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QUESTION 1

The mind, just like the body, has its needs. The needs of the body are the foundations of society; those of the mind are its amenities. While government and laws provide for the safety and well-being of men when they gather together, the sciences and the arts, which are less despotic but perhaps more powerful, spread garlands of flowers over the iron chains that bind them, stifle in them the sense for that original liberty for which they seem to have been born, cause them to love their own enslavement, and turn them into so-called "civilized people." Necessity raised thrones; the sciences and the arts have strengthened them. O earthly powers: cherish talents and protect those who cultivate them. O civilized people, cultivate them: you happy slaves owe to them that delicate and refined taste of which you are so proud, that gentleness of character and urbanity of manner which make relations among you so amiable and easy -- in other words, that semblance of all the virtues, none of which you actually possess... ...How pleasant it would be to live among us, if our external appearance were always a reflection of what is in our hearts, if decency were virtue, if our maxims served as our rules, and if true philosophy were inseparable from the title of philosopher! But so many qualities are seldom found together, and virtue hardly ever walks in such great pomp. Richness of adornment may be the mark of a man of taste, but a healthy, robust man is known by other signs: it is beneath the rustic clothes of a farmer, and not the gilt of a courtier, that strength and vigor of the body will be found. Ornamentation is just as foreign to virtue, which is the strength and vigor of the soul. The good man is an athlete who prefers to compete in the nude: he disdains all those vile ornaments which would hinder the use of his strength, ornaments which were for the most part invented only to hide some deformity. Before art had molded our manners and taught our passions to speak an affected language, our customs were rustic but natural, and differences in conduct revealed clearly differences in character. Human nature, basically, was no better, but men found security in being able to see through each other easily, and this advantage, which we no longer appreciate, spared them many vices. Now that more subtle refinements and more delicate taste have reduced the art of pleasing to set rules, a base and deceptive uniformity prevails in our behavior, and all minds seem to have been cast in the same mold. Incessantly politeness and propriety make demands on us, and incessantly we follow usage but never our own inclinations. We no longer dare to appear as we are, and under this perpetual constraint, the men who form this herd called society, when placed in the same circumstances, will all act similarly unless stronger motives direct them to do otherwise. Therefore we will never know well those with whom we deal, for to know our friends we will have to wait for some crises to arise -- which is to say that we will have to wait until it is too late, as it is for these very crises that it is essential to know one\\'s friends well. What vice would not accompany this uncertainty? No more sincere friendships, no more genuine esteem, no more well-based confidence. Suspicion, offenses, fears, coldness, reserve, hatred and betrayal will constantly hide under the same false veil of politeness, under that much touted urbanity which we owe to the enlightenment of our times. The name of the Master of the Universe will no longer be profaned by swearing, but insulted by blasphemies that will not offend our scrupulous ears. Men will not boast of their own merits, but belittle those of others. An enemy will not be crudely insulted, but adroitly slandered. National hatreds will die, but so will patriotism. A dangerous skepticism will take the place of the scorning of ignorance. Some excesses will be forbidden, some vices dishonored, but others will be dignified with the name of virtues, and one must either have them or feign them. Let those who want to praise the sobriety of the sages of our time do so; as for me, I see in it only a refinement of intemperance that is as unworthy of my praise as their hypocritical simplicity.

According to the tone and content of the passage, which statement best reflects the author\\'s opinion of the purpose of the sciences and the arts?

A. They are necessary for the safety and well-being of mankind.

B. They interfere with responsive action and honest communication.

C. They reinforce the sense of "original liberty" that is present in all men.

D. They have molded our reactions into predictable but essential forms.

Correct Answer: B

The primary argument is that man has become burdened by politeness, which springs from devotion to the graces. He implies that a "natural" man, who responded simply and plainly and with honesty, is preferable because his character is

known from the outset.

A is not true -- government and laws are necessary for the safety and well-being of mankind; C is incorrect because the arts cloud over the "original liberty" that each man is provided with; D is incorrect because the author believes the

molding is absolutely not essential.

