# MCAT-TEST Q&As

Medical College Admission Test: Verbal Reasoning, Biological Sciences, Physical Sciences, Writing Sample

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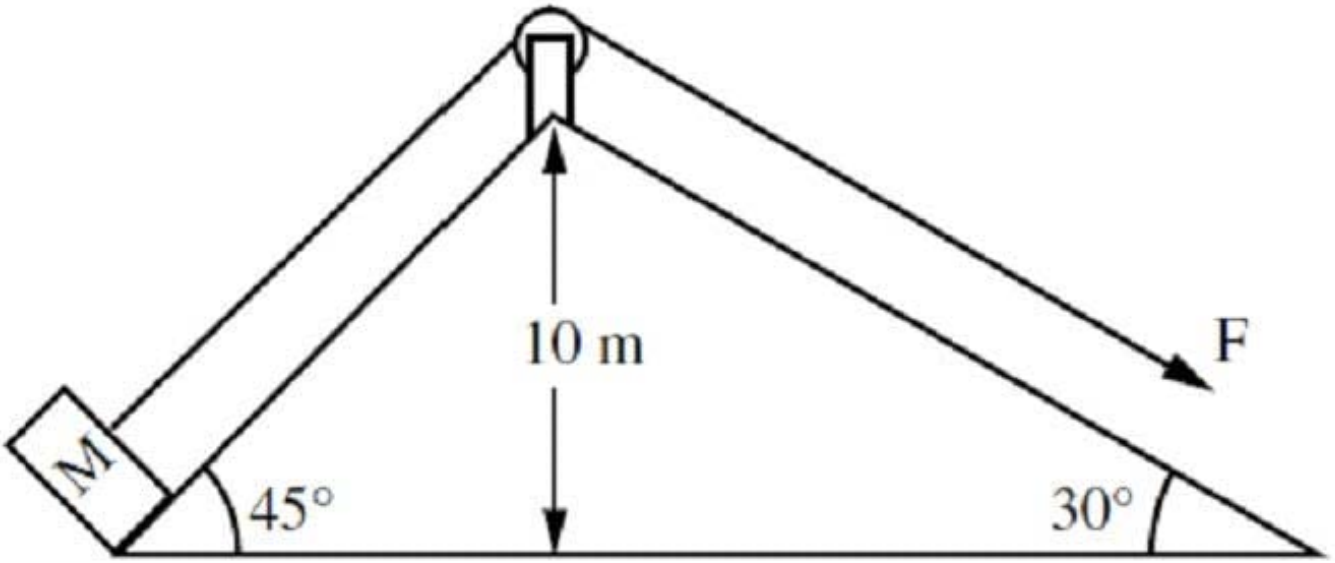
**QUESTION 1**

A5-kg mass M is being raised from the ground to the top of the inclined plane using the set-up shown in the diagram below. Assuming that the inclined plane is frictionless, what is the work done by the force F?




A. $490\ \text{J}$

B. $490\sqrt{3}\ \text{J}$

C. $490\sqrt{2}\ \text{J}$

D. $\frac{490}{\sqrt{2}}\ \text{J}$

$\sqrt{2}\ \text{J}$

A. Option A

B. Option B

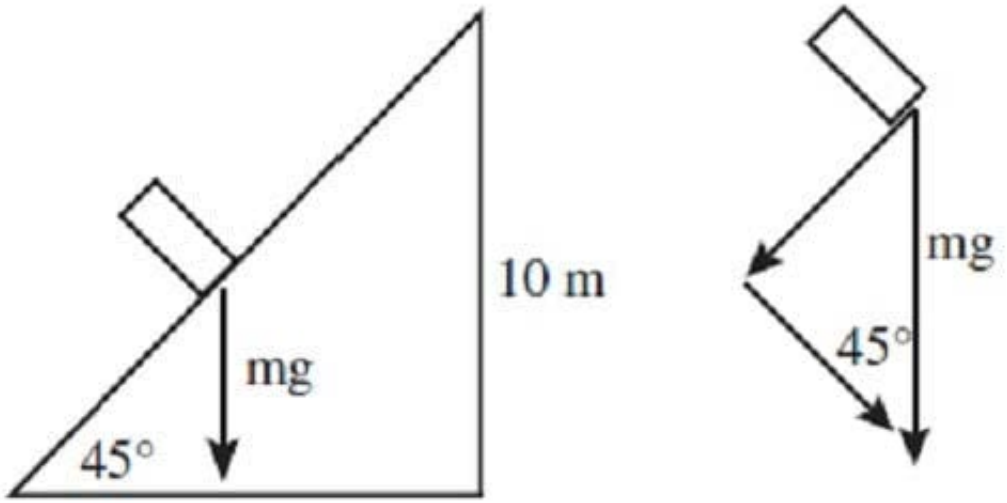
C. Option C

D. Option D

Correct Answer: A

There are two ways to solve this problem. The fast, easy way is to conduct a work-energy analysis. The initial energy of

the mass is taken as 0. The final energy (at the top of the incline) is mgh = 5(10)(10) = 500J. This change in energy is equal to the work done on the mass. We could also calculate the F required to lift the box and the distance over which that force is applied.




$$\frac{\sqrt{2}}{2}mg = \frac{\sqrt{2}}{2}(5)(10) = 25\sqrt{2}\text{N}.$$

$$\sqrt{10^2 + 10^2} = \sqrt{200} = 10\sqrt{2}.$$

The force required to move the box is equal to The distance travelled by the box up the incline is given by the pythagorean equation. Distance =

$$\text{Work} = \text{Distance} \times \text{force} = 10\sqrt{2} \times 25\sqrt{2} = 500\text{J}$$

**QUESTION 2**

Fluoroscopy is an imaging technique that uses X-rays to obtain real-time moving images of the interior of the body. A patient was asked to perform cycles of deep inspiration and deep expiration. Fluoroscopy was used to measure the linear velocity of the movement of the diaphragm and the data was plotted against time. The origin in Figure 1 is the reference time 0 when the diaphragm was essentially in its equilibrium position.

