Exam simulation

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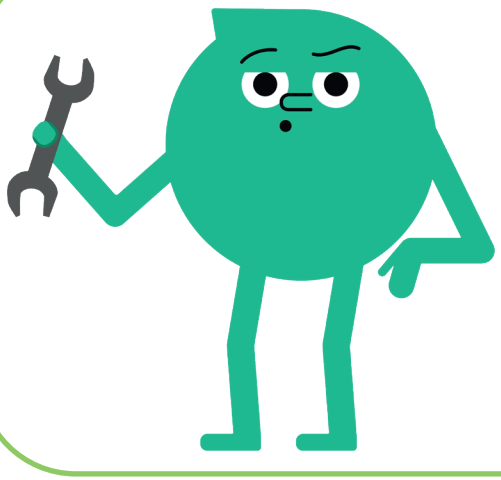
APPLIED SCIENCE AND TECHNOLOGY (AST)
Part B

Constructed-Response Questions



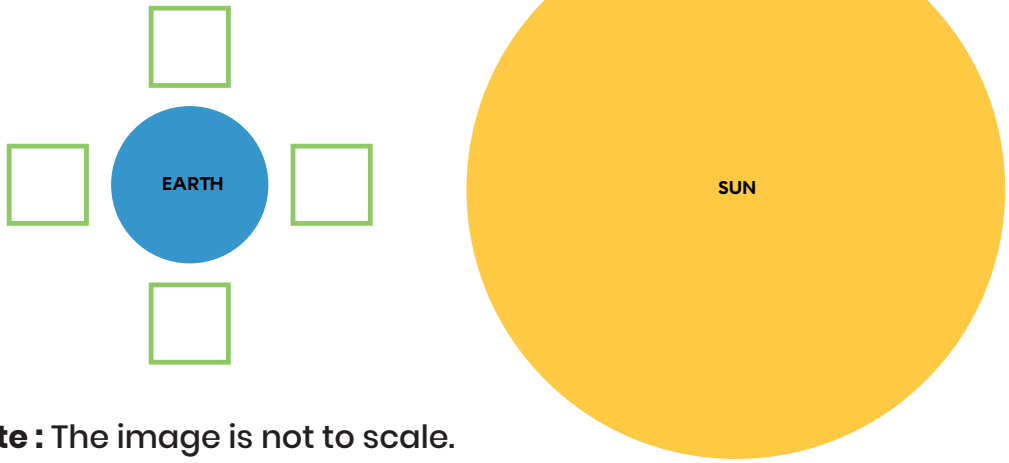
INSTRUCTIONS

Answer questions 1 to 4, showing all your work for each question.
Each question is worth 4 points.
Refer to the list of formulas and quantities on page 6.
Check your answers against the answer key on page 7.

Question 1

Tidal energy is mainly used to generate electricity using tidal power plants.

a) The following diagram is intended to show the alignment of the Earth, Moon, and Sun during a spring tide. Complete the diagram by drawing the Moon in its two possible positions during spring tides.



Note : The image is not to scale.

b) Name one advantage and one disadvantage of using tidal energy to generate electricity.

Advantage

_____

_____

Disadvantage

_____

_____

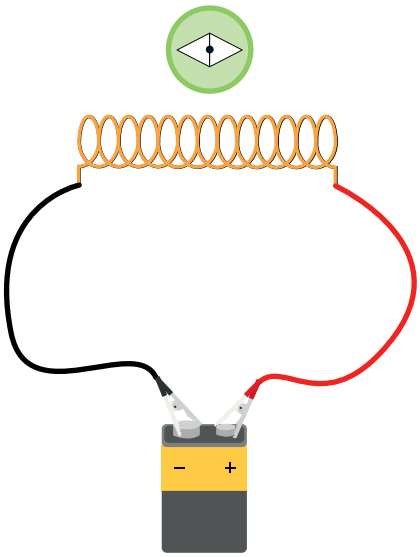
a)	Position of the Moon on the diagram	2	1	0
b)	Advantage	1	0	
	Disadvantage	1	0	

