ROYAL CIVIL SERVICE COMMISSION

BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2010

EXAMINATION CATEGORY: TECHNICAL

PAPER III: SUBJECT SPECIALIZATION PAPER for

METALLURGICAL & MATERIAL ENGINEERING GROUP

Date	**: 24th November 2010**
Total Marks	**: 100**
Examination Time	**: 2.5 Hours**
Reading Time	**: 15 Minutes**

READ THE FOLLOWING INSTRUCTIONS CAREFULLY:

1. Write your **Roll Number** clearly on the answer booklet in the space provided.

2. Do not write for the first 15 minutes. This time must be spent in reading the question paper and to check for any missing pages and printing errors.

3. Use either **Blue or Black ink pen or ball point pen** for the written part and **pencil** for the sketches and drawings.

4. All the answers must be written on the separate Answer Booklet provided. Candidates are not allowed to write anything on the question paper.

5. Use of programmable calculators is not allowed in this examination.

6. This paper contains fifteen (15) pages. It is divided into two sections**:** SECTION A and SECTION B.

7. **SECTION A** consists of two parts, **Part I** and **Part II**.

   Part I consists of 30 multiple choice questions carrying one (1) mark each and is compulsory. The answer of your choice from the option should be clearly written with the question number and option number on the separate Answer Booklet provided.

   Part II consists of four (4) short answer type questions of five (5) marks each. All are compulsory.

8. **SECTION B** consists of two (2) **Case Studies** of fifty (50) marks each**.** You have to answer only one case study question.

SECTION A

PART I – MULTIPLE CHOICE: Answer all the questions [**30 marks]**

There are **30(Thirty)** multiple choice questions of one mark each. Choose the correct answer and write down the question number and the number of the correct answer chosen against it in the separate **Answer Booklet** provided.

1. The elastic limit is:

   a) the limiting load beyond which the material no longer behaves elastically
   b) the limiting load beyond which the material behaves elastically
   c) the limiting load beyond which the material no longer behaves plastically
   d) none of the above.

2. The percentage range of carbon content in high carbon steels is:

   a) 5% - 10% C
   b) 0.65% - 1.70% C
   c) 5.55% - 9.50% C
   d) 1% - 3% C

3. Bronze is an alloy of copper and

   a) Tin
   b) Zinc
   c) Aluminium
   d) lead

4. Which of the following equipment is used to test the hardness of a material?

   a) Torsion tester
   b) Brinell tester
   c) Spring tester
   d) Tensile tester

5. What is the definition of porosity in welding?

   a) Holes which occur in the weld metal due to trapped gases
   b) A cavity which occurs at the end of the weld
   c) Small pinholes which occur in the weld metal
   d) None of the above

6. Mineral dressing is actually a:

a) Hydrometallurgy process
b) Pyrometallurgy process
c) Oil refining process
d) Process in which raw materials are yielded to marketable products and do not destroy the chemical and physical identity of the minerals.

7. Which of the following is the most inexpensive process?

a) Hydrometallurgy process
b) Mineral dressing process
c) Pyrometallurgy process
d) Oil refining process

8. One ounce of gold is

a) 35.3 g
b) 31.1 g
c) 32.1 g
d) 50.1 g

9. Which of the following is the right procedure to extract metal from ore to its pure form?

a) Crushing of the ore → Dressing or concentration of the ore → Reduction of metal → Purification or refining of the metal
b) Dressing or concentration of the ore → Reduction of metal → Crushing of the ore → Purification or refining of the metal
c) Reduction of metal → Crushing of the ore → Dressing or concentration of the ore → Purification or refining of the metal
d) Crushing of the ore → Dressing or concentration of the ore → Purification or refining of the metal → Reduction of metal

10. Following is wrong about a phase diagram.

a) It gives information on transformation rates
b) Relative amount of different phases can be found under given equilibrium conditions
c) It indicates the temperature at which different phases start to melt
d) Solid solubility limits are depicted by it

11. Not a basic step of precipitation strengthening

a) Solutionizing
b) Mixing and compacting
c) Quenching
d) Aging

12. One of the following is not a typical site for nucleation during solid state transformation

a) Container wall
b) Grain boundaries
c) Stacking faults
d) Dislocations

13. Eutectoid product in Fe-C system is called

a) Pearlite
b) Bainite
c) Ledeburite
d) Spheroidite

14. Alloying element that decreases eutectoid temperature in Fe-C system

a) Mo
b) Si
c) Ti
d) Ni

15. Gibbs phase rule for general system is

a) P+F=C-1
b) P+F=C+1
c) P+F=C-2
d) P+F=C+2

16. Electrical power is normally measured in:

a) Horsepower
b) Newtons
c) Watts
d) Joules

17. Which of the following analyses would give an austenitic stainless steel?

a) 12% chromium, 2% nickel
b) 0.2% carbon, 6% nickel, 2% manganese
c) 18% chromium, 8% nickel
d) All of the above.