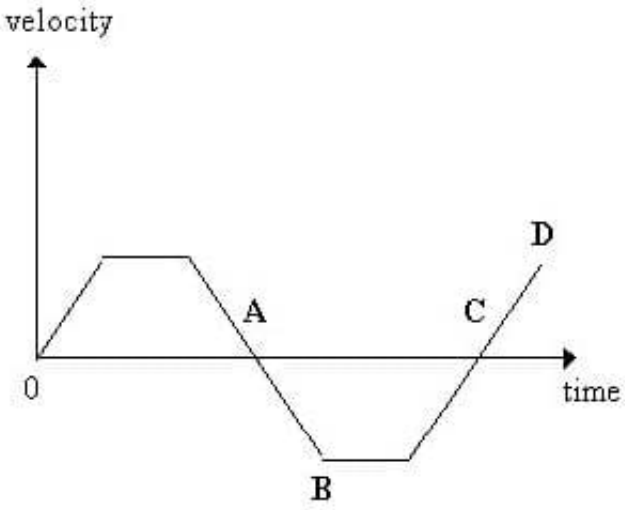



Figure 1

At what time after t = 0 is the displacement of the diaphragm at a minimum?

A. A

B. B

C. C

D. D

Correct Answer: C

To determine the displacement (NOT distance), take the area under the graph. The 2 similar sized trapezoids, one positive and the other negative, cancel each other. At time C, the diaphragm is back or near to its starting position; hence, its displacement has zero magnitude at that moment.

**QUESTION 3**

Ink jet printers produce high resolution output, at a lower cost than laser printers, by generating charged ink droplets which are then deflected onto a sheet of paper by an electric field. Each droplet deflected by the field strikes the paper and forms a tiny dot of ink. While a typical printed letter requires about 100 drops, an ink jet printer is able to produce drops at a rate of 100,000 per second.

$\times 10^{-10}$

The essential elements of the ink jet printer head are shown in Figure 1. The drop generator produces the ink droplets, each with a mass of approximately 1.2 kg and a diameter of approximately 30 m. The drops then enter a

$\times 10^{-13}$

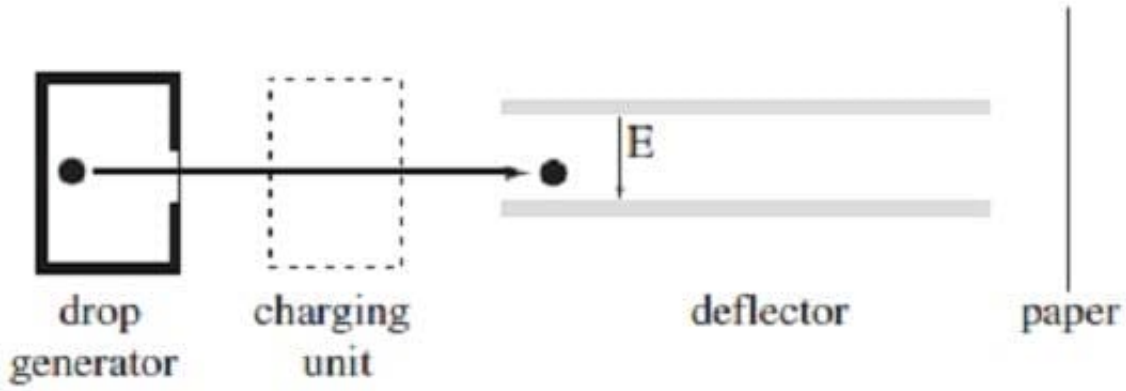
highly precise charging unit which controls the charge q on each droplet to within 2%, with typical charges for drops generated by various ink jet printers ranging from ?.0 C to ?.0 C. The charged droplets are

$\times 10^6$

subsequently passed through the deflecting plates between which a variable electric field is generated. The electronically controlled electric field between the plates is typically varied over a range from 1.0 N/C to 5.4 N/C,

(Note: $B = \frac{\mu_0 i}{2\pi r}$ $F = Eq$, and $k = 8.99 \times 10^9\ N \cdot m^2/C^2$)

and is used to aim the ink droplet at the paper. .




An ink jet printer deflects a particular ink droplet by 1.5 mm in the region of the deflector. Which of the following is a possible value of the work done on the droplet?

A. No work

B. $4.5 \times 10^{-13}$ J

C. $4.3 \times 10^{-10}$ J

D. $8.1 \times 10^{-8}$ J

A. Option A

B. Option B

C. Option C

D. Option D

Correct Answer: C

To deflect an ink droplet, the deflector must do work on the drop. The formula for calculating work is . To answer the question we must calculate the force generated by the electric field of the deflector. Because the electric field is uniform, the electric force will also be uniform. The electric force is related to electric field by the formula F = Eq.So, to calculate the work done by the drop, we can use the formula W = E X q X d. (The field and the displacement are parallel, so =

0?and cos = 1.) The question gives the distance as 1.5 mm and the passage gives a range of values for the field generated by the deflector and for the charge on the oil droplet. Because the answer choices are fairly spread out, we can calculate using average values for the drop charge and field strength.

$$(W = Fd\cos\theta)$$

$$W_{avg} = -E_{avg}\, q_{avg}\, d$$

$$W_{avg} = -(3.2 \times 10^{6}\text{N/C})(-6.5 \times 10^{-14}\text{C})(1.5 \times 10^{-3}\text{m}$$

$$W_{avg} = -(3.2 \times -6.5 \times 1.5)(10^{-11})$$

$$W_{avg} \approx 30 \times 10^{-11} = 3 \times 10^{-10}\,\text{J}$$

Choice A is incorrect because work is done by the electric field. If a magnetic field were involved, no work would be done because the force is always perpendicular to the direction of movement.

