Concordia University
CIVI-231 Geology for Civil Engineers (Fall 2020)

Dec. 07, 2020 **18:00-21:00**

Final exam

Student Name/ ID Number: _____

PART ONE: MULTIPLE CHOICES (0.5 mark each)

1. The process by which magmas cool and solidify to rock is termed _____.
A) volcanism B) plutonism C) crystallization D) thermal metamorphism

2. Which carbonate mineral reacts readily with cool, dilute hydrochloric acid to produce visible bubbles of carbon dioxide gas?
A) calcite B) quartz C) dolomite D) plagioclase

3. Shales are distinguished from other mudrocks by their _____.
A) colour B) sand content C) fissility D) fossil content

4. What is the chemical formula for dolomite, the major mineral in dolostones?
A) NaCl B) $CaSO_4 \cdot 2H_2O$ C) SiO_2 D) $CaMg(CO_3)_2$

5. Which is not a requirement? To be a mineral it must be or have _____.
A) naturally occurring B) well formed external crystal shapes
C) orderly regular atomic or ionic structure D) definite chemical composition

6. Which minerals that make up the Mohs scale are softer than your fingernail?
A) beryl, garnet, tourmaline B) calcite, fluorite, apatite C) feldspar, quartz, topaz, corundum, diamond
D) gypsum and talc

7. Minerals like diamond and graphite exist because of _____.
A) amorphous crystallization
B) different physical and chemical conditions or environments within the earth

C) the law of polymorphism D) the metamorphism of coal

8. The size, shape, and geometric arrangement of mineral grains in igneous rocks is called _____ and it indicates _____.
A) aphanitic form, how much water was present in the melt
B) igneous geometry, the original % of partial melting
C) geomorphology, depth of origin for the original magma
D) texture, the environmental conditions in which the rock formed

9. The main factors which directly govern the development of texture in all igneous rocks are _____.
A) buoyancy, crystal settling, and partial melting B) cooling rate, dissolved volatiles, and silica content
C) volcano or pluton size and shape D) weathering and climate

10. A(n)_____ texture would be most unlikely to occur in an extrusive igneous rock.
A) pyroclastic B) glassy C) aphanitic D) phaneritic

11. Visible quartz and potassium feldspar grains are the main constituents in which igneous rock?
A) granite B) gabbro C) basalt D) rhyolite

12. As _____ increases the surface area of a rock or mineral, this allows _____ to occur at a faster rate.
A) chemical weathering, mechanical weathering B) infernal weathering, mechanistic weathering
C) mechanical weathering, chemical weathering D) recrystallization, carnal weathering

13. How does a sediment become transformed into a sedimentary rock?
A) by compaction and dewatering, followed by cementation B) by destruction of all bedding and original depositional features C) by multiple cycles of redeposition D) by processes of polymorphism

14. Diagenesis occurs at temperatures below _____ in the outer few kilometres of Earth's crust.
A) 10° B) 50° C) 100° D) 200°

15. Compaction is a very important part of the lithification process for which of the following sediments?
A) gravel B) sand C) mud D) cobble
16. _____ cement produces dark red and orange colours in some sandstone.
A) Clay B) Calcite C) Quartz D) Iron oxide

17. Where and how does metamorphism occur?
A) mainly at low temperatures in the roots of volcanic mountain belts
B) beneath the thick accumulations of in sedimentary basins
C) wherever solid rocks are subjected to new conditions of temperature, pressure, stress, and a change in their constituent fluids
D) in response to sudden catastrophic geologic changes, mostly in the Precambrian.

