

State of Israel
Ministry of Education

Type of exam: *Bagrut* for high schools
Exam date: Summer 2016

Exam number: 036101

English translation (3)

מדינת ישראל

משרד החינוך

סוג הבחינה: בגרות לבתי ספר על-יסודיים
מועד הבחינה: קיץ תשע"ו, 2016

מספר השאלון: 036101

תרגום לאנגלית (3)

I studied in the track:

למדתי על פי התכנית:

☐

Physics of Technological Systems
פיזיקה של מערכות טכנולוגיות

☐

Electricity and פעימ"ה
פעימ"ה וחשמל

Mark an X in the appropriate box

סמן X במשבצת המתאימה

Physics

1 point

Instructions to examinees

א. Duration of the exam: One and a half hours

ב. Exam structure and breakdown of points:

This exam has two parts.

Part א – Physics of Technological Systems

(Questions 1-8, pp. 2-16)

Part ב – Electricity and פעימ"ה (Questions 9-17, pp. 18-34)

Note! This year, the פעימ"ה section begins with

Question 9.

You must only answer questions for the track in which you studied.

If you are answering questions from Part א, you must answer three questions, each from a different topic area.

If you are answering questions from Part ב, you must answer three questions from at least two topic areas.

Each question – $33\frac{1}{3}$ points; $3 \times 33\frac{1}{3} = 100$ points

ג. Material that may be used during the exam:

(1) A calculator

(2) A Hebrew-foreign language / foreign language-Hebrew dictionary

ד. Special instructions:

(1) **This booklet is not your answer booklet.** Write your answers in the Hebrew booklet, according to the instructions.

(2) Answer three questions only. Answer all of the items for each question. Answers to additional questions will not be graded. The answers will be graded in the order they appear in the booklet.

(3) **Write your answers in pen. Do not erase with White-Out.** You are allowed to use pencil only for drawings. The use of pencil or White-Out will prohibit any possibility of appealing your score.

(4) Pages 35-36 are intended for draft material. Using any other pages for drafts may lead to the disqualification of your exam!

18										22																													
Examinee No.																																							
23										31										32										39									
Identification number										School number																													

Place the green examinee sticker No. 1 (without your name) here ↑.

If you do not have a sticker, fill in the details yourself.

הדבק כאן ↑ מדבקת נבחן מס' 1 (ללא שם) – צבע ירוק
אם אין לך מדבקה, השלם את הפרטים בכתב יד

פיזיקה

יחידת לימוד אחת

הוראות לנבחן

א. משך הבחינה: שעה וחצי.

ב. מבנה השאלון ומפתח ההערכה:

בשאלון זה שני חלקים.

חלק א – פיזיקה של מערכות טכנולוגיות

(שאלות 1-8, עמ' 2-16)

חלק ב – פעימ"ה וחשמל

(שאלות 9-17, עמ' 18-34)

שים לב! בשנה זו השאלות בחלק פעימ"ה

מתחילות בשאלה 9.

עליך לענות על שאלות רק מהחלק שלמדת.

אם אתה עונה על השאלות מחלק א, עליך לענות על שלוש שאלות, כל שאלה מנושא אחר.

אם אתה עונה על השאלות מחלק ב, עליך לענות על שלוש שאלות, משני נושאים לפחות.

לכל שאלה – $33\frac{1}{3}$ נקודות; $3 \times 33\frac{1}{3} = 100$ נקודות

ג. חומר עזר מותר בשימוש:

(1) מחשבון.

(2) מילון עברי-לועזי/לועזי-עברי.

ד. הוראות מיוחדות:

(1) **שאלון זה אינו משמש מחברת בחינה.**

ענה בנוסח העברי של השאלון, על פי ההוראות.

(2) ענה על שלוש שאלות בלבד, ובכל שאלה

שבחרת ענה על כל סעיפי השאלה.

תשובות לשאלות נוספות לא ייבדקו. התשובות

ייבדקו לפי סדר הופעתן.

(3) **כתוב את תשובותיך בעט. אין למחוק בטיפקס.**

מותר להשתמש בעיפרון רק לסרטוטים. כתיבה

בעיפרון או מחיקה בטיפקס לא יאפשרו ערעור.

(4) עמודים 35-36 מיועדים לטיטות.

רישום טיטות על דפים אחרים עלול לגרום

לפסילת הבחינה!

Good Luck!

בהצלחה!

Questions

Part א – Physics of Technological Systems (100 points)

Note: The questions in **Part א** are intended only for students who studied in the **Physics of Technological Systems** track.

Part א contains eight questions in four topic areas: Electricity in the Home, the Car Engine, Rockets and Satellites, and the Solar Water Heater.

Answer three questions, each from a different topic area.

Answer all of the items for each question you choose to answer.

(Each question — $33\frac{1}{3}$ points)

Write your answers in the Hebrew booklet.

Electricity in the Home

1. א. For each of the sub-items (1)-(4), circle the correct statement:

True or False (in the Hebrew booklet). (12 points)

(1) Red wire is usually used for grounding [הארקה]. True / False

(2) Power is measured in units of kWh. True / False

(3) Electrocuting is the passage of a current of dangerously high intensity through a human body. True / False

(4) A voltage tester [מברג טסטור] is used to measure power.

True / False

The table below shows the power of four electrical appliances for home use and the length of time they were in operation. Assume that all of the appliances were run continuously.

Amount of time appliance was in use (hours)	Power (kilowatts)	Appliance
8	0.5	Computer
2	1.5	Oven
5	1	Air conditioner
1	2	Clothes drier

Use the data in the table to answer Items ב-ד.

