PROCESSO SELETIVO EDITAL PROPEM 03/2023

PROVA DE LÍNGUA INGLESA E GABARITO

Conforme Edital PROPEM 03/2023, de 07 de novembro de 2023 e sua retificação, a seguir é mostrado a Prova de Língua Inglesa e seu gabarito.

First Text

Drop Impact Dynamics: Splashing, Spreading, Receding, Bouncing…

Drop impacts on solid and liquid surfaces are a key element of a wide variety of phenomena encountered in technical applications, such as ink-jet printing, rapid spray cooling of hot surfaces (turbine blades, rolls in rolling mills for steel production, lasers, semiconductor chips, and electronic devices), annealing, quenching of aluminum alloys and steel, fire suppression by sprinklers, internal combustion engines (intake ducts of gasoline engines or piston bowls in direct-injection diesel engines), incinerators, spray painting and coating, plasma spraying, and crop spraying. Microfabrication of structured materials, solder bumps on printed circuit boards, and electric circuits in microelectronics produced by precision solder-drop dispensing, as well as liquid atomization and cleaning, and ice accumulation on power lines and aircraft also involve drop impacts. The latter are also important in criminal forensics, in development of non wettable or fully wettable surfaces, in high-accuracy activation or passivation of substrates by microdrops, in transport of surface contaminants into bulk liquids, and in gas entrapment. Understanding the accompanying physical phenomena is of utmost importance in formulating reliable boundary conditions in numerical codes for spray simulation. Such large-scale and widespread natural phenomena as aeration of the surface layers of lakes, seas, and oceans depend on air bubble entrainment due to rain drop impacts. These impacts at ocean surfaces lead to formation of upward jets and secondary droplets, which evaporate and form salt crystals. The latter serve as nucleation sites in clouds, with the attendant relevance to meteorology. Erosion of soil, dispersal of spores and micro-organisms, and underwater noise during rains are three additional natural phenomena involving drop impact. Nail-like jets and bubbles are a familiar spectacle during rain falling on puddles and ponds.

Worthington (1908) was one of the first to investigate these impacts systematically and his book contains many fascinating photographs of the phenomena accompanying drop- and solid-ball impacts on deep liquid pools. In spite of its commonness, and of more than 100 years of research, the phenomenon is still far from being fully understood and continues to attract physicists, engineers, and mathematicians. It even attracts the general public and motivates potential customers, given the number of commercials based on drop impact scenes aired on television and shown on postcards.

The accompanying phenomena are extremely diverse, involved, and surprising. A drop may be spherical or elliptic (due to oscillations) at the moment of impact. It may impact on the free surface of a liquid in a deep pool, on a thin liquid film on a wall, or on a dry solid surface. The impact may be normal (perpendicular) or oblique, in air or in vacuum. The liquid may be Newtonian or non-Newtonian (e.g., a viscoelastic polymer or a surfactant solution). The liquids of the drop and pool/film may be miscible or immiscible. The solid surface may be hard or soft, rough or smooth, chemically homogeneous or heterogeneous. It may also be porous, flat or

curved, at a temperature different from that of the drop or the same. On liquid surfaces, pre-existing or generated waves may affect the flow pattern. The impact may result in the drop spreading over the solid surface, receding, rebounding, or even levitating if the evaporation near a hot wall is sufficiently strong for the Leidenfrost effect. A crater may form in the liquid bulk in a pool and later on collapse, leading to formation of the so-called Worthington jet flowing out from its center and being subjected to capillary breakup. The impact on a liquid film may result in crown formation, propagation, and breakup, as well as in tiny bubble trapping, or - under certain conditions - non coalescence and even rolling over the surface.

The outcome of drop impact depends on the impact velocity, its direction relative to the surface, drop size, the properties of the liquid (its density, viscosity, viscoelasticity, and some other non-Newtonian effects for rheologically complex fluids), the surface or interfacial tension, the roughness and wettability of the solid surface, the nonisothermal effects (e.g., solidification and evaporation), and air entrapment. In very strong impacts, liquid compressibility is also a factor. By contrast, following the impact of solid balls and projectiles onto armor plates in the hypervelocity range, the solid materials flow like fluids, and the influence of their elasticity, yield stress and plasticity is negligible compared to inertial effects. As a result, phenomena such as frontal ejecta and crater formation in solid-solid impacts are reminiscent of those characteristics of liquid drop impact (i.e., splashing and crown formation), which led Worthington to call the former “permanent splashes.” In cosmic-scale impacts of asteroids (a spectacular example of which is the Arizona Meteor Crater), material vaporization becomes a dominant factor.

Source: A. L. Yarin. Drop Impact Dynamics: Splashing, Spreading, Receding, Bouncing… Annu. Rev. Fluid Mech. 2006.38:159-192.

The questions from 1 to 10 refer to the text 'DROP IMPACT DYNAMICS: SPLASHING, SPREADING, RECEDING, BOUNCING...'"

Para o gabarito, a sentença em negrito é a resposta.