18. Under the application of uniform, confining pressure, rocks will generally _____.
A) bend, fold, buckle, and shear to make typical deformed metamorphic textures
B) grow or crystallize a new set of low density hydrous minerals
C) increase in density but retain primary bedding orientations
D) shatter and turn into a breccia

19. What type of environment is typified by *brittle* deformation?
A) deep burial with great confining pressure
B) intermediate depths with long slow heating and gradual strain rates
C) shallow, low temperature settings with high strain rates
D) shallow very high temperature settings as in contact metamorphism

20. _____ is a strong, parallel alignment of coarse mica flakes and/or of different mineral bands in a metamorphic rock.
A) Rock cleavage B) Foliation C) Brecciation D) Shear stress

21. Chemically active fluids like _____ tend to transport ions and mineral components and their activity _____ with increasing temperature.
A) petroleum hydrocarbons, increases B) HCl and hydrogen sulphide, decreases
C) carbon dioxide, decreases D) water, increases

22. During metamorphism, what is the major effect of chemically active fluids?
A) increase the pressures in deeply buried, regional-metamorphic zones
B) aid in the movement of dissolved ions and silicate constituents from parent minerals and facilitate growth of new metamorphic mineral grains
C) prevent partial melting so solid rocks can undergo very high temperature regional metamorphism
D) facilitate the formation of schistosity and gneissic banding in hornfels and skarns

23. Metamorphic grade refers to _____.
A) economic value of metamorphic rocks
B) how much we'll have to curve your test mark if you are guessing!
C) metamorphic intensity as recorded by particular minerals which are sensitive to temperature and pressure
D) recrystallization versus amount of primary mineral grains

24. How would you correctly refer to the metamorphic grade of a rock that contains abundant chlorite as its highest temperature mineral such as a greenschist or phyllite?
A) "C grade" B) high grade > 600°C C) intermediate grade D) low grade < 200°C

25. The _____ in California is the boundary between the North American and Pacific lithospheric plates.
A) Moine thrust fault B) Garlock left-lateral strike-slip fault
C) San Andreas strike-slip fault D) Queen Charlotte-Fairweather right-lateral strike-slip fault

26. An unconformity is _____.
A) an erosional (or non-depositional) surface with younger strata above and older rocks below

B) the lower contact of an intrusive sill with sedimentary strata
C) a fault with younger, sedimentary rocks above and older, igneous rocks below
D) the contact between a cross-cutting pluton and sedimentary rocks

27. _____ is an erosional contact between tilted, older strata below and horizontal, younger strata above.
A) An angular deformity B) An angular unconformity C) A disconformity D) A cross-cutting fault

28. Which of the following statements is true, concerning sedimentary strata separated by a disconformity?
A) The younger strata were tilted after the older strata were.
B) All strata exhibit parallel bedding or stratification, but there is a hiatus (missing record).
C) The older strata were tilted when the younger strata were deposited.
D) All of the older strata were eroded away before the younger strata were tilted.

29. What are the three types of *differential stress* in the Earth's lithosphere?
A) compression, shear, and tension B) confined, unconfined, and directed
C) hydrostatic, lithostatic, and vibratory D) upwards, downwards, and sideways

30. When measuring the orientation of a planar structure in rocks the dip direction is measured _____ to the strike.
A) at 90 degrees B) parallel C) backwards D) sideways

31. What kind of stress creates most fold belts?
A) compressional B) decompressional C) shear D) tensile

32. New oceanic crust and lithosphere are formed at_____.
A) divergent boundaries by submarine eruptions and intrusions of felsic magma
B) convergent boundaries by submarine eruptions and intrusions of felsic magma
C) divergent boundaries by submarine eruptions and intrusions of mafic magma
D) convergent boundaries by submarine eruptions and intrusions of mafic magma

33. Normal and reverse faults are characterized mainly by _____.
A) strike slip B) horizontal slip C) dip slip D) camisole slip

34. _____ are the products of horizontally directed, tensional stresses.
A) Normal faults B) Crustal thickening C) Reverse faults D) Thrust faults

35. In a _____ fault, the hanging wall block moves up over the footwall block.
A) normal B) detachment C) reverse or thrust D) strike slip

