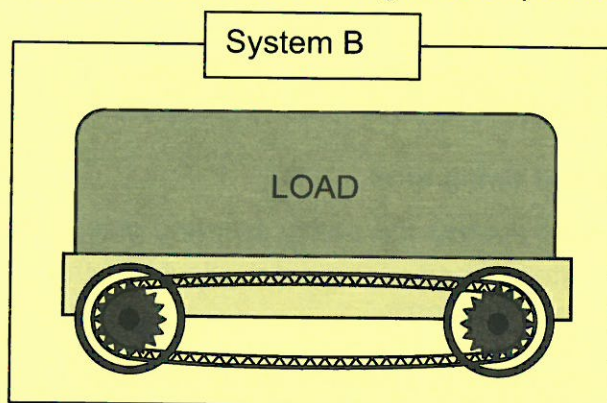
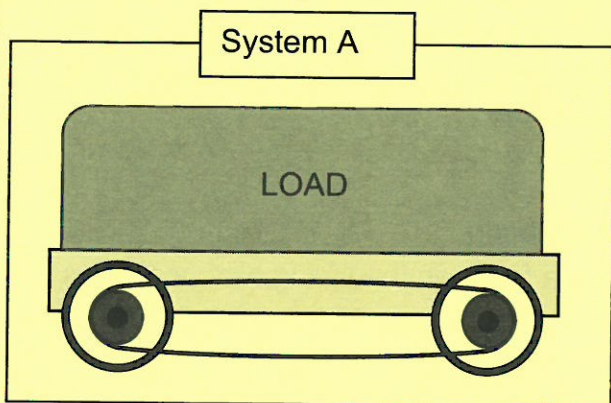


20. In a competition, two teams must manufacture a vehicle that can carry a load over a certain distance. The team whose vehicle moves the largest load the fastest over a distance of 5 m will win the competition.

Given that both vehicles operate with the same motor, which one of the two motion transmission systems shown below will be more effective for winning the competition?



Check off the appropriate box to indicate the system that would be more effective for winning the competition.

System A

System B

Indicate the correct name of the system you have chosen:

*Chain and sprocket system (system B) OR
Belt and pulley system (system A)*

Example of an Appropriate Explanation:

*Because this system prevents **slippage**.*

Indicate a disadvantage of the system you have chosen.

Examples of Disadvantages That Are Considered Appropriate Answers:

*Chain and sprocket system: Requires lubrication
More expensive
Noisier*

Belt and pulley system: The belt may slip.

Note: Give no marks for the system chosen, since this part of the answer is used only to guide the scorer in grading the rest of the student's work for this question.

Correct name	1	0
Appropriate explanation There is no appropriate explanation for system A	2	0
Disadvantage considered an appropriate answer and related to the system chosen by the student	1	0

Answer Key for Part C (Technological Analysis Questions)

21. Explain how the ball launcher operates by describing how each listed set of parts works together.

Ball, push-button switch **and** motor:

*The ball rolls over the push-button switch, which allows the current to flow through the electrical circuit and start the motor. **OR** Once the weight of the ball pushes down on the switch, the electrical circuit closes and the motor starts up.*

Pin **and** swing arm:

The pin pushes the swing arm and gives it rotational motion.

(An integral part of the notched wheel, the pin exerts a force on the swing arm and gives it rotational motion.)

Swing arm **and** spring [complete motion]:

*The rotational motion of the swing arm stretches the spring. When the swing arm completes a half rotation, the spring is stretched out and brings the swing arm around. **OR** The spring is stretched out by the rotational motion of the swing arm. The swing arm comes around as the spring returns to its original shape. **OR** As it rotates, the swing arm stretches the spring. As the spring returns to its original shape, it brings the swing arm back to its initial position.*

(The rotational motion of the swing arm, which is pushed by the pin, stretches the spring. Halfway through the complete motion, the spring returns to its initial position, pulling the swing arm around so that it hits the ball out of the launcher.)

Notched wheel, microswitch **and** motor:

*When the notch on the wheel reaches the microswitch, the electrical circuit opens and the motor stops. **OR** The notched wheel keeps the microswitch closed up to the notch. In this way, the motor (the motor shaft) makes the wheel complete one revolution. When the notch reaches the microswitch, it opens and the motor stops.*

(The microswitch is equipped with a lever. When the lever comes out of the notch, the circuit is closed and the motor starts up. When the microswitch's lever goes back into the notch on the wheel, which acts as a position sensor, the electrical circuit opens and the motor stops.)

- Note: – The parenthetical information indicated above in grey type is not regarded as an essential part of the expected answer at this point, but is regarded as the type of answer that students will eventually be required to give.
- If students do not mention that the electrical circuit closes when referring to the push-button switch or that the circuit opens when the microswitch opens (once the notched wheel has completed one rotation), they should not be penalized twice.