**QUESTION 4**

$$Fe_2O_3$$

Given the following H?values, calculate the H?of formation of (s).

$$6Fe_2O_3(s) \rightarrow 4Fe_3O_4(s) + O_2(g) \qquad +472.0\ \text{kJ mol}^{-1}$$

$$3Fe(s) + 2O_2(g) \rightarrow 4Fe_3O_4(s) \qquad -1118.4\ \text{kJ mol}^{-1}$$

A. Option A

B. Option B

C. Option C

D. Option D

Correct Answer: C

The H?for a reaction can be calculated as the difference between the heat of formation of the products and that of the reactants.

$$\Delta H^{\circ}_{\text{reaction}} = \Delta H^{\circ}_{f}\ \text{products} - \Delta H^{\circ}_{f}\ \text{reactants}$$

Recall that heat of formation is the heat of the reaction that produces 1 mol of the material in question from pure elements in their standard states. The heat of formation of elements in their standard states is zero. The passage provides the

$Fe_3O_4$:

reaction for formation of

$$3Fe(s) + 2O_2(g) \rightarrow Fe_3O_4 \qquad -1118.4\ kJ\ mol^{-1}$$

$Fe_2O_3$

So we can determine the heat of formation of from the first equation and the of given by the equation above.

$$\Delta H^\circ_{reaction} = 4(\Delta H^\circ_f\, Fe_3O_4) + \Delta H^\circ_f O_2 - 6(\Delta H^\circ_f\, Fe_2O_3)$$

$$+472 = 4(-1118.4) + 0 - 6(\Delta H^\circ_f\, Fe_2O_3)$$

$$4944 = -6(\Delta H^\circ_f\, Fe_2O_3)$$

$$\Delta H^\circ_f\, Fe_2O_3 = -824\ kJ\ mol^{-1}$$

You should, of course, use approximations judiciously to save time.

**QUESTION 5**

When Gwendolyn Brooks published her first collection of poetry A Street In Bronzeville in 1945 most reviewers recognized Brooks\\' versatility and craft as a poet. Yet, while noting her stylistic successes few of her contemporaries discussed the critical question of Brooks\\' relationship to the Harlem Renaissance. How had she addressed herself, as a poet, to the literary movement\\'s assertion of the folk and African culture, and its promotion of the arts as the agent to define racial integrity? The New Negro poets of the Harlem Renaissance expressed a deep pride in being Black; they found reasons for this pride in ethnic identity and heritage; and they shared a common faith in the fine arts as a means of defining and reinforcing racial pride. But in the literal expression of this impulse, the poets were either romantics, or realists and, quite often within the same poem, both. The realistic impulse, as defined best in the poems of McKay\\'s Harlem Shadows (1922), was a sober reflection upon Blacks as second class citizens, segregated from the mainstream of American socio-economic life, and largely unable to realize the wealth and opportunity that America promised. The romantic impulse, on the other hand, as defined in the poems of Sterling Brown\\'s Southern Road (1932), often found these unrealized dreams in the collective strength and will of the folk masses. In comparing the poems in A Street in Bronzeville with various poems from the Renaissance, it becomes apparent that Brooks brings many unique contributions to bear on this tradition. The first clue that A Street In Bronzeville was, at its time of publication, unlike any other book of poems by a Black American is its insistent emphasis on demystifying romantic love between Black men and women. During the Renaissance, ethnic or racial pride was often focused with romantic idealization upon the Black woman. A casual streetwalker in Hughes\\' poem, "When Sue Wears Red," for example, is magically transformed into an Egyptian Queen. In A Street In Bronzeville, this romantic impulse runs headlong into the biting ironies of racial

discrimination. There are poems in which Hughes, McKay and Brown recognize the realistic underside of urban life for Black women. But for Brooks, unlike the Renaissance poets, the victimization of poor Black women becomes not simply a minor chord but a predominant theme. ...Brooks\\' relationship with the Harlem Renaissance poets, as A Street in Bronzeville ably demonstrates, was hardly imitative. As one of the important links with the Black poetic tradition of the 1920s and 1930s, she enlarged the element of realism that was an important part of the Renaissance world-view. Although her poetry is often conditioned by the optimism that was also a legacy of the period, Brooks rejects outright their romantic prescriptions for the lives of Black women. And in this regard, she serves as a vital link with the Black Arts Movement of the 1960s that, while it witnessed the flowering of Black women as poets and social activists as well as the rise of Black feminist aesthetics in the 1970s, brought about a curious revival of romanticism in the Renaissance mode.

According to the passage, the poems in A Street in Bronzeville are similar to the poems in Harlem Shadows because they each:

A. portray Black women in early twentieth-century America as resourceful individuals who were able to make successes of themselves.