36. A thrust fault has _____.
A) slickensides parallel to its strike
B) a shallow inclination less than 45° and a hanging wall that slid down relative to the footwall
C) a shallow inclination less than 45° and a hanging wall that rode up over the footwall
D) a steep inclination more than 45° and a hanging wall that rode up over the footwall

37. Most earthquakes form a new fault where one did not exist before?
A) TRUE B) FALSE

38. Which of the following is more likely to exhibit brittle behaviour?
A) clay soil B) granite C) shale D) oil sands

39. The _____ is the point of origination for an earthquake.
A) fault plane B) hypocenter C) seismic belly button D) epizone

40. Which one of the following is true for anticlines but not for synclines?
A) The limbs dip or are inclined towards the fold axis.
B) Some may be asymmetric and some may have plunging axes.
C) After erosion, the younger strata are exposed along the axial region of the fold.
D) The deeper strata are buckled upward along the fold axis.

41. _____ is the widely accepted explanation for the mechanism that generates earthquakes.
A) Dow's recovery theory B) Dupont's plastic-slip theory C) Richter's wave-snap theory
D) Reid's elastic rebound theory

42. What are the smaller magnitude quakes that follow a major earthquake?
A) aftershocks B) airshocks C) hyposhocks D) epishocks

43. Which one the following does not propagate through liquids?
A) seismic sea waves B) S waves C) P waves D) converted inner core waves

44. Which of the following foundation materials is most stable during earthquake shaking?
A) bedrock B) unconsolidated moist soil C) water-saturated sand D) sand and mud

45. _____ refers to the tendency for a foundation material to lose its internal cohesion and fail mechanically during earthquake shaking.
A) Slurrying B) Liquefaction C) Ooey-gooefication D) Seismoflowage

46. Which mass wasting process has the fastest rate of movement?
A) slump B) rockslide C) solifluction D) earthflow

47. Where does the majority of fresh groundwater reside?
A) as large stationary bodies in enormous underground caverns
B) flowing in large underground rivers
C) in pores within soils and sediments or in fractures in rocks
D) as superheated steam in vast hotspring and geyser fields

48. _____ is a measure of the connectedness of pore spaces, which controls the ease (or difficulty) of groundwater transmission through a porous material.
A) Portability B) Potability C) Permeosity D) Permeability

49. Of the choices listed on flow characteristics alone, if the following aquifers became contaminated, which would remain contaminated for the longest time?
A) clay B) gravel C) limestone D) sand

50. What happens inside a rock as a wave front from a P wave passes through?
A) The little parcel of rock rotates about its own location in an ellipse until the wave passes.
B) The little parcel of rock shimmies from side to side as the wave passes, with the greatest motion at the Earth's surface, dying out with depth.
C) The volume of the rock stays fixed, but it shears back and forth, distorting the rock's internal shape as the wave passes through.
D) The rock moves toward and away from the earthquake as the volume of the material alternately expands and contracts, changing the rock's density while the compression-rarefaction wave passes through.

51. Which of the following is not a fundamental particle found in atoms?
A) neutron B) selectron C) electron D) proton

52. Which of the following denotes the tiny, but very massive, central part of an atom?
A) inner shell B) core mass C) valence shell D) nucleus

53. Silicate igneous rocks make up the _____.
A) bulk of volcanic mountains but not much else on Earth
B) bulk of the Earth's crust and mantle
C) densest rocks and are mainly found in the core
D) majority of shallow rocks covering the continents but everything deeper is sedimentary and metamorphic

54. Three processes contribute to the formation of every igneous rock: _____.
A) assimilation, crystallization, and dyke injection
B) extrusion, intrusion, and consolidation
C) partial melting, buoyant rise, and crystallization
D) volcanism, plutonism, and magmatic differentiation

55. The most common non-ferromagnesian silicate minerals (>40 %) in most igneous rocks are _____.
A) calcite B) feldspar C) olivine D) quartz