Question 2

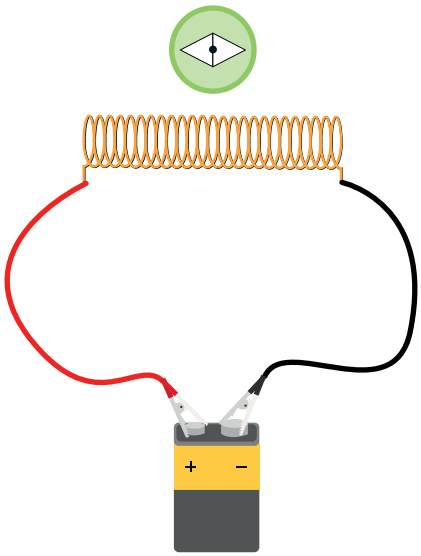
Examine the following circuits. In these circuits:

- The solenoids are made of the same metal.
- The energy source has a voltage of 3 V.

Circuit 1 – Solenoid with 13 Turns



Circuit 2 – Solenoid with 25 Turns



a) Put a checkmark next to the statement that's true, then explain your answer.

☐ The intensity of the magnetic field is higher in circuit 1.
☐ The intensity of the magnetic field is higher in circuit 2.

Explanation

_____

_____

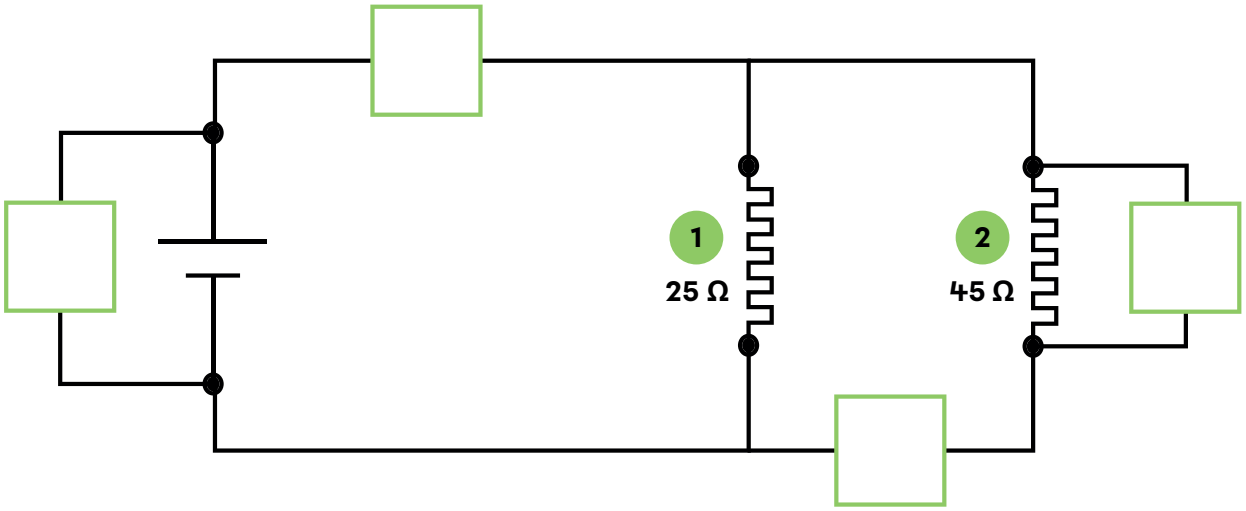
b) In circuits 1 and 2, shade in the north pole of the compasses.

a)	Correct answer	1	0
	Explanation	1	0
b)	Circuit 1: Correct answer	1	0
	Circuit 2: Correct answer	1	0

Question 3

a) In the following circuit diagram, add:

- A voltmeter to measure the potential difference across the terminals of heating element 2
- An ammeter to measure the intensity of the current flowing through the source