- ב. (1) Which appliance performed the most work?
 (2) After operating which appliance did the owner have to pay the Electric Company the smallest amount of money?
 (8 points)
- ג. (1) Calculate how many kWh (kilowatt-hours) the oven consumed.
 (2) Given: The price of a kWh is 0.5 shekels. Calculate how much the operation of the oven cost.
 (8 points)
- ד. One day, the four appliances were connected to the same socket and then turned on. All of the appliances stopped working, even though they were in good working order.
 Four possible explanations, 1-4, are given below. Circle (in the Hebrew booklet) the number of the most reasonable explanation.
1. The intensity of the current that reached each of the appliances was too low to operate the appliance.
 2. The circuit-breaker [ממסר זרם הפחת] cut off the electric current, in order to protect the members of the household from electrocution.
 3. One of the appliances broke down, and therefore all the appliances stopped working.
 4. The load was too great and the fuse in the fuse box cut off the current to that socket.
- (5 $\frac{1}{3}$ points)

Formula: Work (kWh) = power (kW) $\times$ time (hours)

2. א. For each of the sub-items (1)-(4), circle the correct statement:

True or False (in the Hebrew booklet). (12 points)

- (1) All appliances labeled 230 V have the same electrical resistance. True / False
- (2) Resistance is measured in volts. True / False
- (3) The same electrical current will flow through two electric appliances that have the same electrical resistance and are attached to the same voltage source. True / False
- (4) The voltage across resistors that are connected in parallel is identical. True / False

ב. An air conditioner with a power of 2 kW and an oven with a power of 2 kW were connected to a home electrical system. Both appliances were run continuously for one hour at a constant power level.

Circle the number of the correct statement (in the Hebrew booklet).

1. The air conditioner cost less to run than the oven.
2. The air conditioner cost more to run than the oven.
3. The cost of running each of the two appliances was identical.
4. We cannot determine which appliance cost more to run.

(5 $\frac{1}{3}$ points)

- ג. Three air conditioners need to be installed in a school gym. The air conditioning technician presented the school's maintenance manager with two possible installation diagrams and asked him according to which diagram he should install the air conditioners. The two diagrams are shown below (A/C = air conditioner).

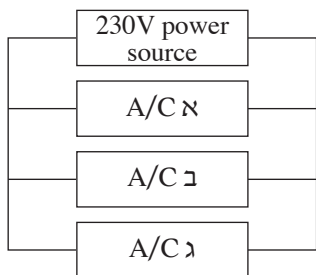


Diagram א

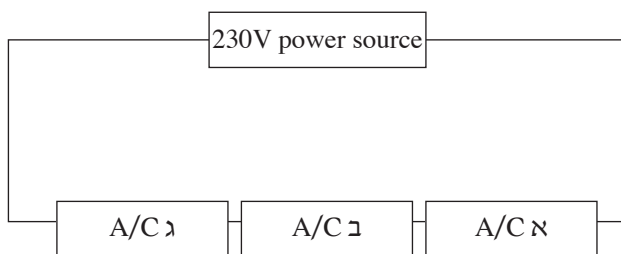


Diagram ב

- (1) Which of the two diagrams, א or ב, represents a parallel circuit?
- (2) According to which of the two diagrams should the air conditioners be installed in the gym?

(6 points)

- ד. Read the statements 1-4 below and circle the number of each correct statement (in the Hebrew booklet).

Note: There may be more than one correct statement.

The air conditioners should be installed according to the diagram that you chose for your answer to Sub-item ג (2):

1. in order to save on the cost of running the air conditioners.
2. because this arrangement will allow each air conditioner to be operated separately.
3. because if one of the air conditioners breaks down, this arrangement will allow the other two to operate.
4. because the air conditioners cannot operate in a satisfactory manner if arranged according to the other diagram.

(10 points)

/Continued on page 6/

The Car Engine

3. א. For each of the sub-items (1)-(4), circle the correct statement:

True or False (in the Hebrew booklet). (12 points)

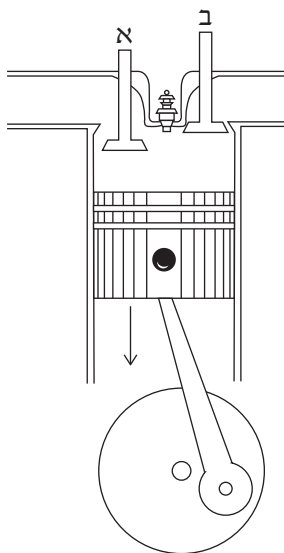
(1) A manometer is a device for measuring pressure. True / False

(2) Pressure is measured in newtons. True / False

(3) One of the units used to measure force is
cm of mercury. True / False

(4) Pressure and force describe different physical
parameters [גדלים פיזיקליים]. True / False

ב. The figure below shows the cylinder of a car engine at the intake stroke [שלב היניקה].



Complete the following sentences, (1)-(4).

(1) As the piston moves downward (in the direction of the arrow in the figure), the pressure of the gas in the cylinder is (greater than / equal to / less than) the atmospheric pressure.

(2) The fuel mixture enters the cylinder through (Valve א / Valve ב).

(3) After the fuel mixture has entered the cylinder, the pressure in the cylinder is (greater than / equal to / less than) the atmospheric pressure.

(4) At the end of the intake stroke, the volume of the mixture in the cylinder is (greater than / equal to / less than) the volume of the mixture at the beginning of that stroke. (8 points)

/Continued on page 7/

- ג. While braking, a car traveled a distance of 30 meters. During the process of braking, the brakes performed 600,000 joules of work. Calculate the force with which the car braked (assume that the force is constant). $(6\frac{1}{3} \text{ points})$
- ד. A motorcycle weighing 2400 newtons was traveling on a road, with both of its wheels on the road. The contact area between each of the wheels of the motorcycle and the road was 300 cm^2 . Calculate the pressure that the motorcycle exerted on the road. (7 points)

Formulas: work = force $\times$ distance

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

4. א. For each of the sub-items (1)-(4), circle the correct statement:

True or False (in the Hebrew booklet). (12 points)

- (1) The force that raises the wing of an aircraft during flight is known as lift [כוח עילוי]. True / False
- (2) Lift acts on the wings of space shuttles in outer space. True / False
- (3) The carburetor of a car provides a spray of water droplets mixed with oil to the motor. True / False
- (4) In a car, the fuel is drawn from the fuel chamber [תא הדלק] via a Venturi tube. True / False

Figure א below shows a Venturi tube through which air is flowing.

