Medical and biological physics (sample questions with answers). Module 1

1. The general solution of differential equation in an implicit form is determined as:

A. $\Phi(x, x_1\ y, C_1, C_2,...C_n) = 0$

B. $F(x, y, y', y'') = 0$;

C. $\Phi(x, y, C_1, C_2,...C_{10}) = 0$;

D. $y^{(n)} + a_{n-1}\cdot y^{(n-1)} + ... a_1\cdot y' + a_0\cdot = f(x)$;

E. $\Phi(x, y, C_1, C_2,...C_n) = 0$**.**

2. Solution of the integral $\int (\sin x - e^x) dx$ is:

A. - cosx – e^x; B. - cosx +e^x + C; C. – sinx + e+ C;

D.- cosx – e^x + C; E. arctgx + C.

3. There are 7 black and several white balls in the box. The probability to pull out a black ball is 1/6. How many white balls are in the box?

A. 1; B. 9;

C. 14; D. 7;

E. 35.

4. Linear correlation dependence between random variables X and Y is called positive if:

A. conditional expectation M(Y/x) increase linearly with increasing of X values;

B. regression line is a vertical straight line;

C. regression function of Y on X is decreasing linear function;

D. correlation coefficient R>1;

E. correlation coefficient R=1.

5. The probability density function f(X) of a continuous random variable X has the form:

A. $f(x) = \frac{dP}{dx}$ B. $f(x) = \int_{-\infty}^{\infty} P(x)dx$

C. $f(x) = \int_{-\infty}^{\infty} F dx$ D. $f(x) = \int_{-\infty}^{X} x \cdot F(x)dx$

E. $f(x) = \int xP(x)dx$

6. Solution of integral $\int \sqrt[3]{x}dx$ is:

A. $\frac{4}{3}x^{\frac{3}{4}} + C;$ B.- $\frac{3}{4}x^{\frac{4}{3}} + C;$ C. - $\frac{4}{3}x^{\frac{3}{4}} + C;$

D. x^3; **E.** $\frac{3}{4}x^{\frac{4}{3}} + C.$

7. Random events $A_1, A_2,\ldots, A_n$ form a complete group of events, if

A. their probabilities are equal to zero;

B. as a result of trial one of these events occurs necessarily, and no one from other events, which falls outside of this group, can occur;

C. sum of probabilities of these events is equal to zero;

D. the probability of one of these events depends on the occurrence of the other event;

E. these events are independent.

8. Significance level (p) is equal to:

A. $p = \frac{1}{n}\sum_{i=1}^{n} x_i$ **B.** $p = 1 - \alpha$ C. $p = \frac{1}{n-1}\sum_{i=1}^{n} x_i$

D. $p = \sqrt{1-\alpha}$ E. $p = \frac{1-\alpha}{n}$

where n is sample size, α is confidence probability

9. The distribution function **F(X)** of a continuous random variable X is equal to the integral from probability density f(X) of this random variable in the interval:

A. from - ∞ to +∞   B. from x to + ∞

C. from -∞ to x   D. from «0» to ∞

E. from «0» to x

10. According to the properties of the definite integral, if B is a constant value and F(x) is an antiderivative of the function f(x), then:

A. $\int_a^b Bf(x)dx = B\int_b^a f(x)dx.$ B. $\int Bf(x)dx = B\int f(x)dx.$ C. $\int_a^b BF(x)dx = B\int_a^b F(x)dx$

D. $\int_a^b Bf(x)dx = \int_a^b \frac{1}{B} f(x)dx.$ **E.** $\int_a^b Bf(x)dx = B\int_a^b f(x)dx.$

11. In the formula for calculation the absolute error with many multiple measurements

$\Delta x = \sqrt{(t(\alpha;k)\frac{S}{\sqrt{n}})^2 + (t(\alpha,\infty)\frac{d}{3})^2}$ the quantity **d** can be calculated:

A. $d = \frac{\gamma}{x_n} \cdot 100\%;$

B. $d = \frac{\gamma + x_n}{100\%};$

C. $d = (\gamma \cdot x_n) \cdot 100\%;$

D. $d = (\gamma - x_n) \cdot 100\%;$

E. $d = \frac{\gamma \cdot x_n}{100\%}$**, where** γ **reduced error of the instrument,** x_n **is a normalising value.**

12. Definite integral is calculated by the formula of:

A. Newton-Leibniz;   B. Bayesian;

C. Bernoulli's;   D. Total probability;

E. Condition of normalization.

13. The unit of measuring of random event probability is

A. hertz;   B. bytes;

C. the dimensionless quantity;   D. radians per second;

E. second.

14. Linear correlation dependence between random variables X and Y is called negative if:

A. conditional expectation M(Y/x) decrease linearly with increasing of X values;

B. regression line is a vertical straight line;

C. regression function of Y on X is increasing linear function;
D. correlation coefficient R>1;
E. correlation coefficient R=1.