MARKING SCALE

4 marks	4 appropriate explanations
3 marks	3 appropriate explanations
2 marks	2 appropriate explanations
1 mark	1 appropriate explanation
0 marks	No appropriate explanations

22. a) Name three (3) components connected to the base with a link that is:
direct, rigid, removable and complete.

Component		Components
Base	and	<i>Starting ramp (item 20)</i> OR <i>Push-button switch (item 15)</i> OR <i>Launching ramp (item 6)</i> OR <i>Battery (item 14)</i>

b) Name two (2) components assembled with a link that is:
indirect, rigid, removable and partial.

Component	and	Component
<i>Swing arm (item 7)</i>	and	<i>Motor shaft (item 22)</i> OR <i>Spring (item 8)</i>

- Note: – The components can be indicated in any order.
– Do not penalize students who identify the components by their item number only.

Give 1 mark for each correctly identified component	3	2	1	0
Correctly identifies two components			1	0

23. The ball launcher has several guiding controls, including those for the ball.

a) Complete the following table by indicating the missing component and the type of guiding involved.

Guided Component	Components Acting as the Guiding Control	Type of Guiding Involved
Ball	<i>Receptacle (item 18)</i>	<i>Translational</i>
	Starting ramp	
	Push-button switch	
	Swing arm	
	Launching ramp	

Suggested vocabulary

Compression – Deflection – Ductility – Elasticity – Hardness – Malleability – Resilience – Shearing – Tension – Torsion

b) What mechanical constraint is the ball launcher's spring subjected to when it is used?

Mechanical Constraint	<i>Tension</i>
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c) What mechanical property must the metal have so it can be used to make a steel spring?

Mechanical Property	<i>Ductility</i>
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Note: Do not penalize students who identify the component by its item number only.

CORRECTION

4 marks 4 correct answers
 3 marks 3 correct answers
 2 marks 2 correct answers
 1 mark 1 correct answer
 0 marks No correct answers

24. a) In the list below, check off five (5) components that had to be taken into account in determining the **length** of the swing arm.

Components That Determine the Length of the Swing Arm	
X	Ball
X	Base
X	Guard
X	Launching ramp
	Microswitch
X	Motor shaft
	Notch
	Notched wheel
	Receptacle
	Spring
X	Starting ramp
	Support

b) Explain what would happen if the swing arm were longer or shorter than it is now.

Example of an Answer

A **longer** swing arm *could hit the components as it rotates or get stuck on another part.*

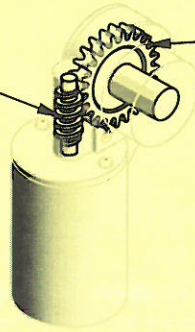
A **shorter** swing arm *may rotate without hitting any of the components, but may not be able to make sufficient contact with the ball to hit it out of the launcher.*

5 components correctly identified Deduct 1 mark for each component omitted or incorrectly identified.	2	1	0
Appropriate explanations Give 1 mark for the explanation regarding the longer swing arm. Give 1 mark for the explanation regarding the shorter swing arm.	2	1	0

25. The diagram below shows the inside of the ball launcher's motor.

a) Check off the appropriate box to identify the driver component and the driven component.

Worm	
<input checked="" type="checkbox"/>	Driver component
<input type="checkbox"/>	Driven component



Worm gear	
<input type="checkbox"/>	Driver component
<input checked="" type="checkbox"/>	Driven component

b) Is this a motion transmission or motion transformation system?
Check off the appropriate box.

<input checked="" type="checkbox"/> Motion transmission system	<input type="checkbox"/> Motion transformation system
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c) Which one of the following changes would allow the swing arm to rotate faster?
Explain why.

Changes	
1	Decreasing the length and diameter of the worm
2	Increasing the diameter and length of the motor shaft
3	Decreasing the diameter of the worm gear and the number of teeth it has

Explanation:

Change **3** would allow the swing arm to rotate faster because . . .

with each complete rotation of the worm, the worm gear moves one tooth forward. This means that if the worm gear had fewer teeth and a smaller diameter, it would rotate faster.

(The rotational speed of the motor shaft must be increased for the swing arm to rotate faster. The rotational speed of the motor shaft is determined by the worm/worm gear ratio. The number of teeth on the worm gear and its diameter can be decreased to increase the speed of a worm and worm gear mechanism. With each complete rotation of the worm, the worm gear moves a distance of one tooth forward.)

Note: The parenthetical information indicated above in grey type is not regarded as an essential part of the expected answer, but rather as clarifications or additional information.

Driver component and driven component correctly identified	1	0
Type of system correctly identified	1	0
Change correctly identified	1	0
Appropriate explanation	1	0