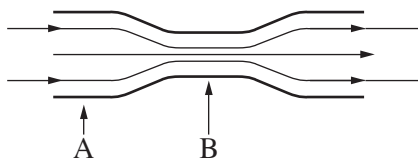


Figure א

- ב. (1) In which section of the tube, A or B, is the speed of the air flow slower?
- (2) In which section of the tube, A or B, is the pressure inside the tube lower?

Explain your answer.

(10 points)

Figure 1 below shows the wing of an aircraft as it moves through the air. The upper side of the wing is marked with the letter A and the lower side is marked with the letter B. The arrows represent air currents.

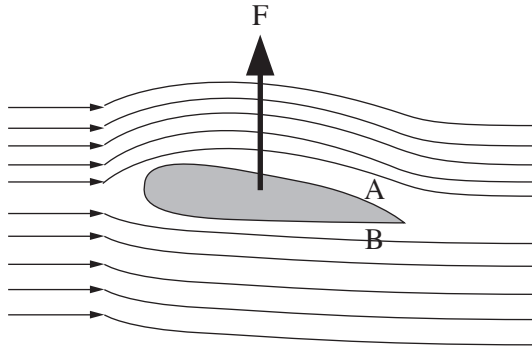


Figure 1

- א. On which side of the wing, A or B, is the speed of the air current greater? (5 points)
- ב. Explain why lift (F) acts on the wing of the aircraft. ($6\frac{1}{3}$ points)

Rockets and Satellites

5. Note: In your answers for this question, consider the effect of the air on the movement of the objects to be negligible.

א. For each of the sub-items (1)-(4), circle the correct statement:

True or False (in the Hebrew booklet). (12 points)

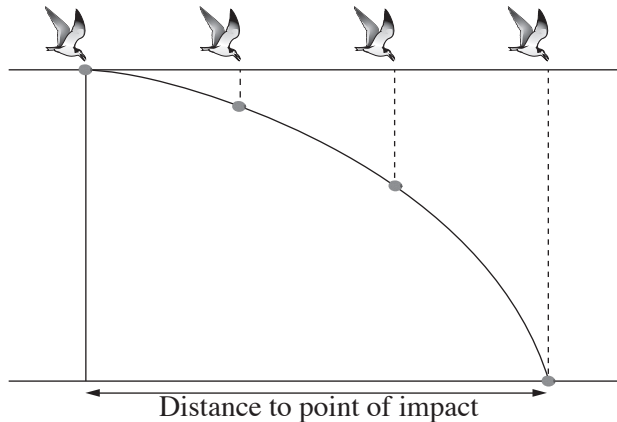
(1) Close to the Earth, any object that is thrown horizontally will move in a straight line. True / False

(2) When two objects of different weights fall from the same height, the heavier object will reach the ground more quickly than the lighter object. True / False

(3) Objects that are inside a rocket that is launched from the Earth are in a state of weightlessness during launching. True / False

(4) When an object is thrown horizontally from a given height, the lower the speed at which it is thrown, the less time it will take for the object to hit the ground. True / False

ב. The figure below depicts the path of a nut that fell out of the beak of a bird that was flying horizontally. The effect of the air on the movement of the nut is negligible.



From among the following possibilities, 1-3, circle (in the Hebrew booklet) the factor(s) that affects (affect) the distance to the point at which the nut will hit the ground [טווח הפגיעה].

1. The speed of the bird.
2. The weight of the nut.
3. The height at which the bird was flying.

(4 points)

/Continued on page 11/

- ג. Every day, a certain bird flies in a horizontal direction from the roof of a building to a tree in the yard and, each time, a nut drops out of its beak.

Complete sentences (1) and (2) below:

- (1) The (lower / greater) the height at which the bird is flying when the nut falls, the slower the speed of the nut when it hits the ground and the (shorter / longer) the time it will take for the nut to reach the ground.
- (2) All the nuts that fall from the bird's beak are identical in weight. The force of gravity acting on each nut is (identical / different), and the time it takes for each nut to reach the ground is (dependent on / independent of) the height at which the bird is flying when the nut is dropped.

(12 points)

- ד. Complete this sentence: The velocity of an object that is free-falling from a tower is (constant / increasing / decreasing).

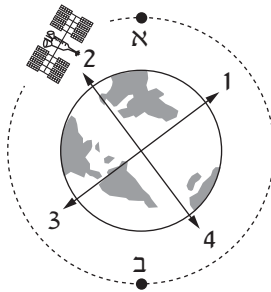
(5 $\frac{1}{3}$ points)

6. א. For each of the sub-items (1)-(4), circle the correct statement:

True or False (in the Hebrew booklet). (12 points)

- (1) The weight of an object located at the North Pole is identical to the weight of the same object located on the equator. True / False
- (2) Disregarding the effect of the air, two objects that are thrown horizontally at the same moment from the same height but at different speeds, will hit the ground at the same time. True / False
- (3) As we travel away from the Earth, gravity increases as a function of the distance from the center of the Earth squared. True / False
- (4) The moon is a satellite of the Earth. True / False

ב. The International Space Station is a manned artificial satellite that moves around the Earth in a circular orbit at a height of about 400 km (see figure).



- (1) Which one of the arrows in the figure, 1-4, describes the direction of the force that the station exerts on the Earth? Circle the correct number (in the Hebrew booklet).

Complete the sentences below.

- (2) If the space station were to orbit the Earth at a greater height, the force it would exert on the Earth would (be greater / be smaller / remain the same).
- (3) Two points, א and ב, on the station's path around the Earth are marked. The magnitude of the force that the station exerts on the Earth at Point א is (equal to / different from) the magnitude of the force that it exerts at Point ב. (9 points)

- ג. Explain why the space station cannot act as a satellite that orbits the Earth at a height of 20 km. $(4\frac{1}{3} \text{ points})$
- ד. A spring scale can be used to weigh objects.
Can an astronaut who is located in the space station in orbit around the Earth use a spring scale to weigh out the food he wants to eat?
(Yes / No).
Explain your answer. (8 points)

The Solar Water Heater

7. א. For each of the sub-items (1)-(4), circle the correct statement:

True or False (in the Hebrew booklet). (12 points)

(1) The absorption of radiation in the collection panel [קולט] of a solar water heater is affected by the color of the pipes. True / False

(2) A black object absorbs more solar radiation than a white object. True / False

(3) The type of material from which the pipes in the collection panel are made does not affect the speed at which the water is heated. True / False

(4) A red ball absorbs all of the red light that strikes it. True / False

ב. Given: a solar water heater that contains 120 liters of water (with a weight of 120 kg). One winter's day, the temperature of the water in the solar water heater was 10°C. The water was heated to a temperature of 50°C.