15. Boundaries of a confidence interval for a mathematical expectation of normally distributed random variable X are:

A. random variables;
B. constants;
C. not random variables;
D. not dependent from a confidence interval;
E. not dependent from sample size.

16. M(X) and M(X^2) of a continuous random variable X equals 1/2 and 1, accordingly. Find for this continuous random variable the variance D(X)?

A. 0; B. -3/4; C. 3/2; D. ½; **E. ¾.**

17. The instrument accuracy class is:
A. the relative error in percents;
B. the absolute error in percents;
C. the reduced error in percents;
D. the quantity reciprocal to the accuracy of measurement;
E. parameter that depends entirely from the measurement error.

18. The probability of a complex event consisting in the occurrence of one of exclusive events A and B (i.e. either event A or event B will occur) is equal to
A. the sum of probabilities of these events;
B. the difference of probabilities of these events;
C. the product of probabilities of these events;
D. ∞ (infinity);
E. –∞ (minus infinity).

19. Positive correlation between random variables X and Y means:
A. conditional expectation M(Y/x) increases when X values increase;
B. conditional expectation M(Y/x) decreases when X values increase;
C. conditional expectation M(Y/x) doesn't change when X values increase;
D. X values are positive for any Y values;
E. Y values are positive for any X values.

20. According to statistical data, 36.9 % of all Europeans have a blood type A, 23.5 % - group B, 0,6 % - AB group, 39 % - group 0. Find the probability that randomly taken European donor has blood group A or B.

A. 0.087; B. 0.1334; C. 60%; **D. 0.604;** E. 13.34%.

21. The probability density function graph f(X) for normally distributed continuous random variable X is symmetrical with respect to straight line
A. y=10
B. x = a
C. y=0
D. $x = -\infty$
E. y = a .

22. All antiderivatives of the function differ from each other:
A. by a derivative;
B. by an independent variable;

C. by a differential of argument;
D. by a constant value;
E. by a partial derivative.

23. If sample size is n =16 and optimal sample estimation of variance is $\widehat{D}(x)$ = 36 then error in mean m_x is equal to
A. 2/3 ; B. 9; **C.** 3/2 **;** D. 6; E. 6/16 .

24. The probability of falling of continuous random variable X in the interval from a to b is calculated by the formula:
A. P(a≤X≤ b) = F(a) · F(b); B. P(a≤X≤ b) = F(b) + F(a);
C. P(a≤X≤ b) = F(a) – F(b); **D. P(a≤X≤ b) = F(b) – F(a);**
E. P(a≤X≤ b) = F(a) / F(b)
where F(X) is the distribution function

25. The formula of total probability is used when:
A. event A cannot occur simultaneously (at the same time) with one of exclusive events B_i (i= 1,2,…n), which form complete group of events
B. event A can occur simultaneously only with two independent events B_i (i= 1,2).
C. event A can occur simultaneously only with one of exclusive events B_i (i = 1, 2, ..., n), which form a complete group of events
D. event A can occur simultaneously only with three dependent events B_i (i = 1, 2, ..., n), which form a complete group of events
E. event A cannot occur only simultaneously with three exclusive events B_i (i = 1, 2, ..., n), which form a complete group of events

26. For function $z= xy – 5x^2$ the partial derivative z_x' is equal to
A. y – 10x
B. xy – 10
C. x + 10x
D. xy^2 – 10x
E. y + 10x

27. Nnumerical characteristic of random variable X is:
A. the mathematical expectation M(X);
B. the frequency function f(x);
C. the distribution function F(x);
D. the probability of values of variable X falling in the interval from a to b;
E. no correct answer

28. Systematic errors occur due to:
A. the fact that all measured values are random;
B. the impact of not constant factors;
C. random changes in ambient temperature
D. the impact of the certain constant factors;
E. the presence of noncontrolled factors which cannot be accounted apriori.

29. If the probability of occurrence of one event is p, then the probability of the opposite event occurrence q is
A. $q = p - 1$; B. $p = q + 1$; C. $p = q - 1$; **D.** $q = 1 - p$ **;** E. $1 = qp$.