B. influenced the poetry and social activism of Black women poets during the Black Arts Movement of the 1960s.

C. are based entirely on the romantic impulse of the New Negro poets of the Harlem Renaissance.

D. illustrate the grim realities of suffering and discrimination faced by Black Americans in early twentieth- century America.

Correct Answer: D

The answer here requires a link between the two paragraphs in which the two works are described. The "realistic impulse" in McKay\\'s work (lines 17-18) parallels the realism credited to Brooks at the end of paragraph three.

Choice A is explicitly untrue about Harlem Shadows (lines 18-22). The author makes no link between Harlem Shadows and the Black Arts Movement of the `60\\'s; thus, choice B can be eliminated.

Choice C implies that Brooks was wholly in sync with Harlem Renaissance romanticism, which we know was not so.

Kaplan strategy: Don\\'t over-think. Proceed to the relevant portion(s) of the text and take the clues you\\'re given.

**QUESTION 6**

Bebop lives! cries the newest generation of jazz players. During the 1980s, musicians like Wynton Marsalis revived public interest in bebop, the speedy, angular music that first bubbled up out of Harlem in the early 1940s, changing the face of jazz. That Marsalis and others thought of themselves as celebrating and preserving a noble tradition is, in one sense, inevitable. After the excesses of experimental or "free" jazz in the 1960s and the electronic jazz-rock "fusion" of the 70s, it is hardly surprising that people should hearken back to a time when jazz was "purer," perhaps even at the apex of its development. But the recent enthusiasm for bebop is also ironic in light of the music\\'s initial public reception.

In its infancy, during the first two decades of the 20th century, jazz was played by small groups of musicians improvising variations on blues tunes and popular songs. Most of the musicians were unable to read music, and their improvisations were fairly rudimentary. Nevertheless, jazz attained international recognition in the 1920s. Two of the people most responsible for its rise in popularity were Louis Armstrong, the first great jazz soloist, and Fletcher Henderson, leader of the first great jazz band. Armstrong, with his buoyant personality and virtuosic technical skills, greatly expanded the creative range and importance of the soloist in jazz. Henderson, a pianist with extensive training in music theory, foresaw the orchestral possibilities of jazz played by a larger band. He wrote out arrangements of songs for his band members that preserved the spirit of jazz, while at the same time giving soloists a more structured musical background upon which to shape their solo improvisations. In the 1930s, jazz moved further into the mainstream with the advent of the Swing Era. Big bands in the Henderson mold, led by musicians like Benny Goodman, Count Basie and Duke

Ellington, achieved unprecedented popularity with jazz-oriented "swing" music that was eminently danceable.

Against this musical backdrop, bebop arrived on the scene. Like other modernist movements in art and literature, bebop music represented a departure from tradition in both form and content, and was met with initial hostility. Bebop tempos were unusually fast, with the soloist often playing at double time to the backing musicians. The rhythms were tricky and complex, the melodies intricate and frequently dissonant, involving chord changes and notes not previously heard in jazz. Before bebop, jazz players had improvised on popular songs such as those produced by Tin-Pan Alley, but bebop tunes were often originals with which jazz audiences were unfamiliar.

Played mainly by small combos rather than big bands, bebop was not danceable; it demanded intellectual concentration. Soon, jazz began to lose its hold on the popular audience, which found the new music disconcerting. Compounding public alienation was the fact that bebop seemed to have arrived on the scene in a completely mature state of development, without that early phase of experimentation that typifies so many movements in the course of Western music. This was as much the result of an accident of history as anything else. The early development of bebop occurred during a three-year ban on recording in this country made necessary by the petrol and vinyl shortages of World War II. By the time the ban was lifted, and the first bebop records were made, the new music seemed to have sprung fully-formed like Athena from the forehead of Zeus. And though a small core of enthusiasts would continue to worship bebop pioneers like Charlie Parker and Dizzy Gillespie, many bebop musicians were never able to gain acceptance with any audience and went on to lead lives of obscurity and deprivation.

Based on the information in the passage comparing bebop to other movements in the history of Western music, it is reasonable to conclude that:

I. most movements in music history passed through a stage of experimentation before reaching mature expression.

II. World War II prevented bebop from reaching a more appreciative audience.

III.

bebop did not go through a developmental stage before reaching mature expression.

A.

I only

B.

III only

C.

I and II only

D.

II and III only

Correct Answer: A

This is in Roman Numeral format. It asks one to draw a reasonable conclusion from information in the passage "comparing bebop to other movements in the history of Western music". That phrase "Western music" appears only once in the passage. It\\'s in the third sentence of the final paragraph. That\\'s where the author compares bebop to "other movements in the course of Western music." The author says there that public alienation or estrangement toward bebop was intense because bebop seemed to have arrived "in a completely mature state of development, without that early phase of experimentation that typifies so many movements in the course of Western music". This not only indicates something about bebop, it educates about most movements in the course of Western music -- namely, that they go through at least two phases: an early, experimental phase, and a later, more mature, more fully developed

phase. This is the substance of Roman Numeral statement I, which is a reasonable conclusion and therefore will be part of the correct answer. Notice that choices (B) and (D) do not include Roman Numeral Statement I; thus, they can be eliminated. Since either choice (A), which offers statement I only, or choice (C), which offers statements I and II, must be the correct answer. One can review only statement II to determine the right answer. Statement II says that W.W.II prevented bebop from reaching a more appreciative audience. This is a distortion of the fifth sentence of the final paragraph, which says that a petrol shortage during World War II necessitated a three-year ban on the making of records. But, according to the author, it was not the recording ban that prevented bebop from reaching a more appreciative audience. Instead, the recording ban was responsible for making it seem to audiences as if bebop had bypassed that early, experimental stage and instantly achieved mature development. It was the radical elements of bebop itself that prevented the music from appealing to a wider audience. So statement II is false, and choice (A), statement I only, is the correct answer. Statement III says that bebop did not go through a developmental stage before reaching mature expression. This is not true. Bebop did go through a developmental stage, and it is discussed in the middle of the last paragraph. The key point here is that few people heard the music during this phase because of the ban on recording. Statement III is false.