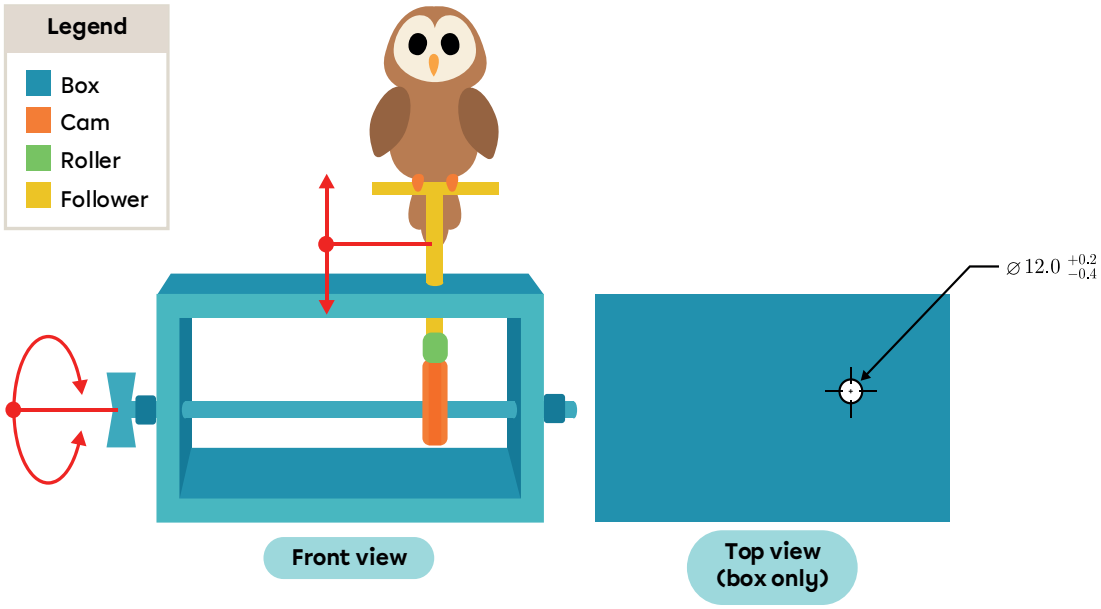
b) If the voltmeter you added in a) measures a potential difference of 1.50 V, what is the electric current intensity flowing through heating element 2?

The electric current intensity flowing through heating element 2 is _____

a)	Voltmeter	1	0
	Ammeter	1	0
b)	Appropriate method and correct answer	2	
	Method with at least one appropriate step	1	
	Inappropriate or no method	0	

Question 4

The following toy allows the owl to move up and down in a bidirectional translational motion. The top of the box has a round hole through which the follower passes.
A mechanical clearance of between 0.1 mm and 0.2 mm is required to insert the follower into the hole and ensure that the follower moves seamlessly.



a) What are the minimum and maximum dimensions of the hole diameter?

Minimum: _____ Maximum: _____

b) Put a checkmark next to the answer that describes the sliding of the follower when the components have the following dimensions. Explain your answer.