(1) By how many degrees Celsius did the temperature of the water rise?

(2) Calculate the amount of heat (in kilocalories) that the water absorbed, as it was being heated.

(3) Complete the following sentence: In order to attain the same difference in temperature in a smaller solar water heater that contains only 40 liters of water, the amount of heat required is (3 times greater / 3 times smaller / 2 times greater / 2 times smaller).

(9 points)

ג. (1) Explain what the greenhouse effect ["עקרון החממה"] is.

(2) Refer to the greenhouse effect to explain why it is dangerous to leave young children in a closed car.

(12 $\frac{1}{3}$ points)

Formula: difference in temperature (°C) = $\frac{\text{amount of heat (kilocalories)}}{\text{quantity of water heated (kg)}}$

/ Continued on page 15/

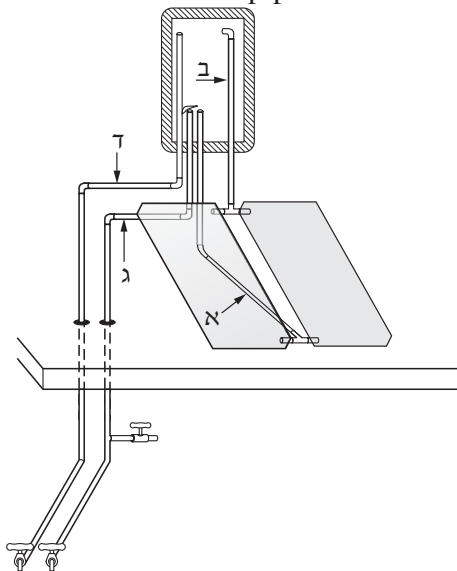
8. א. For each of the sub-items (1)-(4), circle the correct statement:

True or False (in the Hebrew booklet). (12 points)

- (1) The storage tank [דוד האגירה] has a layer of insulating material that prevents the escape of heat from the hot water in the tank. True / False
- (2) The storage tank is connected to the collection panels by two pipes. True / False
- (3) Heat conduction [הולכת חום] is the transfer of heat via a flow of liquid. True / False
- (4) The function of the collection panels is to transform thermal energy into electric energy. True / False

ב. The diagram below shows solar collection panels and a longitudinal section of a storage tank.

The letters א-ד denote the water pipes that are attached to the tank.



Complete the sentences (1)-(4) using the letters א-ד.

- (1) Cold water flows from the pipes in the house to the storage tank via Pipe _.
- (2) Cold water flows from the tank to the collection panels via Pipe _.
- (3) Hot water flows from the collection panels to the storage tank via Pipe _.
- (4) Hot water flows from the storage tank to the pipes in the house via Pipe _.

(8 points)

(Note: This question continues on the next page.)

- ג. The following passage describes the thermostat in a solar water heater. Fill in the missing words, using the list of words that appears below the passage.

The thermostat is a ____ system whose function is to stop the heating of the water when the water temperature rises above the desired temperature.

The thermostat is made of a ____ strip. When the strip is heated, it ____, because of the difference in the ____ of the metals of which it is constructed. In this way, it causes the heating element to be ____ from the power source.

Word list: bimetallic [דו־מתכת], copper [נחושת], cut off [ניתוק], bends [מתכופף], becomes shorter [מתקצר], control [בקרה], cooling [קירור], expansion [התפשטות]

(8 points)

- ד. Explain why the heating element is installed specifically at the bottom of the storage tank.

(5 $\frac{1}{3}$ points)

Good Luck!

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בהצלחה!

זכות היוצרים שמורה למדינת ישראל

אין להעתיק או לפרסם אלא ברשות משרד החינוך

Part ב of the exam is on the next page.

Part ב — פעימ"ה and Electricity (100 points)

Note: The questions in **Part ב** are only for those students who studied in the **פעימ"ה and Electricity** track.

Part ב contains nine questions in three topic areas:

Mechanics, Optics and Electricity.

Choose three questions from at least two different topic areas.

Answer all of the items for each question you choose to answer.

(The point value of each item is given.)

(Each question — $33\frac{1}{3}$ points)

Write your answers in the Hebrew booklet.

Mechanics

9. א. For each of the sub-items (1)-(4), circle the correct answer:

True or False (in the Hebrew booklet).

(12 points)

- (1) The graph below depicts the velocity of an object as a function of time.

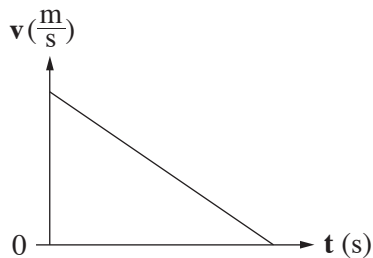


Figure א

We can conclude from the graph that the object is moving at a constant velocity.

True / False

- (2) The graph below depicts the velocity of an object as a function of time.

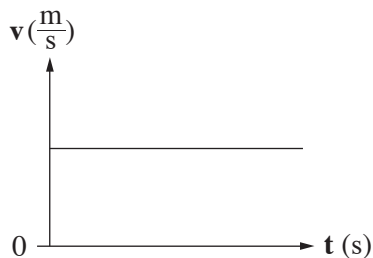


Figure ב

We can conclude from the graph that the velocity of the object is 0.

True / False

- (3) An object in circular motion, traveling at a constant speed, has an acceleration that is constant in magnitude and variable in direction. True / False
- (4) An object that is traveling in circular motion at a constant speed has an acceleration that is directed out of the circle. True / False

The figure below shows two graphs that depict the location of two objects, א and ב, as a function of time.

