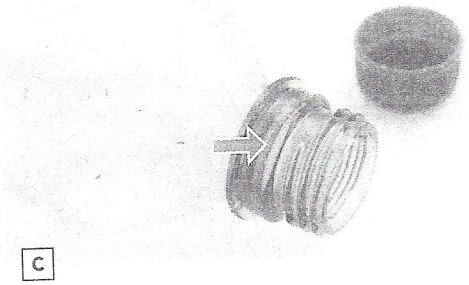
• Linking in technical objects • Guiding control • Motion transmission systems • Speed changes in motion transmission systems • Motion transformation systems

1. What functions are performed by the following components or systems?



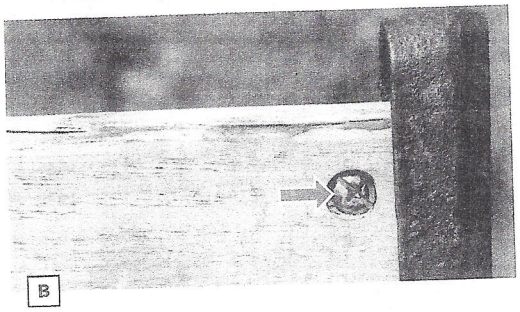
A

Transmission function.



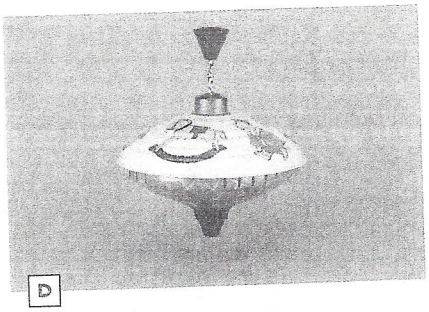
C

Guiding function.



B

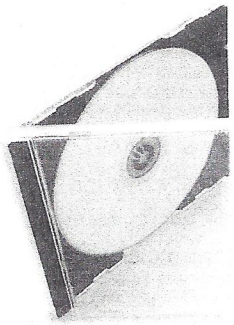
Linking function.



D

Transformation function.

2. Study the compact disk box opposite.



a) What are the characteristics of the links between the box and its lid?

- *Direct.*
- *Rigid.*
- *Non-removable.*
- *Complete.*

b) What type of guiding is used in this object?

Rotational guiding.

c) How many degrees of freedom does the lid have?

1 degree of freedom.

3. Name two types of motion transmission systems that do not include an intermediate component.

Gear trains. Worm and worm gear systems. Friction gear systems.

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4. What is the difference between motion transmission and motion transformation?

With transmission, motion is relayed from one part to another without altering the nature of the motion. With transformation, motion is relayed from one part to another while altering the nature of the motion.

5. Why is it a good idea to put oil in a motor?

To reduce friction and hence wear on engine parts.

6. In winter, cities often spread sand on the roads. Give the reason.

Because sand increases the adhesion of tires to the road when the road is slippery.

7. In a chain and sprocket system, one of the sprockets has 48 teeth. How many teeth must the second gear have if you want it to turn eight times faster? Show your calculations.

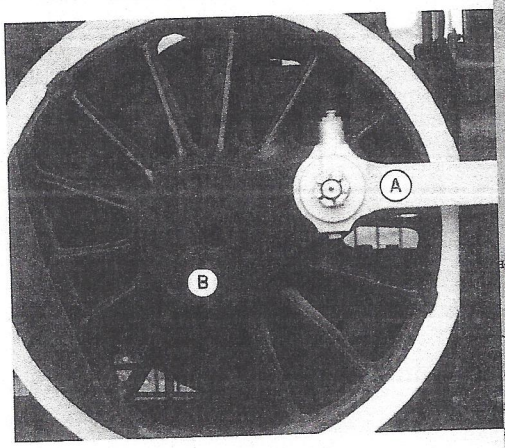
$$\frac{48 \text{ teeth}}{x \text{ teeth}} = 8 \qquad \frac{48}{8} = 6 \text{ teeth}$$

The second sprocket must have six teeth.

8. Which systems are used to transmit motion between distant parts?

Chain and sprocket systems and belt and pulley systems.

9. Here is a system present on a train.



a) What is the name of Component A?

Connecting rod.

b) What is the name of Component B?

Crank.

c) Is this a motion transmission system or a motion transformation system?

A motion transformation system.

10. What types of system require lubrication to run smoothly?

Chain and sprocket systems, rack and pinion systems and slider-crank mechanisms.

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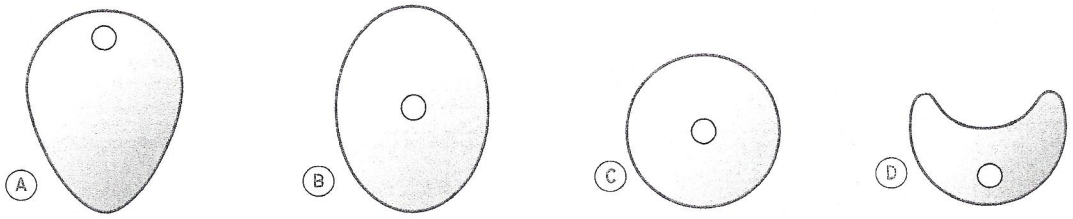
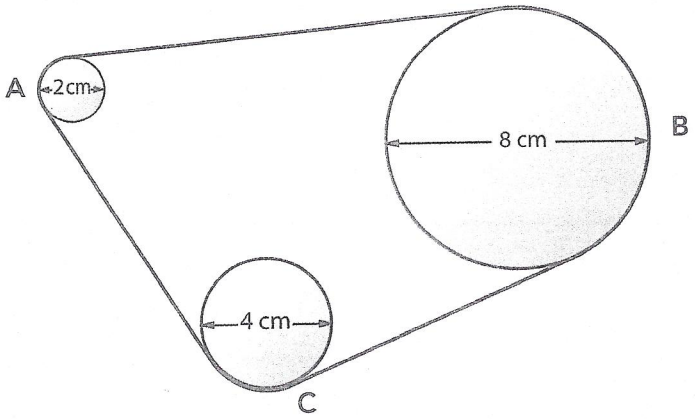
11. Which of these components are eccentrics? *A and D.*



12. Name a system that requires a sliding block. Why?

Answers will vary. Examples. Slider-crank mechanisms require a sliding block to guide the part moving in translation. Cam and follower systems as well.

13. Calculate the speed ratio of Gear A to Gear B, and Gear B to Gear C.



Speed ratio $= \frac{A}{B} = \frac{2}{8} = \frac{1}{4}$ *Gear A turns four times faster than Gear B.*

Speed ratio $= \frac{B}{C} = \frac{8}{4} = 2$ *Gear C turns twice as fast as Gear B.*

14. In the photo opposite, draw the three axes that define dimensions and indicate the independent motion that can be performed by the cover.