30. For function $z = 3y^2 + xy$ the partial derivative z_y' is equal to

A. 6y + xy

B. 6y + x

C. $9y^3 + 2y$

D. 6y – x

E. $3y^2 + xy$

31. The optimal sample estimate of mathematical expectation of random variable X is calculated by the formula:

A. $\hat{M}(X) = \frac{1}{n-1}\sum(x_i - \bar{x})^2$

B. $\hat{M}(X) = \frac{1}{n}\sum_{i=1}^{n} x_i$

C. $\hat{M}(X) = \frac{1}{n-1}\sum_{i=1}^{n} x_i$

D. $\hat{M}(X) = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2$

E. $\hat{M}(X) = \frac{1}{n}\sum_{i=1}^{n} x_i^2$

32. If the random and instrumental errors are the values of the same order then the actual value is taken as

A. any of these values

B. mean value of the entire assembly

C. the absolute error

D. difference between the absolute and relative errors

E. sample average

33. If two exclusive events form a complete group of events, they are

A. independent;

B. dependent;

C. opposite;

D. their probabilities are equal to zero;

E. the sum of probabilities of these events is equal to zero.

34. An equation of the form $y' + p(x) \cdot y = f(x)$, where $p = \frac{b}{a}$ and $f = -\frac{c}{a}$ is called:

A. the homogeneous linear equation if f(x)=0;

B. the non-homogeneous linear equation if f(x) =0;

C. the differential equation with variables separable;

D. the n-order differential equation;

E. the linear equation.

35. For confidence interval estimation of statistical characteristics of an entire assembly it is necessary to calculate:

A. a significance level;

B. confidence probability;

C. boundaries of a confidence interval;

D. value of Laplace function;

E. diffusion coefficient.

36. If σ decreases while a is constant, then the Gauss normal distribution graph

A. compresses to straight-line y = a
B. shifts along the Y–axis without changing its shape;
C. compresses to straight line x = a;
D. shifts along the X–axis without changing its shape
E. doesn’t change.

37. Using the method of integration by parts in integral $\int x^n a^x dx$, where *n* is a nonnegative integer, integration by parts is necessary to carry out
A. one time, and dv = x, the other part of integrand is assumed equal to u;
B. n times, and dv = x^n, the other part of integrand is assumed equal to u;
C. n times, and u = x^n, the other part of integrand is assumed equal to dv;
D. n times, and u = x, the other part of integrand is assumed equal to dv;
E. one time, and u = x^n, the other part of integrand is assumed equal to dv.

38. Small values of systematic error:
A. are the evidence of measurement correctness
B. indicate that the instrumental error is minimal
C. are not evidence of measurement correctness
D. show the absence of noncontrolled factors
E. are approximately equal to the random errors

39. Partial derivatives are calculated for

A. constant values

B. functions of one variable

C. functions of several variables

D. finding the acceleration

E. finding of area of the figure

40. Calculation of the definite integral by the Newton-Leibniz’ formula

$\int_a^b f(x)dx = F(b) - F(a)$ is

A. differentiation of the function f(x); substitution in the resulting expression instead of x numbers a and b; and finding the difference between the resulting values.
B. integration of the function f(x); substitution in the resulting expression instead of x numbers a and b; and finding the difference between the resulting values.
C. integration of the function f(x), and. finding the constant of integration.
D. differentiation of the function f(x); and finding the constant of integration.
E. definition of the integration limits.

41. Derivative of the composite function *y = cos 2x* is equal to

A. – sin 2x

B. 2sin 2x

C. – 2sin 2x

D. 2cos 2x

E. sin 2x

42. Differential of argument *x* is designated by symbol:
A. Δx
B. *dy*
C. *x*
D. *dx*
E. Δy

43. According to the basic properties of derivatives $y'=(u(x)\pm v(x))'$ is equal to
A. $u(x)\pm v'(x)$
B. $u'(x)+v'(x)$
C. $u'(x)\pm v(x)$
D. $u'(x)-v'(x)$
E. $\boldsymbol{u'(x)\pm v'(x)}$

44. Derivative of function $y = cot(x)$ is equal to
A. $-\frac{1}{\sin^2 x}$
B. $\frac{1}{\cos^2 x}$
C. tan(x)
D. sin(x)
E. cos(x)

45. Calculate the definite integral $\int_0^1 e^x dx$
A. e – 1
B. 1 – e
C. 0
D. (e – 1) + C
E. (1 – e) + C

46. According to the properties of definite integral
A. $\int_a^b f(x)dx = c\int_a^c f(x)dx$
B. $\int_a^b f(x)dx = \int_a^c f(x)dx + \int_c^b f(x)dx$
C. $\int_a^b f(x)dx = \pm\frac{1}{c}\int f(x)dx$
D. $\int_a^b f(x)dx = \int_a^c f(x)dx - \int_c^b f(x)dx$