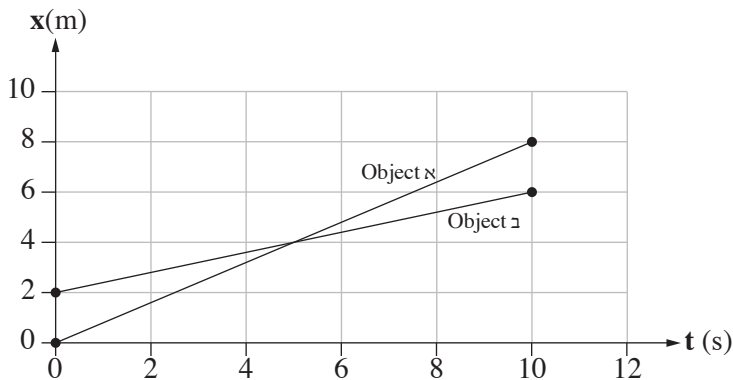


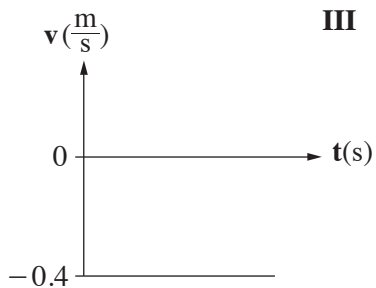
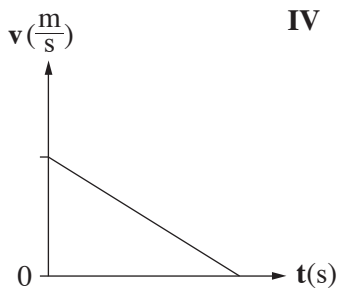
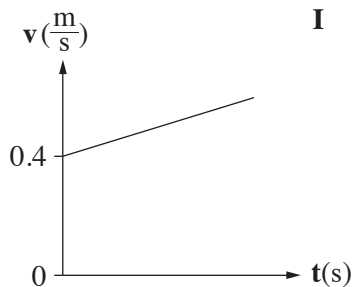
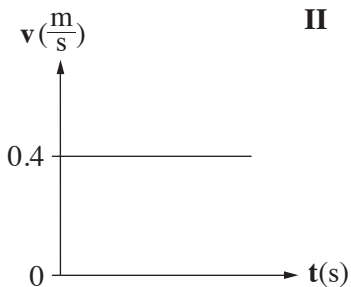
Figure א

Refer to the graphs and complete the sentences in Items ב through ה below.

- ב. Object א is moving at a (constant velocity / variable velocity). (4 points)
- ג. Object א and Object ב are moving in (the same direction / opposite directions). (4 points)
- ד. The distance traveled by Object א in 10 seconds is (greater / less) than the distance traveled by Object ב in the same period of time. (4 points)
- ה. The paths of Object א and Object ב (crossed / did not cross) as they were moving. (4 points)

(Note: Item ו of this question is on the next page.)

- ג. Circle (in the Hebrew booklet) the number of the graph that correctly depicts the velocity of Object ב (shown in Figure ג) as a function of time.



(5 $\frac{1}{3}$ points)

10. א. For each of the sub-items (1)-(4), circle the correct answer:

True or False (in the Hebrew booklet). (12 points)

- (1) The frequency of an object traveling in periodic motion is always equal to its period [זמן המחזור]. True / False
- (2) Frequency is measured in hertz (Hz). True / False
- (3) Tangential velocity [המהירות ההיקפית] of circular motion is measured in units of $\frac{1}{\text{second}}$. True / False
- (4) The acceleration of an object in circular motion at a tangential velocity of a constant magnitude is zero. True / False

A cyclist is traveling along a circular path that has a radius of 10 meters at a velocity of a constant magnitude. He completed one circuit in six seconds.

ב. Calculate the cyclist's tangential velocity. ($5\frac{1}{3}$ points)

ג. Calculate the cyclist's angular acceleration [התאוצה הרדיאלית]. (6 points)

ד. Calculate the frequency of the cyclist's movement. (6 points)

ה. After a while, the cyclist increased the radius of his path to 15 meters, but still completed the circuit within the same period of time.

Complete the sentences (1)-(2) below.

- (1) The cyclist's tangential velocity (increased / decreased / remained the same).
- (2) The cyclist's angular acceleration (increased / decreased / remained the same).

(4 points)

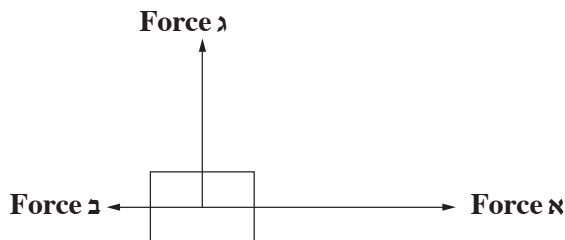
Formulas: $a_r = \frac{v^2}{r}$, $v = \frac{2\pi r}{T}$, $f = \frac{1}{T}$

11. א. For each of the sub-items (1)-(4), circle the correct answer:

True or False (in the Hebrew booklet). (12 points)

- (1) The Earth exerts a force of about 1 newton on a volume of 100 cm^3 of water on the Earth's surface. True / False
- (2) The resultant force [כוח שקול] acting on an object moving in a straight line at a constant velocity is different from zero. True / False
- (3) The resultant force acting on an object moving in a circle at a velocity of a constant magnitude is different from zero. True / False
- (4) According to Hooke's Law, the force acting on a spring is directly proportional to the degree to which that spring is extended. True / False

Three forces are acting on an object, as described in the figure below.