**QUESTION 7**

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.)

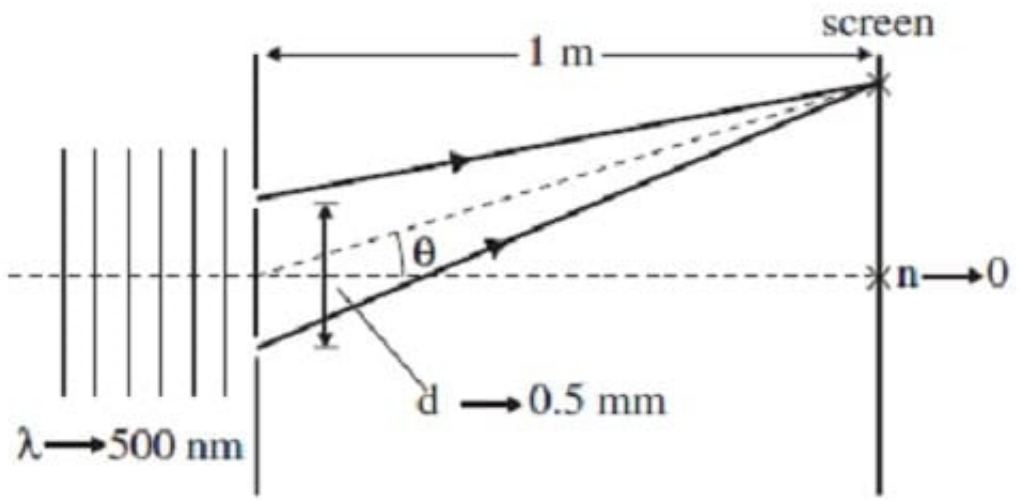



Figure 1

Light waves can be described in terms of frequency f and wavelength or in terms of wave number k and angular frequency . These quantities are related by the following equations:

k = 2/ and = 2f

Which equation below accurately describes the speed of the wave v in terms of k and ?

A. v = f

B. v = + k

C. v = /k

D. v = k

Correct Answer: C

You should know that the speed v of a wave is given by v = f, where f is the frequency of the wave, and is its wavelength. This makes sense, since is the distance traveled by the wave in one cycle, and frequency is the inverse of the period, which is the time it takes for one wave to cycle. Now solve the relation in the question stem k = 2/ for to obtain = 2/k. Also solve = 2f for f to obtain f = /2. Substituting these expressions into the speed equation, we obtain v = f = (/2)(2/k) = /k, which is choice C. Choice A, while a correct relation, is not the right answer because it does not express v in terms of and k. Choices B and D can be eliminated on the basis of dimensional analysis because they do not have the units of speed, m/s. k has units of m-1 and has units of S-1, so choice B is nonsensical and choice D has units of 1/(ms).

**QUESTION 8**

A continuous spectrum of light, sometimes called blackbody radiation, is emitted from a region of the Sun called the photosphere. Although the continuous spectrum contains light of all wavelengths, the intensity of the emitted light is much greater at some wavelengths than at others. The relationship between the most intense wavelength of blackbody radiation and the temperature of the emitting body is given by Wien\\'s law, ? = 2.9 x 106 /T, where ? is the wavelength in nanometers and T is the temperature in kelvins.

As the blackbody radiation from the Sun passes through the cooler gases in the Sun\\'s atmosphere, some of the photons are absorbed by the atoms in these gases. A photon will be absorbed if it has just enough energy to excite an electron from a lower energy state to a higher one. The absorbed photon will have an energy equal to the energy difference between these two states. The energy of a photon is given by E = hf = hc/? where h = 6.63 x 10-34 J•s, Planck\\'s constant, and c = 3 x 108 m/s, the speed of light in a vacuum.

The Sun is composed primarily of hydrogen. Electron transitions in the hydrogen atom from energy state n = 2 to higher energy states are listed below along with the energy of the absorbed photon:

Final Energy State Energy (x 10-19 J)

n = 3

3.02

n = 4

4.08

n = 5

4.57 n = 6

4.84 n = ?

5.44

The energy absorbed by a hydrogen atom as its electron undergoes a transition from the n = 1 energy state to the n = ? state is: (Note: The n = 1 energy state is the ground state of hydrogen.)

A. infinite.

B. equal to the binding energy of the electron.

C. equal to the energy of a zero-frequency photon.

D. smaller than the energy absorbed in the n = 2 ton = transition.

Correct Answer: B

**QUESTION 9**

A psychologist conducts an experiment in which subjects are asked to learn a series of "facts" which are actually statements that have been fabricated by the research team. The subjects consist of undergraduate students at the university where the experiment is being conducted. The subjects are randomly assigned to groups that are compensated either $10 or $20 for their participation, are given either 15 minutes or 30 minutes to learn the facts, and are asked to recall the facts either in the same room in which they learned the facts or in a very different, unfamiliar setting.

Which of the following are dependent variables in this experiment?

I. The amount the subjects were compensated.

II. The room in which the subjects were asked to recall facts.

III. The number of facts the subjects can recall.

IV.