18. Which metal is used as fuse wire?

a) Lead
b) Zinc
c) Iron
d) None of the abovel

19. Polymers are characterized by which of the following bonding types?

a) Adhesive
b) Hydrogen
c) Van der Waals
d) Ionic

20. Which one of the following materials has the highest modulus of elasticity?

a) Aluminum
b) Diamond
c) Titanium
d) Tungsten

21. Which one of the polymer types is not normally considered to be a plastic?

a) Thermoplastics
b) Thermosets
c) Elastomers
d) Both a) and b)

22. In casting, a flask is which one of the following?

a) Beverage bottle for foundrymen
b) Which holds the cope and drag
c) Container for holding liquid metal
d) Metal which extrudes between the mold halves

23. For a given weight of metallic powders, the total surface area of the powders is increased by

a) Larger particle size
b) Smaller particle size
c) Smaller shape factor
d) None of the above

24. Smaller grain size in a grinding wheel tends to do which one of the following?

a) Improve surface finish
b) Have no effect on surface finish
c) Degrade surface finish
d) None of the above

25. Which of the following is not an objective of heat treatment?

a) Increase hardness
b) Increase toughness
c) Reduce density
d) Reduce brittleness

26. On which one of the following metals can the treatment called austenitizing be performed?

a) Aluminum alloys
b) Brass
c) Copper alloys
d) Steel

27. How many atoms are there in the unit cell of the face- centered cubic (FCC) unit cell?

a) 8
b) 10
c) 12
d) 14

28. Which one of the following manufacturing processes will likely result in the best surface finish?

a) Arc welding
b) Grinding
c) Sand casting
d) Sawing

29. Which one of the following manufacturing processes will likely result in the worst surface finish?

a) Grinding
b) Cold rolling
c) Machining
d) Sand casting

30. What will happen to the strength and hardness of steel as carbon content increases?

a) Steel strength and hardness increases
b) Steel strength and hardness decreases
c) Steel strength and hardness remains same
d) None of the above.

PART II: SHORT ANSWER QUESTIONS (*Answer all FOUR questions*)

1. A tensile test uses a test specimen that has a gage length of 50 mm and an area = 200 mm^2. During the test the specimen yields under a load of 98,000 N. The corresponding gage length = 50.23 mm. This is the 0.2 percent yield point. The maximum load = 168,000 N is reached at a gage length = 64.2 mm. Determine: (a) yield strength *Y*, (b) modulus of elasticity *E*, and (c) tensile strength *TS*. [5 marks]

2. i) What are some of the disadvantages of Powder Metallurgy methods? [2.5 marks]

ii) Name some of the reasons for the commercial importance of powder metallurgy technology. [2.5 marks]

3. i) What is the difference between machine welding and automatic welding? Discuss the reasons why most welding operations are inherently dangerous. [2.5 marks]

ii) What are the advantages and disadvantages of welding compared to other types of assembly operations? [2.5 marks]

4. One of the inspectors in the Standard Quality Control department has frequently used the Brinell and Rockwell hardness tests, for which equipment is available in the company. He claims that all hardness tests are based on the same principle as the Brinell test, which is that hardness is always measured as the applied load divided by the area of the impressions made by an indentor. [5 marks]

a) Is he correct?

b) If not, what are some of the other principles involved in hardness testing, and what are the associated tests?

SECTION B – CASE STUDY (*Answer any one question*) [50 marks]

1. **(a)** A pile of iron powder weighs 2 lb. The particles are spherical in shape and all have the same diameter of 0.002 in. (i) Determine the total surface area of all the particles in the pile. (ii) If the packing factor = 0.6, determine the volume taken by the pile. Note: the density of iron = 0.284 lb/in^3. [20 marks]

(b) Solve Problem **1(a),** except that the diameter of the particles is 0.004 in. Assume the same packing factor. [5 marks]

(c) Suppose in Problem **1(a)** that the average particle diameter = 0.002 in; however, the sizes vary, forming a statistical distribution as follows: 25% of the particles by weight are 0.001 in, 50% are 0.002 in, and 25% are 0.003 in. Given this distribution, what is the total surface area of all the particles in the pile? [25 marks]

2. A team from a ferro alloy company in Bhutan has discovered a massive deposit of Iron ore in southern Bhutan. The Managing Director of that company is very much interested to extract the ore into pure iron. You as a Metallurgist is hired to carry out the task. Explain all the possible methods and procedures that you can think of in the extraction of iron ore. [50 marks]