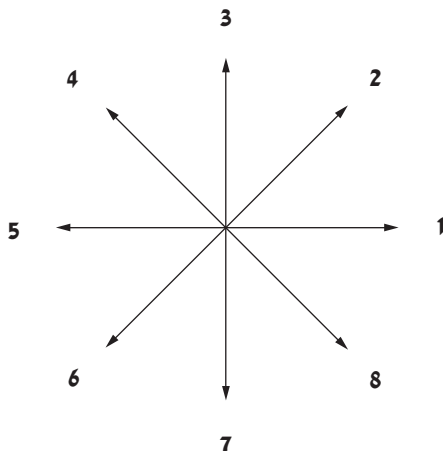


Given: Force א has a magnitude of 6 newtons and is directed to the right.
 Force ב has a magnitude of 2 newtons and is directed to the left.
 Force ג has a magnitude of 4 newtons and is directed upward.

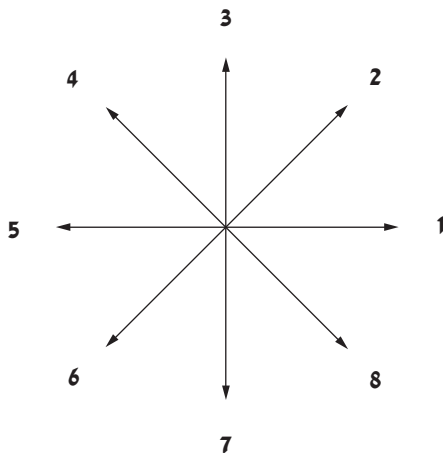
Answer the items ב through ה, based on this data.

- ב. The magnitude of the resultant force acting on the object horizontally is ___ and it is directed to the (right / left). (5 points)

- ג. Circle (in the Hebrew booklet) the number of the arrow that depicts the direction of the resultant force (of the three forces) acting on the object. (5 points)



- ד. Calculate the magnitude of the resultant force (of the 3 forces). (6 $\frac{1}{3}$ points)
- ה. Circle (in the Hebrew booklet) the number of the arrow that represents the direction in which a fourth force needs to act on the object, in order for the resultant force of the four forces acting on the object to be zero. (5 points)



Formula: $F_{\text{resultant}} = \sqrt{F_{\text{horizontal}}^2 + F_{\text{vertical}}^2}$

Optics

12. א. For each of the sub-items (1)-(4), circle the correct answer:

True or False (in the Hebrew booklet).

(12 points)

- (1) A narrow beam of light that enters through one surface of a transparent glass window will continue in the same direction, when it exits the opposite surface of the window. True / False
- (2) The refractive index [מנת (מקדם) השבירה] of all transparent materials is less than 1. True / False
- (3) The speed of light in transparent materials is greater than the speed of light in a vacuum. True / False
- (4) A critical angle [זווית גבולית (קריטית)] exists only when light passes from material with a low refractive index to material with a high refractive index. True / False

Given: a container full of water. Positioned at the bottom of the container is a flashlight that is shining light from inside the water outward. The angle of incidence [זווית הפגיעה] of the ray of light on the surface of the water is $\alpha = 30^\circ$, as shown in Figure א below.

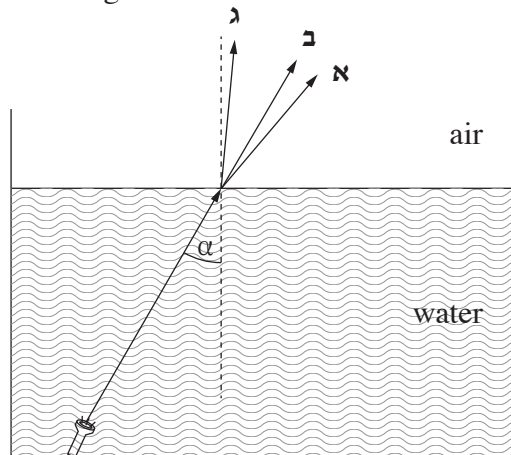


Figure א

- ב. Which of the arrows, א, ב or ג, describes the ray of light as it exits the water into the air? (3 points)
- ג. Calculate the angle of refraction of the ray as it moves into the air.

(4 $\frac{1}{3}$ points)

/Continued on page 25/

- ד. The flashlight was moved, and now, the beam of light emitted from the flashlight strikes the surface of the water at Point M, at an angle of incidence [זווית פגיעה] that is **equal** to the critical angle, as described in Figure ב below.

Circle (in the Hebrew booklet) the letter of the arrow that represents the direction in which the beam will continue its path from Point M:

א / ב / ג / ד .

(7 points)

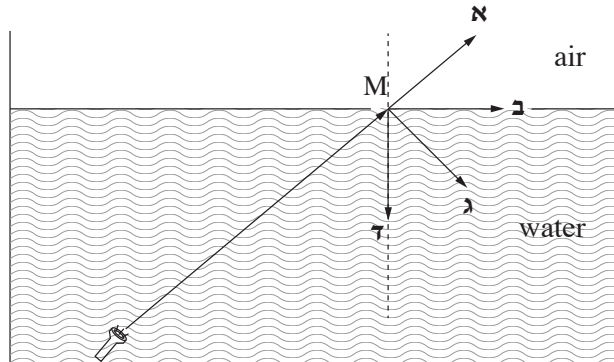


Figure ב

- ה. In another case, the beam of light emitted from the flashlight strikes the water at Point N, at an angle of incidence that is **greater** than the critical angle, as described in Figure ג below.

Circle (in the Hebrew booklet) the letter of the arrow that represents the direction in which the beam will continue its path from Point N:

א / ב / ג / ד .

(7 points)

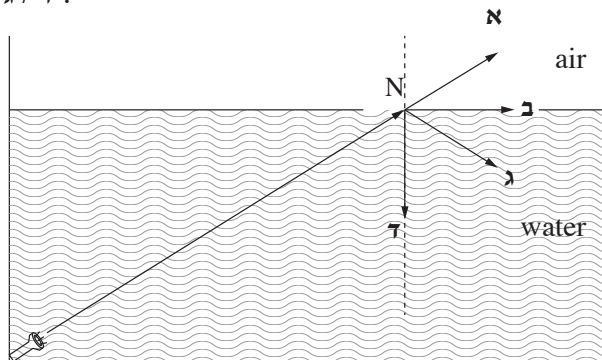


Figure ג

Given: $n_{\text{water}} = 1.3$, $n_{\text{air}} = 1$

Formula: $n_1 \cdot \sin(\alpha_1) = n_2 \cdot \sin(\alpha_2)$

13. א. For each of the sub-items (1)-(4), circle the correct answer:

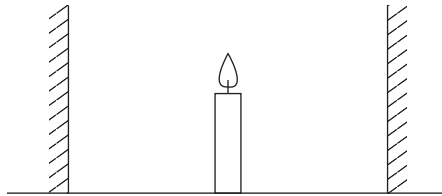
True or False (in the Hebrew booklet).