Hole diameter: 11.7 mm **Follower diameter:** 11.4 mm

☐ Will always work	☐ May not always work	☐ Will never work

Explanation

_____

_____

a)	Minimum and maximum dimensions	2	1	0
b)	Functioning	1	0	
	Explanation	1	0	

List of Formulas and Quantities

Formulas

$V = RI$

V: potential difference
R: resistance
I: electric current intensity

$F_g = mg$

F_g: gravitational force
m: mass
g: intensity of the gravitational field

$P = VI$

P: electrical power
V: potential difference
I: electric current intensity

$E = P\Delta t$

E: energy consumed
P: electrical power
Δt: time difference

$v = \frac{d}{\Delta t}$ v: speed d: distance Δt: time difference

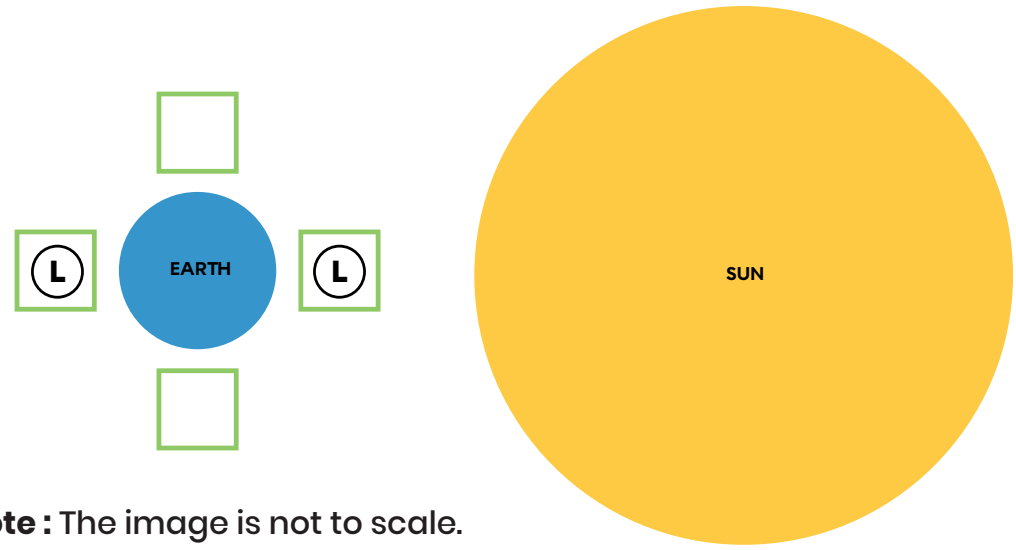
$$\text{Energy efficiency } (\%) = \frac{\text{Amount of useful energy}}{\text{Amount of energy consumed}} \times 100$$

Quantities

Name	Symbol	Value
Intensity of the gravitational field on Earth	g	9.8 N/kg
Kilowatt hour	kWh	1 kWh = 3 600 000 J

Answer Key

Question 1



Note : The image is not to scale.

b) Here are a few of the possible answers.

Advantages:

- It is a renewable energy resource.
- Its use emits very little greenhouse gas.
- Its use is predictable over time and does not depend on weather conditions.

Disadvantages:

- Tidal power plants disrupt coastal ecosystems.
- Installing and maintaining a tidal power plant involves geographical and financial constraints.
- Current technologies have relatively low energy efficiency.

To review these concepts, check out the following concept sheets!	
Tides	Energy Resources

