Instructions for teachers:

This option is for teachers and students who feel the current ACT science is too fast for comfort. This option allows the students and teacher to break down the figures, examine more carefully what the variables are in each graph, what is being studied, and how everything is measured.

The document is 2 pages, so you can photocopy the document front-to-back and have students keep this paper for the entire week.

The suggestion is the spend days 1 and 2 on the open-ended questions examining the graphs, and then starting the multiple-choice questions either part-way on day 2, or on day 3.

It is more important that some discussion takes place about the figures rather than rushing through the answers to the questions.

Any feedback on Science ACT practice is appreciated to the science team. Send e-mails to Victor Chen.

DAYS 1-2 of ACT Week

PASSAGE II

An *electromagnetic wave* (or EM wave) is a wave that has oscillating electric and magnetic fields that vary over time and space. The electric and magnetic fields are perpendicular both to each other and to the direction of propagation of the wave. Light is an EM wave, and one can generalize its behavior in most cases to that of all other EM waves. A normal beam of light is made up of a large number of waves emitted by the atoms or molecules of the light source. Each atom produces a randomly directed electric field, and the resulting beam is considered to be *unpolarized*. However, with the use of a *polarizing filter*, it is possible to pick out the components of the electric field pointing in a particular direction. This direction is called the *axis of polarization* of the filter. A beam of light is called *polarized* if the electric field always vibrates in the same direction at a particular point. In the experiments below, scientists investigated various properties of polarized and unpolarized light.

Experiment 1

The scientists used a laser emitting unpolarized light. The light was directed toward a polarization filter with an axis of polarization pointing straight up, and then through another whose axis of polarization varied. The scientists chose to describe the axis of the second filter by examining the angle between its axis and the axis of the first filter. The intensity of the original beam was 8 W/m^2 (watts per square meter). Their results are shown in Table 1.

Table 1

Angle between axis of first and second filters (degrees)	Intensity of emerging beam (W/m^2)
0	4.00
15	3.73
30	2.99
45	2.01
60	1.00
75	0.27
90	0.00

Experiment 2

The scientists repeated the experimental setup of Experiment 1 but used a source of polarized light polarized in the same direction as the axis of the first polarization filter (straight up). The intensity of the original beam was still 8 W/m^2. The results are shown in Table 2.

Table 2

Angle between axis of first and second filters (degrees)	Intensity of emerging beam (W/m^2)
0	8.00
15	7.46
30	6.01
45	3.99
60	2.00
75	0.54
90	0.00

Experiment 3

The scientists decided to polarize the original beam of light at an angle of 30° to the first polarization filter. The intensity of the original beam was kept at 8 W/m^2. The results are shown in Table 3.

Table 3

Angle between axis of first and second filters (degrees)	Intensity of emerging beam (W/m^2)
0	6.01
15	5.60
30	4.49
45	2.99
60	1.50
75	0.41
90	0.00

In the ACT Science Section, you will see three "Experiments" passages. In these passages, They are easy to spot. They usually contain an introductory paragraph followed by a number of experiments and six questions.

1. The first thing you need to do in an Experiments passage is to identify the ***objective***. The objective is a statement that tells you the purpose of the study (*what* they are studying). The objective is usually found in the beginning or the end of the introductory paragraph. Once you find it, underline the objective.

2. The second thing you need to do is to follow the procedure of each experiment and identify the variables. Then, jot down a few words along side each of the experiments to make a note of what is changing in each case.

3. The final thing you need to do in an Experiments section is to study the results. The results are the conclusion of the study. When you study the results, make sure you underline them or write some notes in the margin. Once you've finished this step

Instructions: In the Science ACT, you will see three "Experiments" passages where the results from different experiments will be presented. Skim through the opening paragraphs to get the basic idea of what is being tested. Then, after reading each experiment, jot some quick notes about what is being tested, what was the testing condition, and brief results.

PASSAGE II

An *electromagnetic wave* (or EM wave) is a wave that has oscillating electric and magnetic fields that vary over time and space. The electric and magnetic fields are perpendicular both to each other and to the direction of propagation of the wave. Light is an EM wave, and one can generalize its behavior in most cases to that of all other EM waves. A normal beam of light is made up of a large number of waves emitted by the atoms or molecules of the light source. Each atom produces a randomly directed electric field, and the resulting beam is considered to be *unpolarized*. However, with the use of a *polarizing filter*, it is possible to pick out the components of the electric field pointing in a particular direction. This direction is called the *axis of polarization* of the filter. A beam of light is called *polarized* if the electric field always vibrates in the same direction at a particular point. In the experiments below, scientists investigated various properties of polarized and unpolarized light.

Experiment 1

The scientists used a laser emitting unpolarized light. The light was directed toward a polarization filter with an axis of polarization pointing straight up, and then through another whose axis of polarization varied. The scientists chose to describe the axis of the second filter by examining the angle between its axis and the axis of the first filter. The intensity of the original beam was 8 W/m² (watts per square meter). Their results are shown in Table 1.