The time the subjects were given to learn the facts.

A.

II only

B.

III only

C.

I and IV only

D.

I and III and IV only

Correct Answer: B

In experimental design, the dependent variable is the variable being tested as a possible effect or output, whereas the independent variables are those that are controlled by the experimenters and tested as possible causes. Here, the experimenters controlled the compensation amount, the time to learn, and the room in which the subjects were asked to recall the information. Thus, I, II, and IV are independent variables. The dependent variable here is III, the measured recall rate of the facts.

**QUESTION 10**

Band theory explains the conductivity of certain solids by stating that the atomic orbitals of the individual atoms in the solid merge to produce a series of atomic orbitals comprising the entire solid. The closely-spaced energy levels of the orbitals form bands. The band corresponding to the outermost occupied subshell of the original atoms is called the valence band. If partially full, as in metals, it serves as a conduction band through which electrons can move freely. If the valence band is full, then electrons must be raised to a higher band for conduction to occur. The greater the band gap between the separate valence and conduction bands, the poorer the material\\'s conductivity. Figure 1 shows the valence and conduction bands of a semiconductor, which is intermediate in conductivity between conductors and insulators.

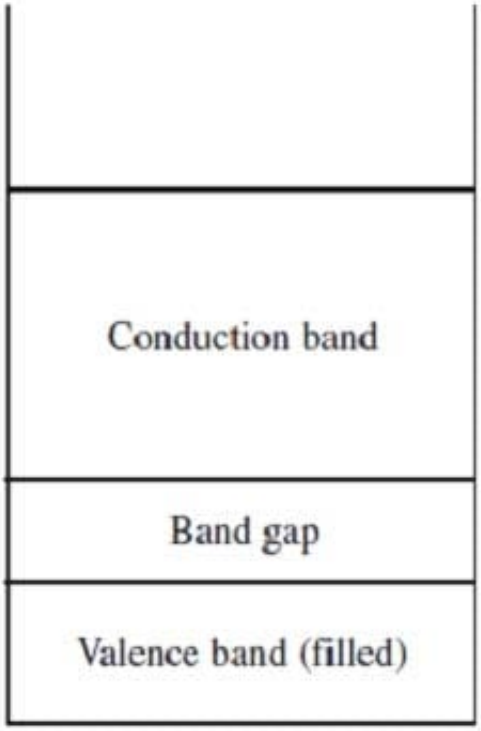



Figure 1

When silicon, a semiconductor with tetrahedral covalent bonds, is heated, a few electrons escape into the conduction band. Doping the silicon with a few phosphorus atoms provides unbonded electrons that escape more easily, increasing conductivity. Doping with boron produces holes in the bonding structure, which may be filled by movement of nearby electrons within the lattice. When a semiconductor in an electric circuit has excess electrons on one side and holes on the other, electron flow occurs more easily from the side with excess electrons to the side with holes than in the reverse direction.

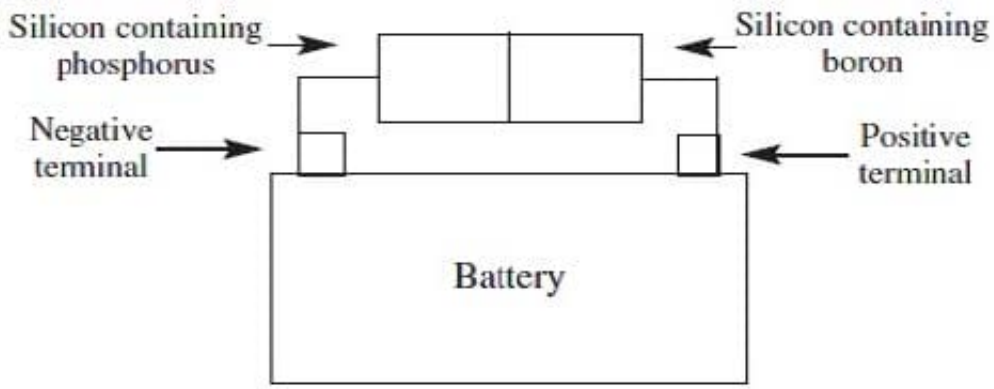



Figure 2 If the semiconductor orientation in Figure 2 were reversed so that the boron-doped silicon was on the left and the phosphorus-doped silicon on the right, what could be said about the electron flow of the new setup?

A. The electron flow is easier in the new direction than in that of Figure 2.

B. The electron flow is the same in either direction.

C. The electron flow is more difficult in the new direction than in that of Figure 2.

D. The electrons cannot flow in the new setup.

Correct Answer: C

The passage provides almost all the necessary information to answer this question. The only piece of background information needed is that electrons flow from the negative terminal to the positive terminal. The passage states that phosphorus-doped silicon has more electrons than pure silicon and that boron-doped silicon has fewer electrons than pure silicon. In addition, it is stated that electrons flow more easily from a side with excess electrons -- the phosphorus-doped silicon -- to a side with fewer electrons -- the boron-doped silicon. So, if the semiconductor orientation were switched, electron flow would not be as easy as the original configuration. Choice C is therefore the correct response.

**QUESTION 11**

How will the gravitational force between two objects change if the distance between them is doubled?

A. It will remain constant.

B. It will decrease by a factor of 4.

C. It will increase by a factor of 4.

D. It will be cut in half.

Correct Answer: B

The gravitational force between two objects is inversely proportional to the distance between them squared.