1) Mark the option that does NOT shows a technical application arising from the phenomenon of the drop impact.
a) inkjet printer.
b) fire extinguisher.
c) internal combustion engines.
d) spray painting.

2) What technical application of drop impacts does forensics use?
a) accumulation of ice on power lines.
b) microfabrication of structured materials.
c) solder points on printed circuit boards.
d) electrical circuits in microelectronics.

3) The aeration of the surface layers of lakes, seas, and oceans depends on
a) specifically on the area.
b) only on the air drag carried out by the waves.
c) indirectly on the impact of rainfall.
d) solely on the natural phenomenon of layer accumulation.

4) The term "latter" in the passage "These impacts at ocean surfaces lead to the formation of upward jets and secondary droplets, which evaporate and form salt crystals. The **latter** serve as nucleation sites in clouds, with the attendant relevance to meteorology." refers to:

a) ocean.
b) jets.
c) clouds.
d) salt crystals.

5) According to the text, Worthington:

a) published photographs of the impact phenomenon of drops and solid balls in a pool.
b) investigated the natural phenomenon of salt crystallization in drops.
c) systematized all phenomena strictly related to jets.
d) discovered how water behaves when related to low temperatures.

6) The phenomenon researched by Worthington

a) has less than 100 years of research.
b) has little relevance in academia nowadays.
c) has not been fully understood yet.
d) is used only by the media.

7) At the moment of impact, the drop can change shape due to

a) oscillations.
b) speed.
c) contact surface.
d) temperature.

8) Mark the alternative that presents one of the results of a drop falling on a solid surface.

a) waves.
b) spreading.
c) evaporation.
d) sliding.

9) In the sentence "A crater **may** form in the liquid bulk in a pool and later on collapse," the highlighted term indicates

a) certainty.
b) impossibility.
c) probability.
d) obligation.

10) The author points out several factors to get the result of the drop impact, but one of them occurs in very strong impacts, which is

a) surface tension.
b) liquid compressibility.

c) surface wetting.
d) evaporation.

Second Text

NESTED MODEL REVEALS POTENTIAL AMPLIFICATION OF AN HIV EPIDEMIC DUE TO DRUG RESISTANCE

By the end of 2010, there were around 34 million people living with human immunodeficiency virus (HIV) worldwide, with an estimated 2.7 million new infections in 2010 alone (UNAIDS, 2011). Since 1995, an estimated 2.5 million deaths had been averted in low- and middle-income countries by implementing prevention measures and using antiretroviral therapy (ART) (UNAIDS, 2011). ART coverage in low- and middle-income countries is around 47% of eligible people living with HIV, with several countries achieving universal coverage (UNAIDS, 2011). ART represents a crucial epidemic intervention since, besides slowing down disease progression and increasing survival periods, it decreases transmissibility (Cohen et al., 2011). Although there are clear recommendations available for treatment eligibility of HIV-infected patients (World Health Organization, 2010), alternative cost-effective treatment strategies are constantly under evaluation; for instance, frequent HIV testing of at-risk population with immediate administration of treatment (Granich et al., 2012).

ART was implemented after the use of a single antiretroviral (zidovudine in 1987) led to the emergence of drug resistance (Clavel and Hance, 2004). Drug-resistant (DR) viruses, strains that have the ability to replicate in the presence of drugs, are favored by the fast replication rate of the virus and its lack of proofreading mechanisms (Margeridon-Thermet and Shafer, 2010). The main predictors for acquired drug resistance are suboptimal antiviral therapy and incomplete therapy adherence (Bangsberg et al., 2006). It has been estimated that first-line ART fails to suppress viremia in around 20% of patients, with DR strains present in the majority of cases (Barth et al., 2010).

Although drug resistance normally carries fitness costs for the virus, DR strains are transmitted even in ART-naïve individuals (Hué et al., 2009). Pretreatment DR is associated with virological failure after ART is initiated (Hamers et al., 2011a). Drug resistance prevalence is directly influenced by ART coverage: the prevalence of transmitted drug resistance is around 9-15% in Europe and USA and around 5.6% in Sub-Saharan Africa (Hamers et al., 2011b). Transmitted DR is a concern as a DR strain may persist in a patient for several years without the selective pressure of ART (Jain et al., 2011, Little et al., 2008) and may lead to virological failure when treatment starts (Wittkop et al., 2011). Even if a wild-type (drug-sensitive, DS) strain replaces the DR strain as the more abundant virus, latently infected CD4+ lymphocytes (Richman et al., 2009) and viral mutations (Bonhoeffer and Nowak, 1997) are feasible mechanisms for sustaining the persistence of DR. Most studies, using mathematical models for the analysis of epidemic dynamics of drug resistance, have omitted this potential impact of transmitted drug resistance (Baggaley et al., 2006, Blower et al., 2005, Sánchez et al., 2005, Smith et al., 2010, Wagner and Blower, 2012) - a notably exception is the study by Supervie et al. (2011). These models tend to assume that an individual can develop drug resistance or reverse to drug sensitive, depending on treatment status, but the difference between transmitted and acquired drug resistance is ignored; thus the risk of developing drug resistance when ART is administered is the same regardless of being initially infected with a DS strain or being originally infected with DR and reversed to DS.