Table 1

Angle between axis of first and second filters (degrees)	Intensity of emerging beam (W/m²)
0	4.00
15	3.73
30	2.99
45	2.01
60	1.00
75	0.27
90	0.00

Experiment 2

The scientists repeated the experimental setup of Experiment 1 but used a source of polarized light polarized in the same direction as the axis of the first polarization filter (straight up). The intensity of the original beam was still 8 W/m². The results are shown in Table 2.

Table 2

Angle between axis of first and second filters (degrees)	Intensity of emerging beam (W/m²)
0	8.00
15	7.46
30	6.01
45	3.99
60	2.00
75	0.54
90	0.00

Experiment 3

The scientists decided to polarize the original beam of light at an angle of 30° to the first polarization filter. The intensity of the original beam was kept at 8 W/m². The results are shown in Table 3.

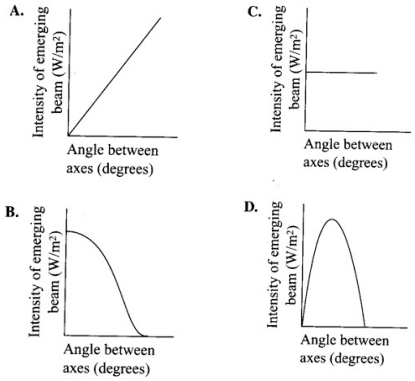
Table 3

Angle between axis of first and second filters (degrees)	Intensity of emerging beam (W/m²)
0	6.01
15	5.60
30	4.49
45	2.99
60	1.50
75	0.41
90	0.00

1. A beam of unpolarized light is shone through two polarizing filters with axes of polarization separated by 20□. The intensity of the original beam is 8 W/m². Which of the following could be the intensity of the emerging beam?
A. 3.53 W/m² B. 5.32 W/m²
C. 6.97 W/m² D. 8.00 W/m²

2. The scientists conducted a fourth experiment similar to the first three. The two polarizing filters were placed with their axes 90□ apart. Light poplarized in the same direction as the axis of the first filter was then shone through the two filters, and the second filter was rotated. As the angle between the axes of the two filters decreased from 90□ to 0□, the intensity of the emerging beam:
F. decreased. G. increased, then decreased.
H. decreased, then increased. J. increased

3. Which of the following graphs best describes the relationship between the angle between the axes of the filters and the intensity of the emerging beam as determined in Experiment 3?



4. How does the setup of Experiment 1 differ from that of Experiment 2?
F. In Experiment 1, the original beam was polarized, but in Experiment 2, it was unpolarized.
G. In Experiment 1, the original beam was unpolarized, but in Experiment 2, it was polarized.
H. In Experiment 1, the scientists tested a wider range of angles than they did in Experiment 2.
J. In Experiment 1, the original beam of light was more intense than the one in Experiment 2.

5. The scientists hypothesize that the color of the original beam of light will affect the intensity of the emerging beam. The frequency of a beam of light determines its color. Which of the following would be the best way to test this hypothesis?
A. Repeating the experiments using more than two polarizing filters
B. Repeating the experiments on different planets
C. Repeating the experiments using beams of both high and low frequencies
D. Repeating the experiments using different intensities for the original beam.

6. In Experiment 1, if the angle between the axes of polarization increases by 15□, the intensity of the resulting beam:
F. halves G. doubles
H. increases, but not by any constant factor
J. decreases, but not by any constant factor

Answers

1. The best answer is A. This experiment begins with unpolarized light, so we need to look at Experiment 1. Table 1 shows us that the intensity of the beam at 15□ is 3.73 and the intensity at 30□ is 2.99. We know that at 20□ the intensity will be between these two values. Therefore, the answer is (A).

2. The best answer is J. In each of the tables, as the angle between the axes of the filters increases, the intensity decreases. Therefore we have good reason to believe that as the angle is decreased from 90□ to 0□, the intensity of the resulting beam will steadily increase.

3. The best answer is B. If we look at the values of intensity on Table 3, we see that as the angle goes up, the intensity drops off consistently. In fact, it drops more rapidly as the angle gets greater. The only graph that shows a consistently dropping intensity is graph (B).

4. The best answer is G. The first line of Experiment 1 states that the scientists were using unpolarized light; the first line of Experiment 2 states that the scientists used the same setup but used polarized light. The choice that best restates this idea is (G).

5. The best answer is C. The question tells us that the frequency of the beam determines its color, so to know whether color has any effect on the intensity of the emerging beam, we will need to try beams of different frequencies. The choice that paraphrases this idea is (C).

6. The best answer is J. It's clear from the table that the intensity decreases as the angle of axis increases, so we can eliminate (G) and (H) right away. To choose between (F) and (J) we should first look at the difference between 0□ and 15□. According to the table, the intensity changes from 4.00 to 3.73, a difference of 0.27. Now let's look at the difference between 15□ and 30□. In this case, the intensity changes from 3.73 and 2.99, a difference of 0.74. Therefore, the difference isn't constant, and the answer is (J).