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QUESTION 1

Saul Hoffman\\'s scientific journal paper published in 2015 in Societies explores the relationship between two topics that at the surface are very distant from each other. As he goes on to state, "It is relatively easy, at least for an economist, to see why economists would be attracted to issues like teen pregnancy and teen childbearing, despite their apparent distance from the core topics of economics. First, economics ?especially microeconomics ?is fundamentally the study of choices that individuals make, traditionally and most often in formal markets with monetary prices, but now more and more frequently outside that sphere. Viewed from that perspective, choices involving sexual and fertility behavior among teens are an incredibly challenging, but inviting, target. Is it possible to identify the role of economic incentives, including government policy, on these behaviors? Is it sensible to apply traditional models of rational choice decision-making to teens?

Second, the traditional concern about teen fertility was predicated on the notion that it was an economically catastrophic act. In a famous and oft-quoted 1968 article, Arthur Campbell wrote that \\'The girl who has an illegitimate child at the age of 16 suddenly has 90 percent of her life\\'s script written for her,\\' including reduced opportunities for schooling, the labor market, and marriage. But it doesn\\'t take too much reflection to appreciate that more may be going on in leading to these poor outcomes than just a teen birth. Disentangling the causal effect of teen childbearing on subsequent socio-economic outcomes from its correlational effect is another deliciously inviting and challenging target, this time well-suited for the applied economist or econometrician.

Just to make all this yet more inviting, the two research strands are closely related. Suppose it could be demonstrated that for some teens the socio-economic impact of a teen birth was negligible. For example, maybe future prospects for some teens were equally poor with or without a birth or perhaps government programs provided substantial benefits, so that the net impact on socio-economic well-being was consequently small or even positive. Then, it might well be \\'rational\\' in an economic sense to have a teen birth in the first place, thereby linking the research on the causal impact of a teen birth with the research on the choice determinants of a teen birth. So what came to be known as the teen birth `causes\\' literature and the teen birth `consequences\\' literature were clearly interrelated.

And then, to add yet another layer of challenge, the teen fertility rate in the U.S. has fallen at a rate that is totally unprecedented. Teen fertility was once widespread, with most of it occurring within early and sometimes not entirely voluntary marriage. In 1960, the teen fertility rate was approximately 90 births per 1000, which implied that more than 40% of women ever had a teen birth. When I published my first article on teen births 25 years ago, the teen fertility rate was 60 births per 1000, down one-third from 1960, but it had increased six years in a row in what turned out to be a deviation from the downward trend. Since then the rate has declined every single year, except for a short but puzzling uptick between 2005 and 2007. In 2014, the teen fertility rate was 24.2 births per 1000, the lowest teen fertility rate ever recorded in the U.S., though still shockingly high by European standards. Thus, the rate fell by more than 50% during my professional association with the topic and by 70% since 1960. Of course, at the same time teen marital births largely disappeared, falling from 85% of teen births to 12%.

This adds yet another focus for economic research. Why did the rate fall? Did it have anything to do with changes in the costs of teen childbearing or changes in policy? Is it a good thing or not?

In this article I try to make sense out of these various research strands by providing a personal narrative through the economics literature on teen childbearing, with a special emphasis on the three issues discussed above. My goal is to make the literature, including some reasonably technical content, accessible and valuable to a non-economist."

Hoffman, S. (2015). Teen Childbearing and Economics: A Short History of a 25-Year Research Love Affair. Societies, 5(3), 646-663. doi:10.3390/soc5030646

The author would likely view the choice of whether to use birth control as:

A. a personal choice that should be governed by one\\'s beliefs about the morality of using it.

B. a decision governed by cost-benefit analyses including factors such as cost of the birth control.

C. a sign of innate intelligence.

D. an ethical choice involving having children only when one can provide them with a good life.

Correct Answer: B

This Reasoning-Beyond-the-Text question asks you to make inferences about the author\\'s overall style of thought and how it might apply to a new topic. He describes economics as "fundamentally the study of choices that individuals make," with a focus on incentives, especially financial ones. A focus on incentives that prompt the choice to use birth control, and the factors that prevent them, could interest an economist. A ?incorrect. The author never describes behavior as moral or immoral, suggesting this is irrelevant to his explanatory framework in the passage. C ?incorrect. The passage does not discuss innate qualities of a person, but focuses on the outward forces that shape their choices. D ?incorrect. As with A, this choice focuses on ethics, while the passage discusses choices in an amoral way, as based on incentives.