(12 points)

(1) In a plane mirror [מראה מישורית], the distance of the image from the mirror is greater than the distance of the object from the mirror.

True / False

(2) A candle is placed between two parallel plane mirrors, as shown in the figure below.



In each of the mirrors, an infinite number of images of the candle is obtained.

True / False

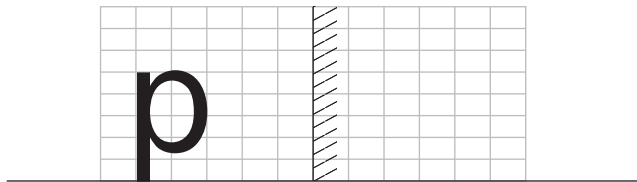
(3) A periscope contains only one plane mirror that is slanted at an angle of 45° .

True / False

(4) The image obtained in a concave mirror [מראה קעורה] is always smaller than the object.

True / False

ב. In the figure below, the letter P is positioned in front of a plane mirror.

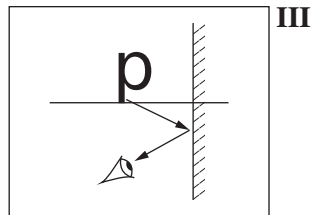
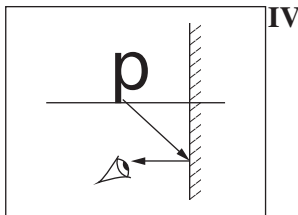
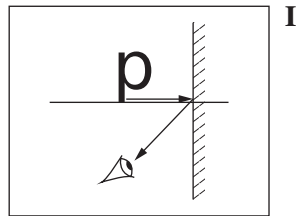
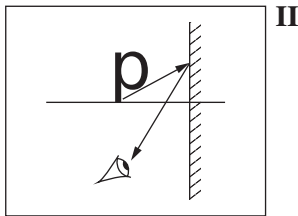


In the figure (in the Hebrew booklet), sketch the image of the letter that is obtained in the mirror. Make sure that the shape and location of the image are accurate.

(5 points)

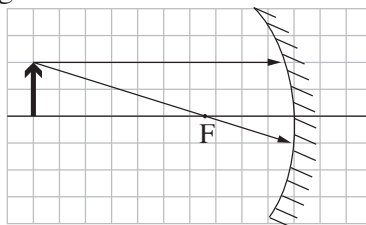
- ג. Figures I-IV are shown below.

Circle (in the Hebrew booklet) the number of the figure that correctly depicts the path of a ray of light that exits a point on Object P, strikes a mirror and is reflected from the mirror to the eye of the observer. (5 points)



- ד. The figure below depicts a concave mirror, an arrow-shaped object and two of the principal rays [הקרניים האופייניות] emitted from the top of the object.

In the figure (in the Hebrew booklet), sketch the rays reflected from the mirror and the image that is obtained. ($5\frac{1}{3}$ points)



- ה. For each of the sub-items (1)-(3), circle (in the Hebrew booklet) the term that describes the image obtained in your answer for Item ד.

The obtained image is:

- (1) real / virtual
- (2) right side up / inverted
- (3) reduced in size / enlarged / the same size as the object.

(6 points)

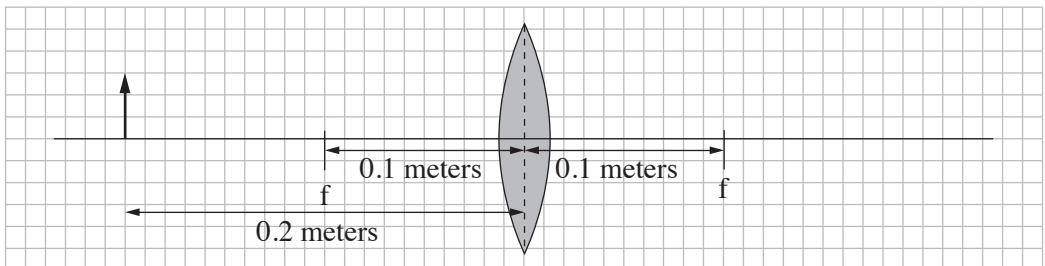
/Continued on page 28/

14. א. For each of the sub-items (1)-(4), circle the correct answer:

True or False (in the Hebrew booklet). (12 points)

- (1) In a converging lens [עדשה מרכזית], the center of the lens is thicker than the periphery of the lens. True / False
- (2) The image obtained on a diverging lens [עדשה מפזרת] is always inverted. True / False
- (3) The image obtained through the lens of a pair of eyeglasses is always real. True / False
- (4) Any ray of light that is parallel to the optical axis of a converging lens and is refracted by the lens must pass through the focal point of the lens. True / False

The figure below depicts a converging lens that has a focal length of $f = 0.1$ m and an arrow-shaped object located at a distance of 0.2 meters from the lens.



- ב. Calculate the optical power of the lens in diopters (P). (4 points)
- ג. In the figure (in the Hebrew booklet), sketch two of the principal rays emitted from the top of the object and use them to add the obtained image to the figure. (6 points)

- ד. For each of the sub-items (1)-(3), circle (in the Hebrew booklet) the term that describes the image obtained in your answer for Item ג.

(1) real / virtual

(2) right side up / inverted

(3) reduced in size / enlarged / the same size as the object.

(6 points)

- ה. Use a formula to calculate the distance of the image from the lens.