**QUESTION 12**

A researcher in a molecular biology lab planned to carry out an extraction procedure known as an alkaline plasmid prep, which is designed to purify plasmids, small pieces of the hereditary material DNA, from bacterial cells. The bacteria are first placed into a test tube containing liquid nutrient medium and allowed to grow until they reach a high population density. The culture, which consists of solid cells suspended in the medium, is then centrifuged; a solid pellet is formed. The supernatant is poured out, leaving the pellet behind, and the cells are resuspended in a mL of lysis buffer solution (50 mM glucose, 25 mM Tris buffer and 10 mM ethylenediaminetetraacetic acid (EDTA), with 5 mg of the enzyme lysozyme added). They are then incubated for 30 minutes at 0°C, during which time the bacterial cell walls break down and the cell contents are released into the solution. After incubation, 1 mL of 0.4 N sodium hydroxide and 1 mL of 2% sodium dodecyl sulfate (SDS) are added, and the solution is again incubated on ice for 10 minutes. 2 mL of 3 M sodium acetate are added and the mixture is incubated for 30 minutes at 0°C. The test tube is centrifuged once more and the supernatant is decanted into a clean tube, leaving behind the protein and most other cell components in the pellet. Finally, 10 mL of pure ethanol are added to the supernatant from the previous step to precipitate out the DNA, and the test tube is incubated at –20°C for 60 minutes, during which the mixture remains liquid. The mixture is centrifuged a final time and the supernatant removed. The translucent precipitate that results is washed with 70% ethanol (70% ethanol and 30% water by volume), allowed to dry, and resuspended in 1 mL of TE buffer (10 mM Tris, 1 mM EDTA). In preparation for this experiment, the researcher prepared stock solutions of the various chemicals that she will need in the experiment. Stock solutions are highly concentrated solutions of commonly used chemicals in water from which dilute solutions are prepared for daily use. Table 1 shows the chemicals, their molecular formulas and weights, and the composition of commonly used stock solutions.

**Table 1**

| Compound | Formula | MW | Stock |
|---|---|---|---|
| Tris | $(CH_2OH)_3CNH_2$ | 121 | 1*M* (pH 8) |
| EDTA | $(HOOCCH_2)_4(CNH_2)_2$ | 292 | 0.5 *M* (pH 8) |
| Sodium hydroxide | NaOH | 40 | 5 *N* |
| SDS | $C_{11}H_{23}CH_2OSO_3^-Na^+$ | 288 | 10% |
| Sodium acetate | $CH_3COO^-Na^+$ | 82 | 3 *M* (pH 5.2) |
| Ethanol | $CH_3CH_2OH$ | 46 | 95% |

Which of the following conclusions can be reached based on the fact that DNA precipitates in the last step of the plasmid prep procedure?

A. DNA dissolves better in water at lower temperatures.

B. DNA is polar and therefore dissolves better in water than in a mixture of water and ethanol.

C. DNA is nonpolar and therefore dissolves better in ethanol than in water.

D. DNA dissolves well in ethanol and precipitates only because the solution is centrifuged.

Correct Answer: B

In the last step of the plasmid prep procedure, ethanol is added to the mixture, which is an aqueous solution, or a solution whose solvent is water. Then the test tube is incubated at low temperature for an hour, and finally the solution is centrifuged and a DNA precipitate forms. This happens because DNA, or deoxyribonucleic acid, is a highly polar substance, and is therefore more soluble in an aqueous solution than in a solvent composed mostly of ethanol. Thus, choice B is correct. Remember the rule that like dissolves like: thus a highly polar substance will dissolve better in a more polar solvent -- water -- than in a less polar solvent -- ethanol. Choice c is wrong because there\\'s no evidence in the passage that DNA dissolves better in ethanol than in water; in fact, there\\'s evidence against this conclusion, since the DNA is fully dissolved in the water solution but precipitates out of the water-ethanol solution. Choice D is wrong because centrifugation can\\'t make a substance precipitate out of a solution; it can only make a precipitate that is suspended in the solution settle to the bottom. Finally, choice A is wrong because there\\'s no evidence that DNA dissolves better at lower temperatures; on the contrary, the incubation at ?0?apparently contributes to its precipitation.

**QUESTION 13**

Which of the following glands is known as "master gland"?

A. Thyroid

B. Pituitary

C. Island of Langerhans

D. Adrenal

Correct Answer: B

**QUESTION 14**

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.

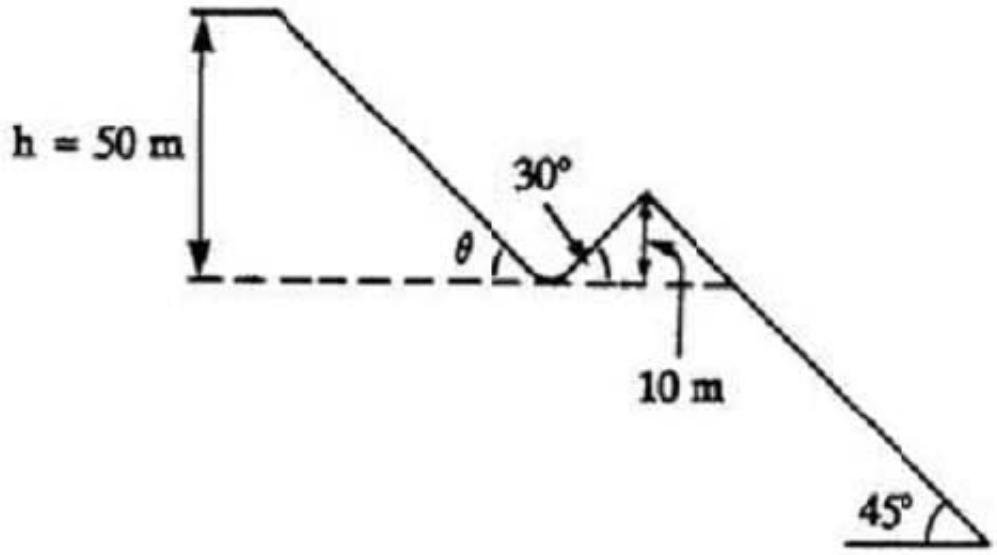



Figure 1

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.