QUESTION 2

Aski jump is an inclined track from which a ski jumper takes off through the air. After traveling down the track, the skier takes off from a ramp at the bottom of the track. The skier lands farther down on the slope.

Figure 1 shows a ski jump, in which the ramp at the lower end of the track makes an angle of 30?to the horizontal. The track is inclined at an angle of to the horizontal and the slope is inclined at an angle of 45?to the horizontal. A ski jumper is stationary at the top of the track. Once the skier pushes off, she accelerates down the track, and then takes off from the ramp. The vertical height difference between the top of the track and its lowest point is 50 m, and the vertical height difference between the top of the ramp and its lowest point is 10 m.

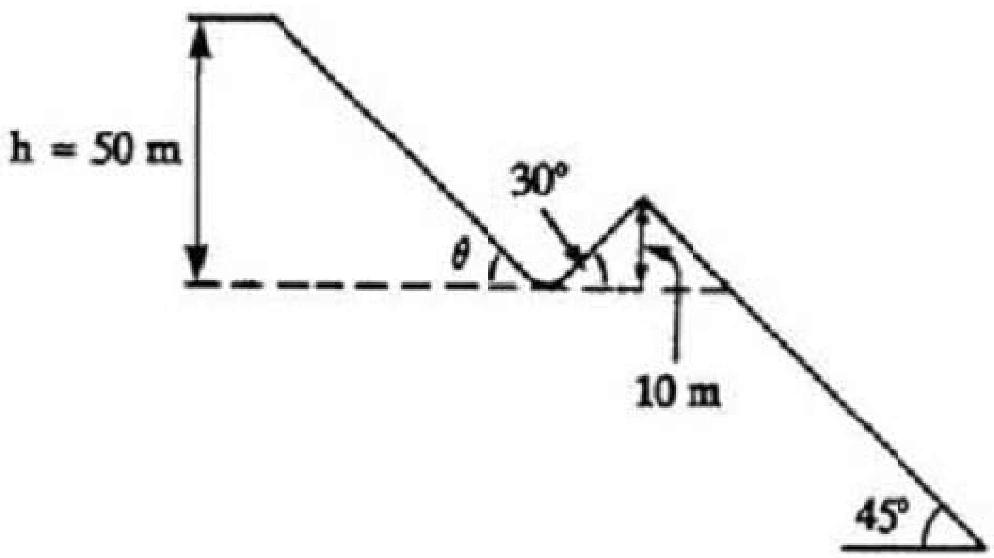


Figure 1

The distance traveled by the skier between leaving the ski jump ramp and making contact with the slope is called the jump distance. In some cases, in order to increase the jump distance a skier will jump slightly upon leaving the ramp,

thereby increasing the vertical velocity. Unless otherwise stated, assume that friction between the skis and the slope is negligible, and ignore the effects of air resistance.

How would the speed of a skier leaving the jump ramp change if the vertical height of the jump ramp were increased from its original height of 10 meters?

A. increase

B. decrease

C. remain the same

D. The answer depends on the incline angle of the jump ramp.

Correct Answer: B

This question is testing your knowledge of the conservation of energy. When the skier is at the top of the track, she is not moving so all her energy is potential energy. At the top of the track she has potential energy. When she leaves the jump ramp, she is moving. So she has kinetic energy equal to 1/2 mv2. The difference in height between the top of the track and the point on the jump ramp where she jumps from is proportional to the amount of potential energy that gets converted to kinetic energy. Let h equal the height of the platform at the top of the track minus the height of the top of the jump ramp. The greater h is, the more potential energy gets converted to kinetic energy, and the greater the skier\\'s speed when

$$\sqrt{2gh}$$

she jumps. Specifically, neglecting friction and air resistance, mgh = 1/2 mv2, and solving for v, we find that v = . In the question stem, we are told that the height of the ski jump ramp is increased; so h is decreased. Since v = , we see that a decrease in h corresponds to a decrease in v. Therefore, choice B is correct. You might have chosen answer choice A if you were careless and thought the track height increased.