Using a novel mathematical modeling framework, we study the impact of treatment-related variables such as ART coverage and timing when ART is initiated, on an epidemic of HIV and on drug resistance dynamics.

An age-of-infection epidemiological model, with homogeneous population and random-mixing, is employed. The epidemic model receives feedback, in terms of infectiousness and infectious period, from a within-host model of two-strain viral dynamics following the general framework of nested models (Mideo et al., 2008). It also incorporates the change in infectiousness in each of the three stages of HIV infection. Importantly, the model assumes that individuals receiving ART may or may not develop drug resistance but the DR strain would always be selected during ART if initial infection was with DR strain. The effect of both within-host parameters, e.g., the fitness cost of drug resistance, and between-host parameters, e.g., ART coverage, on epidemic outcomes such as cumulative infections and DR prevalence are reported.

Source: Roberto A Saenz, Sebastian Bonhoeffer. Epidemics. 2013 Mar; 5(1): 34-43. doi: 10.1016/j.epidem.2012.11.002. Epub 2012 Nov 17.

The questions from 11 to 20 refer to the text "NESTED MODEL REVEALS POTENTIAL AMPLIFICATION OF NA HIV EPIDEMIC DUE TO DRUG RESISTANCE."

Para o gabarito, a sentença em negrito é a resposta.

11) Regarding HIV, it is correct to state that:
a) by the end of 2010, a record of 34 million infected people was reached.
b) since 1995, 2.5 million deaths occurred in low- and middle-income countries.
c) more than 47% of people in low- and middle-income countries are on antiretroviral therapy.
d) approximately 2.7 million people were infected in 2010.

12) Mark the alternative that does NOT show a factor of epidemic intervention by antiretroviral therapy.
a) decrease in disease progression.
b) increase in drug resistance.
c) increase in survival period.
d) decrease in transmissibility.

13) Drug-resistant viruses:
a) are favored by the lack of review mechanisms.
b) are strains incapable of making exact copies of their RNA.
c) have a low replication rate.
d) prevail in the organism only under favorable conditions.

14) Researchers Jain et al and Little et al state that:
a) the replacement of the drug-resistant strain by the drug-sensitive one is common.
b) drug resistance can lead to virological failure.
c) concern should be given to drug resistance, as it can exist in the patient for years.
d) there is an improvement in drug resistance through viral mutations.

15) According to the author, most studies on drug resistance and antiretroviral therapy:
a) focus mainly on analyzing drug resistance transmission.
b) address the difference between transmission and acquisition of drug resistance.

c) use antiretroviral therapy as the basis for understanding and differentiating drug resistance and drug sensitivity.
d) using mathematical models for their analysis, omit the impact of transmitted drug resistance.

16) The following paragraph provides an assessment of the text.
I. Antiretroviral therapy was introduced after the appearance of drug resistance.
II. In 1995, 2.5 million people were saved due to antiretroviral therapy and other preventive measures.
III. However, alternative treatments to antiretroviral therapy are still preferred today due to their high cost.

The alternatives correct is(are):
a) Only I.
b) Only II.
c) I and II.
d) II and III.

17) According to the author, his study differs from previous ones because:
a) it studies only the initial moment of antiretroviral therapy.
b) it uses an innovative structure of mathematical modeling.
c) it relates the HIV epidemic to drug resistance.
d) it is the most current study on the topic.

18) Read the statements below.
I – The epidemic model is fed with information such as the level of infectivity and the period of infection.
II – In the epidemic model, it is established that every person who underwent antiretroviral therapy will develop drug resistance.
III – No parameter was established for the epidemic model.

According to the text, is/are correct:
a) Only II.
b) Only III.
c) I and II.
d) I, II, and III.

19) In the sentence: "**Although** there are clear recommendations available for treatment eligibility of HIV-infected patients, alternative cost-effective treatment strategies are constantly under evaluation; for instance, frequent HIV testing of at-risk population with immediate administration of treatment," the highlighted term indicates:
a) concession.
b) contrast.
c) explanation.
d) affirmation.

20) The term "both" in the passage "It also incorporates the change in infectiousness in each of the three stages of HIV infection. Importantly, the model assumes that individuals receiving ART may or may not develop drug

resistance but the DR strain would always be selected during ART if initial infection was with DR strain. The effect of **both** within-host parameters, e.g., the fitness cost of drug resistance, and between-host parameters, e.g., ART coverage, on epidemic outcomes such as cumulative infections and DR prevalence are reported." refers to:

a) model and individuals.
b) ART and DR.
c) host and parameters.
d) drug and epidemic.

Ouro Preto, 06 de fevereiro de 2024.

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Prof. Ronilson Rocha

Membro

VINICIUS CARVALHO TELES:01616492112
Assinado de forma digital por VINICIUS CARVALHO TELES:01616492112
Dados: 2024.02.06 11:07:47 -03'00'

Prof. Vinícius Carvalho Teles

Membro