56. Which of the following igneous rocks is composed mainly of ferromagnesian minerals with less than 20% feldspar?
A) peridotite B) rhyolite C) andesite D) granite

57. Which of the following is the dominant feldspar in basalt?
A) plagioclase B) microcline C) orthoclase D) pyroxene

58. What weight percentage of silica (SiO_2) typifies granites and rhyolites?
A) 30% B) 90% C) 70% D) 50%

59. When magma cools and consolidates without growth of mineral grains, it is
A) glassy B) aphanitic C) phaneritic D) porphyritic

60. Clay minerals formed from gabbro or diorite bedrock illustrate which kind of weathering?
A) chemical B) proactive C) syntropical D) mechanical

61. What percentage of the Earth's crust is composed of sedimentary rocks?
A) 5% B) 15% C) 25% D) 75%

62. The type of diagenesis that occurs in the transformation of aragonite to calcite is _____.
A) weathering B) decarbonation C) dehydration D) re-crystallization

63. Hot regions having basins with limited input and restricted circulation tend to have _____ deposits.
A) sandy beach B) glacial dropstone C) limestone reef and bank D) evaporite

64. Which major component of detrital sedimentary rocks only rarely occurs as a primary mineral in igneous rocks?
A) clays B) carbonates C) quartz D) ferromagnesian minerals

65. Broad upwarps in the basement rock may deform the overlying sedimentary cover strata to generate large elliptical to circular folds called _____.
A) anticlines B) domes C) doubly plunging synclines D) monoclines

66. How wide is the San Andreas Fault Zone at its northern and southern ends?
A) <1 kilometre B) 5 kilometres C) 10 kilometres D) >100 kilometres

67. The _____ of the Earth does not transmit S waves.
A) outer mantle B) inner crust C) outer core D) deep mantle

68. What force pushes groundwater from pore to pore below the water table?
A) integrated saturation impulse B) surface tension C) hydraulic gradient D) permeability steepness

69. How are travertine or silica deposits formed from boiling geysers and related hydrothermal systems?
A) Boiling off steam forces the remaining hot solution to be saturated or supersaturated as the same mineral content is now concentrated in less water and it precipitates.
B) More gases enter the system once boiling starts forcing precipitation.
C) As pressures increase less mineral matter is soluble.
D) By introduction of cold fresh recharge water which quenches the system.

70. When water is quickly produced from a well, locally the water table and aquifer experience _____
A) artesian flow B) artificial insemination C) decreased flow velocity towards the well D) drawdown

71. Which of the following describes the configuration of an unconfined water table around a pumping well?
A) a bad impression B) cone of depression C) depression withdrawal D) inverted cone head

72. An artesian well is one in which _____.
A) the water is warm, fairly saline, and recharged by a stream
B) water has enough head to rise above the top of the aquifer without any pumping
C) the well is horizontal and the water table is perched
D) pressurized groundwater rises from a deep, unsaturated aquifer

73. Which of the following statements is false for an area subsiding because of excessive pumping of groundwater?
A) Dewatered aquifer material compacts. B) Effluent streams may dry up.
C) Water table is substantially lowered. D) The aquifer is consolidated bedrock.

74. The mechanical removal or diminution of unwanted substances such as bacteria, viruses, or mineral turbidity from groundwater is termed _____.
A) aqua-cleansing B) filtration C) derriereation D) dolomitization

75. What percentage of the Earth's water is in the form of groundwater?
A) 97.2%
B) 94%
C) 0.6%
D) 0.03%

76. What proportion of the world's water for agriculture (irrigation, greenhouses, golf courses) is supplied by groundwater aquifers?
A) 25%
B) 40%
C) 50%
D) 87%

77. After ice sheets and glaciers, _____ contains the next highest percentage of Earth's freshwater that is readily accessible to humans.
A) groundwater
B) the atmosphere
C) lakes and rivers
D) Dasani/Coca-cola Ltd.