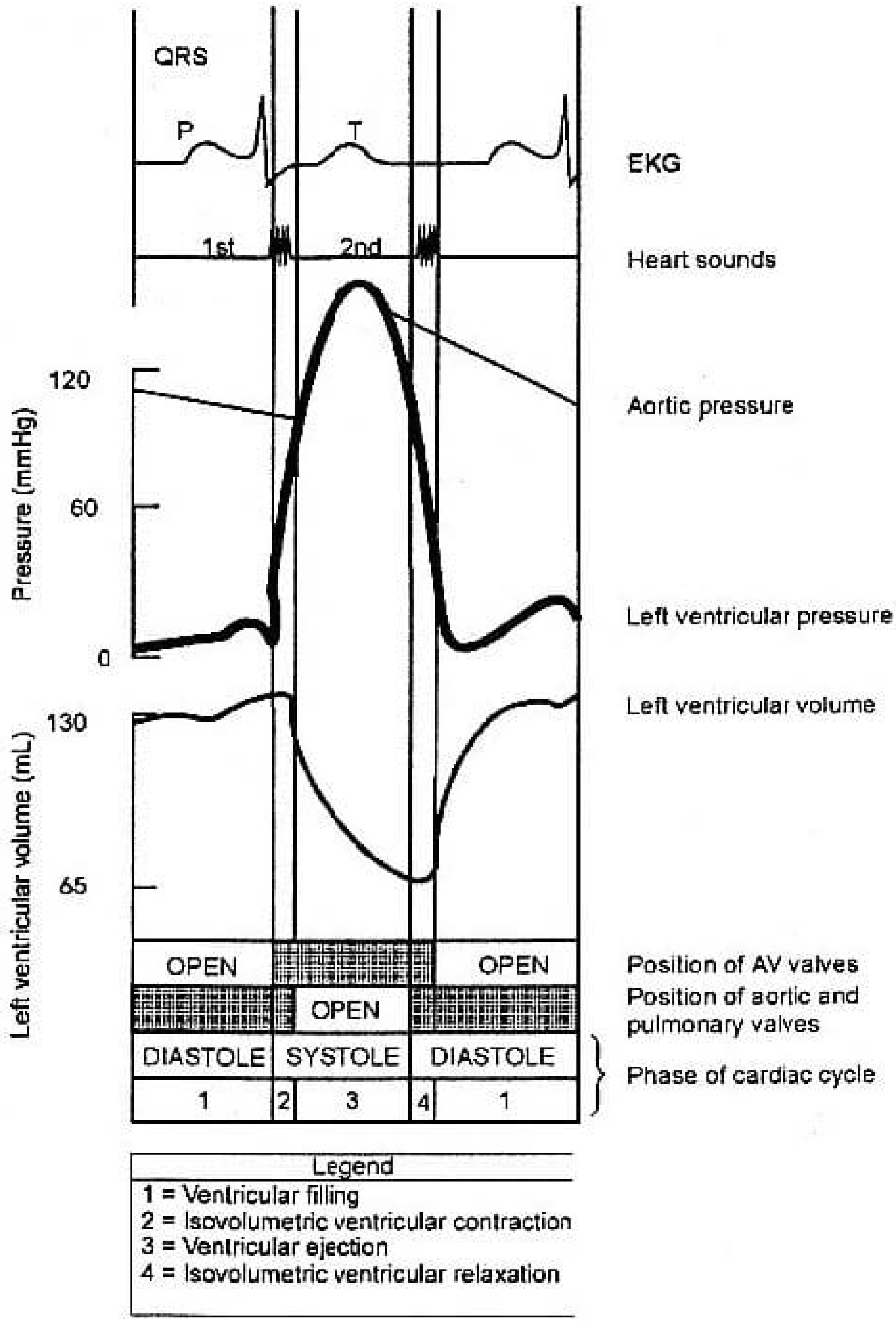
QUESTION 3

The process of depolarization triggers the cardiac cycle. The electronics of the cycle can be monitored by an electrocardiogram (EKG). The cycle is divided into two major phases, both named for events in the ventricle: the period of ventricular contraction and blood ejection, systole, followed by the period of ventricular relaxation and blood filling, diastole.

During the very first part of systole, the ventricles are contracting but all valves in the heart are closed thus no blood can be ejected. Once the rising pressure in the ventricles becomes great enough to open the aortic and pulmonary valves, the ventricular ejection or systole occurs. Blood is forced into the aorta and pulmonary trunk as the contracting ventricular muscle fibers shorten. The volume of blood ejected from a ventricle during systole is termed stroke volume.