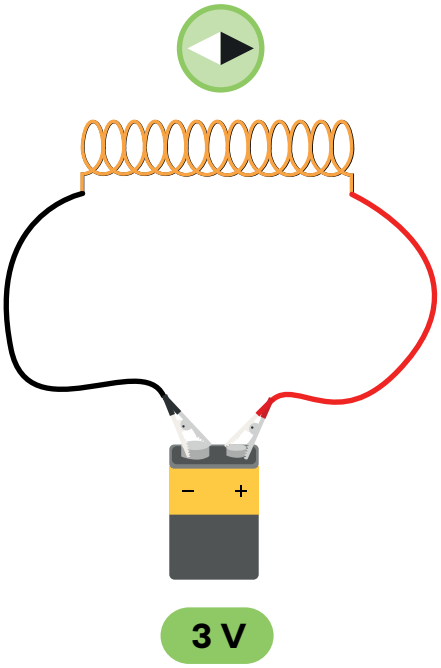
Answer Key

Question 2

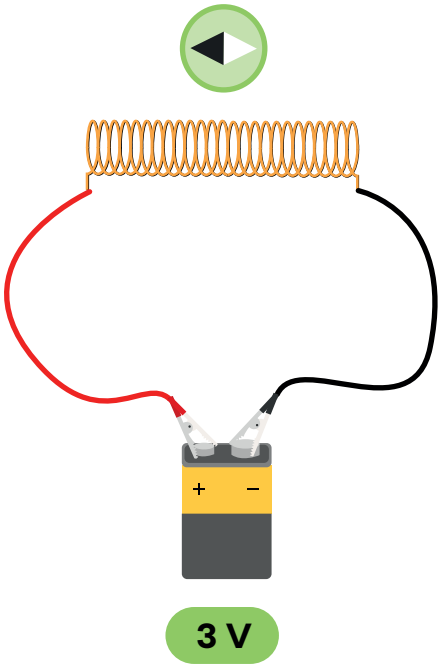
a) ✓ The intensity of the magnetic field is higher in circuit 2.
Explanation: The intensity of the magnetic field is higher in circuit 2 because the solenoid has more turns.
(Other formulations are acceptable.)

b)

Circuit 1 - Solenoid with 13 Turns



Circuit 2 - Solenoid with 25 Turns



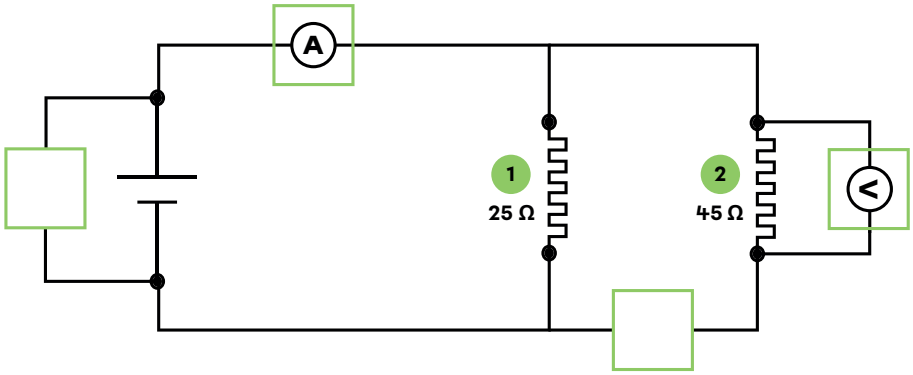
Note : The north pole of the compass is attracted by the south pole of the solenoid. Using the second right-hand rule, we can determine the position of the north pole of a solenoid.

To review these concepts, check out the following concept sheet!	
The Magnetic Field Around a Solenoid	How to Locate a Solenoid's North Pole

Answer Key

Question 3

a) The voltmeter is connected in parallel with heating element 2.
The ammeter is connected in series with the source (battery).



b)

$V = 1.50\ \text{V}$
$R = 45\ \Omega$
$I = \ ?\ \text{A}$

$$V = RI$$
$$\frac{V}{R} = \frac{\cancel{R}I}{\cancel{R}}$$
$$I = \frac{V}{R}$$
$$I = \frac{1.50\ \text{V}}{45\ \Omega}$$
$$I \approx 0.033\ \text{A}$$

Answer: The electric current intensity flowing through heating element 2 is approximately 0.033 A.

To review these concepts, check out the following concept sheets!	
Electrical Measuring Instruments	Ohm's Law

Answer Key

Question 4

a)

$$\text{Diameter} = 12.0\ ^{+0.2}_{-0.4}$$

$$\text{Minimum dimension} = 12.0\ \text{mm} - 0.4\ \text{mm} = 11.6\ \text{mm}$$

$$\text{Maximum dimension} = 12.0\ \text{mm} + 0.2\ \text{mm} = 12.2\ \text{mm}$$

Answers: Minimum dimension: 11.6 mm Maximum dimension: 12.2 mm

b) ✓ May not always work

Explanation: The clearance is too wide. It is 0.3 mm, which is greater than 0.2 mm. (Other formulations are acceptable.)

To review this concept, check out the following concept sheet!

Dimensioning and Dimensional Tolerances