E. $\int_a^b f(x)dx = \int_b^c f(x)dx + \int_c^a f(x)dx$

47. Antiderivatives of the function *f(x) = sin x – 2x* are
A. – cos x + x^2 + 2; – cos x + x^2 + 5; – cos x + x^2 – 4 etc.
B cos x – x^2 + 4; cos x – x^2 + 1; cos x – x^2 etc.
C. – cos x – x^2 + 3; – cos x – x^2 – 1; – cos x – x^2 etc.
D. cos x – 2x + 3; cos x – 2x – 1; cos x – 2x etc.
E. arcsin x – x^2; arcsin x – x^2 + 3; arcsin x – x^2 – 6 etc.

48. According to the properties of the definite integral, if *B* is a constant value and *F(x)* is an antiderivative of the function *f(x),* then

A. $\int_a^b Bf(x)dx = \int_a^b \frac{1}{B} f(x)dx$

B. $\int Bf(x)dx = B\int f(x)dx$

C. $\int_a^b BF(x)dx = B\int_a^b F(x)dx$

D. $\int_a^b Bf(x)dx = B\int_a^b f(x)dx$

E. $\int_a^b Bf(x)dx = B\int_b^a f(x)dx$

49. The differential equation of the form $a(x)\cdot y' + b(x)\cdot y + c(x) = 0$ is called
A. the equations homogeneous in the argument and in the unknown function
B. the linear equation
C. the differential equation with variables separable
D. the differential equation of the n-order
E. the ordinary differential equation with partial differential equation of the second order

50. If the unknown function in differential equation depends on one variable, the differential equation is called
A. an integral equation
B. an algebraic equation
C. ordinary differential equation
D. a partial differential equation
E. an equation homogeneous in the argument and in the unknown function

51. The frequency function *f(X)* of a continuous random variable *X* is related to the distribution function *F(X)* by the formula

A. $f(X)=\int_{-\infty}^{+\infty} F^2(X)dx$

B. $f(X)=\int_{-\infty}^{\infty} F(X)dx$

C. $f(X)=\frac{dF}{dx}$

D. $f(X)=\int_{-\infty}^{x} F(X)dx$

E. $f(X)=\frac{dx}{dF}$

52. The second order ordinary differential equation is

A. $y^{(n)}+a_{n-1}\cdot y^{(n-1)}+....+a_1\cdot y'+a_0\cdot y=f\left(x\right)$

B. $y'''+3y'-5y=7$

C. $(yy')^2+y\cdot sinx=2$, where x, y are arguments, z is unknown function

D. $\frac{\partial^2 z}{\partial x\partial y}=3\left[\frac{\partial z}{\partial y}+z\right]$, where x, y are an arguments, z is unknown function

E. $2y''+7y'+21y=8$

53. There are 6 blue, 5 red and 4 white balls in a box. Calculate the probability of the event that a red ball has been taken out.

A. $\frac{1}{5}$

B. 5

C. 1

D. $\frac{1}{3}$

E. $\frac{2}{3}$

54. The probability of a complex event consisting in occurrence of both event A and event B is equal to

A. the ratio of the probabilities of these events

B. the sum of probabilities of these events

C. the difference of probabilities of these events

D. the probability of event A

E. the product of probabilities of these events

55. The probability of a complex event consisting in the occurrence of one of two exclusive events A or B (i.e. either event A or event B will occur) is equal to

A. the sum of probabilities of these events
B. the difference of probabilities of these events
C. the product of probabilities of these events
D. ∞ (infinity)
E. –∞ (minus infinity)

56. The theory of probability studies
A. Newton's mechanical laws
B. laws of mass-scale phenomena having random character
C. electromagnetic phenomena
D. differentiation and integration
E. optics phenomena

57. If the probability of one of two events *A* and *B* depends on the occurrence of another event, then these two events are called
A. impossible
B. independent
C. exclusive
D. dependent
E. sure

58. There are two children in the family. Define the probability that there are boy and girl in the family. The probability of the boy birth is 0.5.
A. 0.5
B. 0.48
C. 0.6
D. 0.3
E. 0.25

59. The confidence probability is equal to 0.95. Find the value of the significance level.
A. 0.001
B. 0.01
C. 0.005
D. 0.05
E. 0.5

60. There are 3 white and 7 black balls in a box. At first, one black ball was pulled out from a box and was not returned back. What is the probability to pull out black ball second time?
A. 60%
B. $\frac{2}{9}$

C. $\frac{10}{7}$

D. $\frac{6}{10}$

E. $\frac{2}{3}$