During the very first part of diastole, the ventricles begin to relax, and the aortic and pulmonary valves close. No blood is entering or leaving the ventricles since once again all the valves are closed. Once ventricular pressure falls below atrial pressure, the atrioventricular (AV) valves open. Atrial contraction occurs towards the end of diastole, after most of the ventricular filling has taken place. The ventricle receives blood throughout most of diastole, not just when the atrium contracts.

Figure 1: Electronic and pressure changes in the heart and aorta during the cardiac cycle.



Would the walls of the atria or ventricles expected to be thicker?

A. Atria, because blood ejection due to atrial contraction is high.

B. Atria, because blood ejection due to atrial contraction is low.

C. Ventricles, because ventricular stroke volume is high.

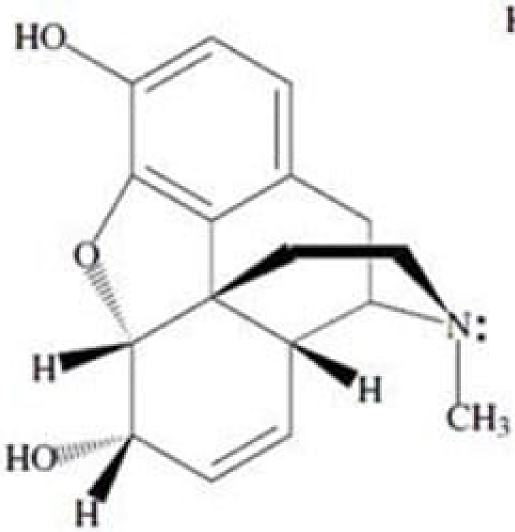
D. Ventricles, because ventricular stroke volume is low.

Correct Answer: C

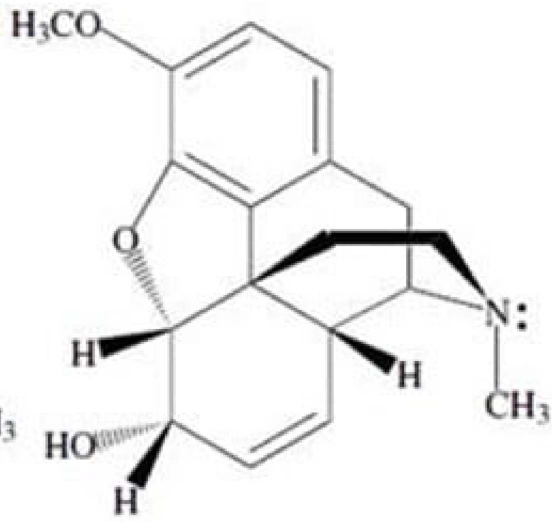
Thicker walls in a particular part of the heart would indicate that it is more muscular, and therefore is more efficient or forceful during its contraction. This immediately rules out answer choices B and D, as they suggest that the thicker walled chamber would be less efficient or forceful. It should be known from the biology review (BIO 7.2) that the ventricles are more muscular (thicker-walled), but in the event that this is not initially known, information regarding the function of both the atria and the ventricles from the passage may help lead to this conclusion. First, systole, the period of contraction, refers to the period of contraction of the ventricles not the atria (paragraph 1, line 5). This would indicate that the contraction of the ventricles might be more relevant in some way. Second, during diastole, atrial contraction occurs after most of the ventricle is already filled (paragraph 3, sentence 4) and serves to push the small amount of blood necessary to complete the filling into the ventricles. Since the atrial contraction does not need to move a large amount of blood (the ventricle is already mostly full), it does not need to be as muscular.

QUESTION 4

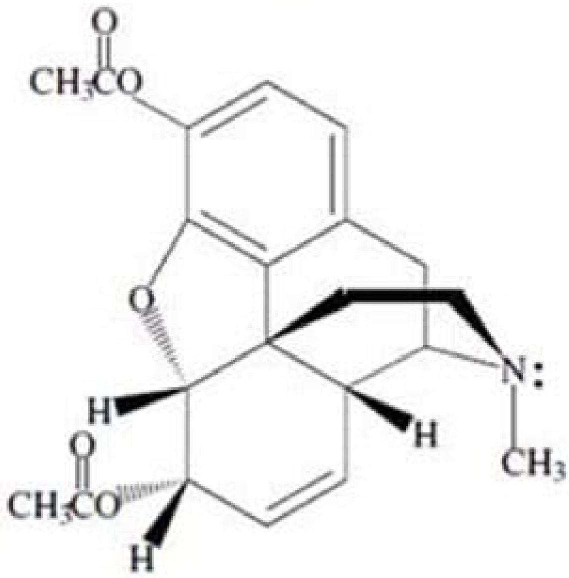
Morphine alkaloids derived from the opium poppy have long been used as analgesics. Codeine, the methyl ether of morphine, is a naturally occurring alkaloid with medicinal properties very similar to those of morphine. Thousands of derivatives of morphine have been synthesized and tested for their biological effects. For example, the diacylated derivative of morphine, heroin, is a highly addictive drug. Much effort has gone into understanding how morphine and its derivatives function.