78. What is the *belt of soil moisture*?
A) a viable farming region across southern Alberta and Saskatchewan without rain
B) the layer in the ground with the largest roots, just beneath the zone of saturation
C) at shallow depth, a surface film of water retained on soil, sediment, or organic particles
D) where permafrost has melted leaving completely saturated soils

79. Under most conditions, groundwater moves _____.

A) very quickly as it flows predominantly in open cavernous underground rivers
B) only between rainstorms by drainage
C) very little as most of it is stagnant and all at a single level
D) at slow but variable rates generally less than a few metres per day

80. The porosity of typical unconsolidated sediments and sedimentary rocks is _____.
A) 10-50%
B) <0.1%
C) 1-5%
D) 6-9%

81. For unconfined aquifers, what hydrologic factor is approximated by the slope of the water table?
A) hydraulic gradient
B) hydraulic competency
C) porosity head
D) affluent decline

82. A perched water table develops when _____.
A) an aquifer below the regional water table is underlain by a horizontal aquitard
B) an aquifer above the regional water table is overlain by a horizontal aquitard
C) a horizontal aquitard above the regional water table lies below an aquifer
D) an aquitard below the regional water table lies above a horizontal aquifer

83. Which one of the following concerning artesian wells is false?
A) The well penetrates an aquifer overlain by an aquitard.
B) The well penetrates an aquifer underlain by an impermeable bed.
C) The aquifer is generally inclined, and it is saturated to an elevation above the point where the well penetrates the aquifer.
D) When the well penetrates the aquifer, the water rises to the bottom of the aquitard above the aquifer.

84. Which of the following geologic materials would have the highest groundwater velocities and be least effective in removing unwanted pollutants from the water?
A) a sandy loam soil with high organic carbon content
B) limestone with numerous solution channels and fractures widened by dissolution
C) lakebeds consisting of unconsolidated very fine-grained sand and silt
D) sandstone; well-cemented with a few, widely spaced vertical fractures

85. Frost wedging and thawing on vertical cliffs produces _____.
A) alluvial fans
B) debris flows and torrents
C) fast moving rock glaciers
D) talus cones

86. During wet weather or times when snow is melting, what sometimes happens to the downhill toe of a slump?
A) It turns into a rock avalanche.

B) It becomes an earthflow.
C) It stops moving because water makes the clay sticky.
D) It collapses and is deposited as talus at the base of the slope.

87. Which mass-wasting event involves movement on a zone of compressed air?
A) slump
B) earthflow
C) rockslide
D) creep

88. What are the most serious mass wasting hazards in mountain valleys?
A) airborne rockslides
B) debris flows
C) glacier bursts
D) rock bursts

89. How do freezing, thawing, wetting, and drying contribute to soil creep?
A) The soil becomes much weaker when dry and frozen.
B) Gravity exerts a much stronger force when the soil is wet and thawed.
C) The soil expands and contracts, lifting particles then lowering them a slight distance downslope.
D) Eventually these cause the soil and regolith to suddenly slide down the slope.

90. How does a seismograph detect vibrations from the passing wave front of an earthquake?
A) The whole instrument moves up and down (or back and forth) on the ground, so that it starts jiggling a little weight inside that trips the detector to record the earthquake.
B) The instrument is anchored to the ground or buried in a vault so that it is stationary with respect to the earth. When the instrument moves, the suspended mass inside is relatively stationary due to inertia. The relative motion registers the quake.
C) The instrument vibrates with the ground as it rolls along a track above the hyypocentre.
D) The wave front seeks out the instrument which stops vibrating when the wave front reaches it.

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PART TWO: WRITING QUESTIONS

91. Please describe the process and characteristics of subsidence due to mining groundwater (10 Marks)

92. Where does burial metamorphism occur, how is it recognized and what conditions does it represent? (10 Marks)

93. Considering the factors which influence the formation of sedimentary rocks, how might sedimentary rocks be different on another planet such as Mars or Venus? (5 Marks)