(5 $\frac{1}{3}$ points)

Formulas: $\frac{1}{f} = \frac{1}{a} + \frac{1}{b}$, $P = \frac{1}{f}$

Electricity

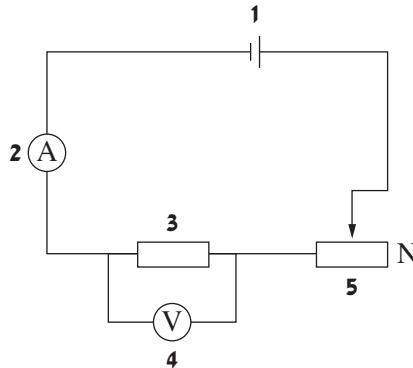
15. א. For each of the sub-items (1)-(4), circle the correct answer:

True or False (in the Hebrew booklet).

(12 points)

- (1) Specific resistance [התנגדות סגולית] is the resistance of any conductor that has a length of 1 meter. True / False
- (2) When resistors are connected in parallel, the voltage on each of them is always equal. True / False
- (3) When resistors are connected in parallel, the current flowing through each of them is always equal. True / False
- (4) When resistors are connected in a series, the current flowing through each of them is always equal. True / False

The figure below depicts an electrical circuit that includes a power source, a rheostat (variable resistor), a fixed resistor, a voltmeter and an ammeter. The components are labeled 1-5.



- ב.** Next to each of the numbers listed in the Hebrew booklet, write the name of the component represented by that number. (5 points)

- ג. For each of the sub-items (1)-(4), circle the correct answer:

True or False (in the Hebrew booklet). (4 points)

In the circuit presented in the figure:

- (1) the voltmeter measures the voltage on all of the components of the circuit. True / False
- (2) the ammeter measures the intensity of the current flowing through the rheostat. True / False
- (3) the voltmeter measures only the voltage on the variable resistor. True / False
- (4) the ammeter does not measure the intensity of the current flowing through the power source. True / False

- ד. One of the circuit's components is a rheostat (variable resistor).

If we move the wiper [זחלן] of the rheostat to Point N, the intensity of the current reported by the ammeter will (increase / decrease / remain the same). ($4\frac{1}{3}$ points)

- ה. Given: The voltage on the power source shown in the figure is 24 volts.

The ammeter reports 4 amperes and the voltmeter reports 10 volts.

- (1) Calculate the resistance of the fixed resistor R.
- (2) Calculate the resistance of the rheostat in this situation (assume that the voltmeter has an infinite resistance and that the ammeter, power source and wires have no resistance).

(8 points)

Formula: $R = \frac{V}{I}$

16. א. For each of the sub-items (1)-(4), circle the correct answer:

True or False (in the Hebrew booklet). (12 points)

(1) The electric grid in Israel has a voltage of 110 volts. True / False

(2) All of the appliances in a house are connected in series. True / False

(3) A diode is an electrical component through which current can flow in one direction only. True / False

(4) Voltage is measured in watts. True / False

ב. A charge of 0.004 coulombs passes through the cross-section of a conductor over the course of one minute.

(1) Calculate the number of electrons that pass through the conductor over the course of one minute.

(2) Calculate the intensity of the current flowing through the conductor.

(6 points)

ג. Which one of the statements below, 1-3, is correct? Circle (in the Hebrew booklet) the correct answer. ($3\frac{1}{3}$ points)

1. Power is work performed in a unit of time.

2. Power is force per unit of time.

3. Power is the efficiency [נצילות] of the appliance.

ד. Given: a bulb that is marked: 110 W , 220 V

(1) Explain what is written on the bulb.

(2) Calculate the resistance of the bulb.

(3) If we connect the bulb to a voltage of 180 volts, what will its power be?

(4) Complete the sentence: When the voltage on the bulb is 180 volts, the intensity of the light it emits is (equal to / greater than / less than) the intensity of the light it emits when it is connected to a voltage of 220 volts.

(12 points)

Given: The charge of an electron is $1.6 \cdot 10^{-19}$ coulombs.

Formulas: $I = \frac{q}{t}$, $P = \frac{V^2}{R}$, $\frac{\text{overall charge}}{\text{electron charge}} = \text{no. of electrons}$

17. א. For each of the sub-items (1)-(4), circle the correct answer:

True or False (in the Hebrew booklet).

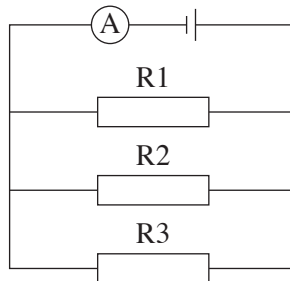
(12 points)

- (1) The greater the number of resistors that are connected in a circuit in parallel, the greater the overall intensity of the current. True / False
- (2) The greater the number of resistors that are connected in a circuit in series, the greater the overall intensity of the current. True / False
- (3) When resistors are connected in series, the voltage on each resistor is always equal. True / False
- (4) Electric power [קוואט] is measured in volts. True / False

The figure below shows an electric circuit that consists of a voltage source (V), three resistors (R_1 , R_2 , R_3), and an ammeter.

Given: $V = 30$ volts , $R_1 = 10 \Omega$, $R_2 = 20 \Omega$, $R_3 = 30 \Omega$.

Assume that the voltage source, the ammeter and the wires have no resistance.



- ב.** Calculate the equivalent resistance [ההתנגדות השקולה] of the three resistors. $(5\frac{1}{3}$ points)

(Note: This question continues on the next page.)

- ג. Calculate the intensity of the current reported by the ammeter.
(5 points)
- ד. Calculate the intensity of the current flowing through each of the three resistors.
(6 points)
- ה. Circle (in the Hebrew booklet) the correct answer in the sentence below.

If we add an additional resistor that is parallel to R_3 to the three resistors in the figure, the intensity of the current reported by the ammeter will: increase / decrease / remain the same. (5 points)

Formulas: $I = \frac{V}{R}$, $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

Good Luck!

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בהצלחה!

זכות היוצרים שמורה למדינת ישראל
אין להעתיק או לפרסם אלא ברשות משרד החינוך.

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