Morphine



Codeine



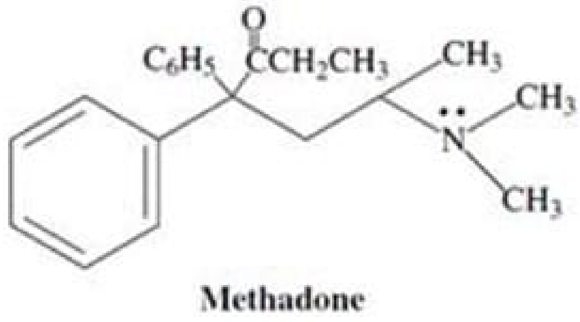
Heroin

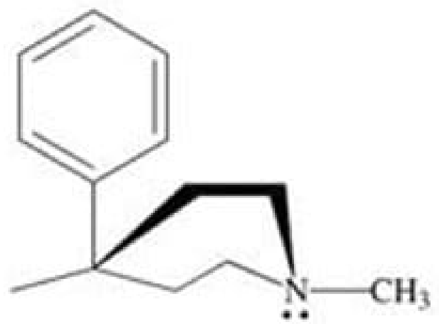
Studies have shown that certain common structural features of alkaloids are required for the compound to exhibit biological activity. These structural requirements are summarized by the so called "morphine rule":

Demerol and methadone, shown in Figure 2, are two synthetic alkaloids designed to satisfy the "morphine rule." Synthetic alkaloids such as these have been found to mimic certain physiological properties of morphine and its derivatives, and

have found pharmacological application due to other, more desirable biological effects. Methadone has been used widely in the United States and Great Britain as a treatment for heroin addiction; it reduces the physical symptoms

accompanying withdrawal without producing many of the other effects of heroin.

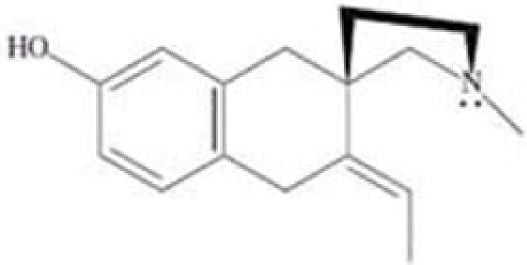




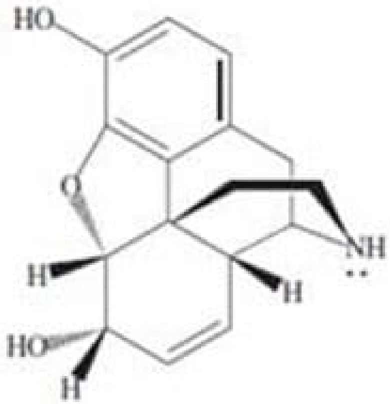
Meperidine (demerol) Figure 2

Which of the following compounds would be most likely to have morphine-like biological effects?

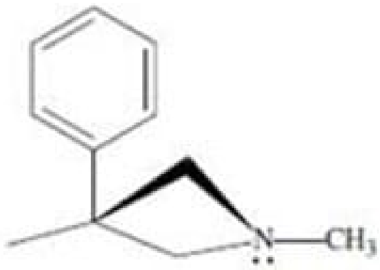
A.



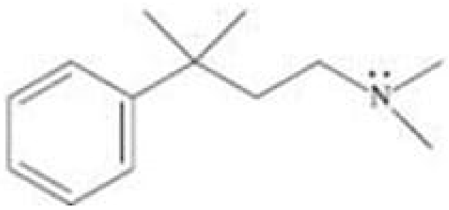
B.



C.



D.