If a skier uses skis of greater surface area, which of the following would occur?

A. The normal force of the slope on the skier would increase.

B. The normal force of the slope on the skier would decrease.

C. The pressure exerted on the slope by the skis would increase.

D. The pressure exerted on the slope by the skis would decrease.

Correct Answer: D

The only condition that changes in this question is the surface area of the skis. The normal force of the slope on the skier depends only on the mass of the skier, the acceleration due to gravity, and the angle of the slope. Therefore, changing the surface area of the skis would not affect the normal force, and choices A and B are incorrect. Therefore, the pressure exerted on the slope by the skis must depend on the surface area of the skis. The exact relationship is P = F/A, where P is the pressure on the slope due to the skis, F is the force exerted by the skis on the slope, and A is the surface area over which the force acts, which in this case is the surface area of the skis. The force exerted by the skis is just the component of the weight of the skier normal to the slope, or the normal force, which is constant. Therefore, the pressure is inversely proportional to the surface area of the skis. So the pressure decreases as the surface area increases, choice

D.

**QUESTION 15**

Four major blood types exist in the human ABO blood system: types A, B, AB, and O; and there are three alleles that code for them. The A and B alleles are codominant, and the O allele is recessive. Blood types are derived from the presence of specific polysaccharide antigens that lie on the outer surface of the red blood cell membrane. The A allele codes for the production of the A antigen; the B allele codes for the production of the B antigen; the O allele does not code for any antigen. While there are many other antigens found on red blood cell membranes, the second most important antigen is the Rh antigen. Rh is an autosomally dominant trait coded for by 2 alleles. If this antigen is present, an individual is Rh+; if it is absent, an individual is Rh-. For example, a person with type AB blood with the Rh antigen is said to be AB+.

These antigens become most important when an individual comes into contact with foreign blood. Because of the presence of naturally occurring substances that closely mimic the A and B antigens, individuals who do not have these antigens on their red blood cells will form antibodies against them. This is inconsequential until situations such as blood transfusion, organ transplant, or pregnancy occur.

Erythroblastosis fetalis is a condition in which the red blood cells of an Rh+ fetus are attached by antibodies produced by its Rh- mother. Unlike ABO incompatibility, in which there are naturally occurring antibodies to foreign antigens, the Rh system requires prior sensitization to the Rh antigen before antibodies are produced. This sensitization usually occurs during the delivery of an Rh+ baby. So while the first baby will not be harmed, any further Rh+ fetuses are at risk.

The Coombs tests provide a method for determining whether a mother has mounted an immune response again her baby\\'s blood. The tests are based on whether or not agglutination occurs when Coombs reagent is added to a sample. Coombs reagent contains antibodies against the anti-Rh antibodies produced by the mother. The indirect Coombs test takes the mother\\'s serum, which contains her antibodies but no red blood cells, and mixes it with Rh+ red blood cells. Coombs reagent is then added. If agglutination occurs, the test is positive, and the mother must be producing anti-Rh antibodies. The direct Coombs test mixes the baby\\'s red blood cells with Coombs reagent. If agglutination occurs, the test is positive, and the baby\\'s red blood cells must have been attacked by its mother\\'s anti-Rh antibodies.

How might one most practically assess the risk of erythroblastosis fetalis in a pregnant woman?

A. Test all women for the presence of anti-Rh antibodies.

B. Test all fetuses for the presence of the Rh antigen within the first trimester of pregnancy.

C. Test only Rh?mothers for the presence of anti- Rh antibodies.

D. Test all mothers of Rh+ children for the presence of anti-Rh antibodies.

Correct Answer: C

In answering this question, you must have an understanding of Rh incompatibility and also keep in mind that you\\'re asked to choose the most PRACTICAL screening program. Rh incompatibility exists when an Rh negative mother, who has been sensitized to the Rh antigen by a previous pregnancy, is pregnant with another Rh positive baby. The risk exists in that the mother, as a result of this previous exposure to the Rh antigen, has produced antibodies that will now attack the fetus\\' red blood cells, which are Rh positive. So, the first step in making the assessment of erythroblastosis fetalis risk is to narrow down the group being assessed. Well, the mother must definitely be Rh negative for there to be ny risk at all, which means that testing all women, as a choice A, is extremely impractical. So choice A is incorrect. Choice B is incorrect because it tests all fetuses for the presence of the Rh antigen. This is useless unless the mother is known to be Rh negative. The most practical test is the one that singles our Rh negative mothers for testing. So, choice B is also incorrect. Choice C, however, is practical. It does single out Rh negative mothers to test them for the presence of anti-Rh antibodies. Choice D is not practical because all mothers of Rh positive children, regardless of their own blood type, are tested. Both Rh positive and Rh negative mothers would be tested, which is unnecessary and expensive. So, choice C is the correct answer; test Rh negative mothers to determine whether or not they are producing anti-Rh antibodies. If the test is positive, then there is a risk of erythroblastosis fetalis for an Rh positive fetus.