QUESTION 2

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

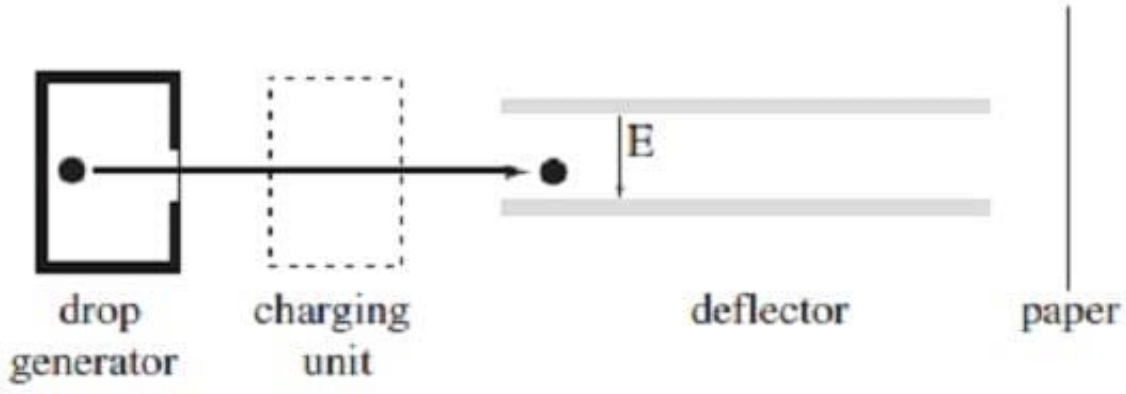
$\times 10^{-13}$

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 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,

$\times 10^{6}$

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

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



In which direction would the deflector in Figure 1 deflect the ink drop?

A. Upwards in the plane of the page

B. Downwards in the plane of the page

C. Into the plane of the page

D. Out of the plane of the page

E. (0,1) and (2,1)

F. (0,1) and (0,2)

G. (1,1) and (3,1)

H. (2,1) and (1,2)

Correct Answer: A

An electric field indicates the direction in which a positive charge would be accelerated. The ink droplet is negatively charged and will thus be accelerated in the opposite direction to that of the electric field. Since the electric field in Figure 1 points down, the charged ink droplet will be defelected upwards in the plane of the page. Choice B is incorrect because a positive charge would be deflected downwards in the plane of the page. Choices C and D are incorrect applications of the right hand rule. The right hand rule is used to determine the force on a charge moving through a magnetic field. This problem concerns movement of a charge through an electric field.

QUESTION 3

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

Based on the data in the table, what is the approximate wavelength of a photon emitted in the electron transition from

energy state n = 4 to energy state n = 3?

A. 5 nm

B. 30 nm

C. 100 nm

D. 2,000 nm

Correct Answer: D

QUESTION 4

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.

A couple decide to have a child. If the father\\'s genotype is AO and the mother has type B blood of unknown genotype, which of the following are possible blood types for their child?

I. A

II. B

III. A, B

IV.

O

A.

I and II only

B.

I, II, and III only

C.

I, II, and IV only

D.

I, II, III, and IV

Correct Answer: D

This is one of those questions requiring an understanding of simple genetics and the ABO system. If you didn\\'t already know it, you\\'re told in the passage that the A and B alleles are codominant to each other, and that the O allele is recessive. Codominance means that both the alleles are phenotypically expressed. So, when a person has both the A and the B alleles, a person is said to have type AB blood and expresses the properties ascribed to BOTH alleles -- that is, their red blood cells have both the A and B antigens on their surface. During sexual reproduction, the mother and father each donate one allele to their offspring. In this case we know the father\\'s genotype is AO. This means that he can donate either an A allele or an O allele to his child. We don\\'t, HOWEVER, know the mother\\'s genotype; we only know that her phenotype is type B blood. Well, this means that her genotype is either BO or BB -- we simply don\\'t know which one it actually is. Let\\'s first assume the mother to have the genotype BB and must therefore donate a B allele to the child. In this situation, if the father donates an A, the child\\'s genotype and phenotype will b ABk. If the father donates an O allele, the child\\'s genotype will be BO and the phenotype will be type B. Therefore, statements II and III are correct. Well, since III is correct, you can rule out choices A and C because they don\\'t contain it. Now let\\'s assume the mother\\'s genotype to be BO. This means that she can donate an O allele to the child. In this case, if the father donates an A allele, the child\\'s genotype will be AO and the phenotype will be A. This means that statement I is also correct; but this doesn\\'t help you decide between choices B and D because they both contain statement I. In fact, you should have known that I was correct because it appears in both of these remaining choices. So what it comes down to is whether or not this child could have type O blood. Well, if the father donates an O allele, the child\\'s genotype will be OO and the phenotype could have type O. This means that statement IV is also correct; all four blood types are possibilities.

QUESTION 5

A pendulum of length L has a period T. If the period is doubled, the length of the pendulum is:

A. doubled

B. halved

C. quadrupled

D. increased by 2

Correct Answer: C

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