A. Option A

B. Option B

C. Option C

D. Option D

Correct Answer: D

The passage states that there are certain requirements, the "morphine rules," that give a compound morphine-like biological activity. These requirements are an aromatic ring attached to a quaternary carbon and a tertiary amine situated two

carbons away from that quaternary carbon. A quaternary carbon is a carbon bonded to four alkyl groups. A tertiary amine is bonded to three alkyl groups. The only structure that meets these requirements is structure D. The other answer

choices look like the structures in the passage but do not meet all of the "morphine rules". Note that if the written description of the "morphine rules" is not clear enough, you can look at the figures in the passage as well. Choice A is incorrect

because the aromatic ring is not attached to a quaternary carbon. It is attached to two secondary carbons.

Choice B is incorrect because it lacks a tertiary amine. It has a secondary amine bonded to only 2 alkyl groups.

Choice C is incorrect because the tertiary amine is not located two carbons away from the quaternary carbon. It is only one carbon away from the quaternary carbon.

QUESTION 5

There are two opposing theories of light: the particle theory and the wave theory. According to the particle theory, light is composed of a stream of tiny particles that are subject to the same physical laws as other types of elementary particles.

One consequence of this is that light particles should travel in a straight line unless an external force acts on them. According to the wave theory, light is a wave that shares the characteristics of other waves. Among other things, this means

that light waves should interfere with each other under certain conditions.

In support of the wave theory of light, Thomas Young\\'s double slit experiment proves that light does indeed exhibit interference. Figure 1 shows the essential features of the experiment. Parallel rays of monochromatic light pass through two

narrow slits and are projected onto a screen. Constructive interference occurs at certain points on the screen, producing bright areas of maximum light intensity. Between these maxima, destructive interference produces light intensity minima.

The positions of the maxima are given by the equation dsin = n, where d is the distance between the slits, is the angle shown in Figure 1, the integer n specifies the particular maxima, and is the wavelength of the incident light. (Note:

sin tan for small angles.)

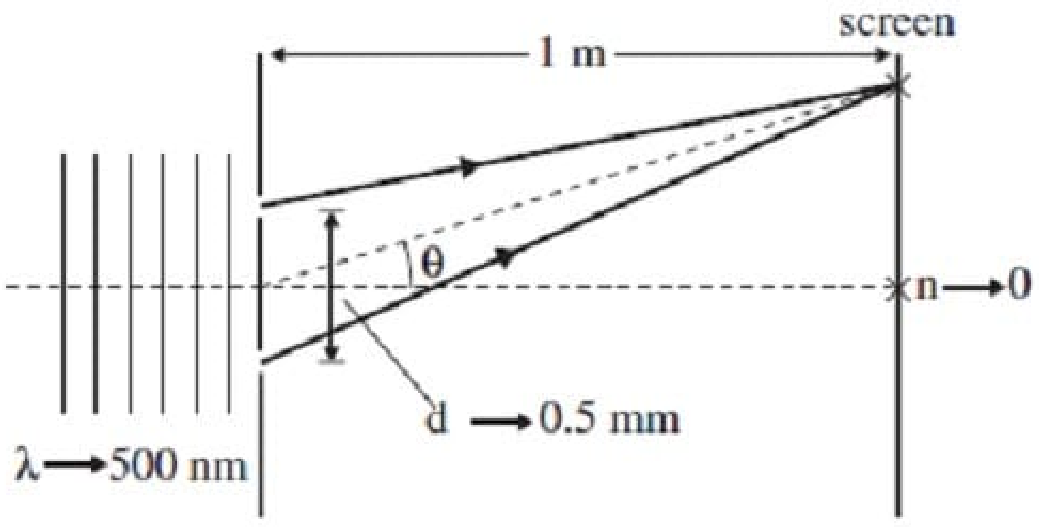


Figure 1

θ

What is the angle for the third maximum (n = 3)?

A. 3×10^{-5} radians

B. 3×10^{-3} radians

C. 0.3 radians

D. 0.3 degrees

A. Option A

B. Option B

C. Option C

D. Option D

Correct Answer: B

To solve this problem, apply the formula given in the passage which quantifies the positions of the intensity maxima. The formula is dsin = n, where d is the distance between the slits, is the angle, and is the wavelength. The note in the passage says that sin when is small. You have to know that this approximation is only valid when is measured in radians. Making this approximation, we obtain d = n, and solving for we obtain = n /d. Note that the distance units of and d can be anything as long as they

$$\theta = \frac{3(500 \times 10^{-9} m)}{5 \times 10^{-4} m} = 3 \times 10^{-3} \text{ radian}$$

are the same. n is given in the question stem, and and d are given in Figure 1. Substituting, we obtain

which is choice B.

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