※ 注意：請於試卷上「選擇題作答區」依序作答。

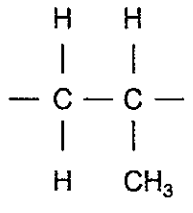
- Closed book; closed note
- There are in all **100** points.
- Time: 80 min
- Please put **ALL** your answers on the answer sheet, **NOT** the question sheet
- Please return all the sheets back after the exam.

I. Multiple choices (**There may be more than one correct answer.** Except for the last question, all others have **7** points each. **One** error costs you **4** points, until no more point is available with that particular problem)

1. About aluminum alloys:
(A) The density of Al alloys is smaller than that of steels. (B) Aluminum alloys are widely applied in structural parts of aircrafts. (C) Pure aluminum has a melting point of 660 °C, similar to that of pure copper. (D) A type of aluminum alloy is designated 7075–T6. "T6" indicates which type of alloying element is present. (E) 3xxx series of aluminum alloys is mainly strengthened by precipitation hardening; therefore, they are often used to make cans.

2. About ceramic materials, which is (are) true?
(A) Dislocation movements do not need to be considered when ceramics are deformed. (B) The bonding types of ceramics range widely, from purely covalent to purely ionic. (C) Since ceramic materials are very brittle, hardness testing is difficult to perform. (D) Elastic modulus of a ceramic is a function of its porosity. (E) Both Frenkel defects and Schottky defects lead to charge neutrality.

3. About polymers:
(A) The repeat unit molecular weight of nylon 66 is about 262 g/mol. (B) Given the degree of polymerization is 38, the number-averaged molecular weight for a polypropylene is about 1600 g/mol. (C) Polypropylene can be ground up and reused. (D) PVC is widely used in making shampoo bottles and can be recycled because it is a thermoset polymer. (E) The repeat unit of polystyrene is:



4. Carbon is ubiquitous and can be found and applied in different aspects of materials' science. Which of the following is (are) true?
(A) Graphene is a single atomic layer of graphite. (B) Diamond is hard, brittle, and has sp^2 bonding. (C) Graphite is opaque optically, and flaky by morphology. (D) Doping carbon into pure iron makes an increase in hardness because dislocation density increases. (E) A propane molecule consists of 3

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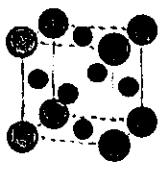
carbon atoms.

5. Which of the following is (are) true for zinc-blende (A_xB_y) structures?
(A) Colors of such structures can be altered by doping. (B) A unit cell of a zinc-blende structure looks like this:  (C) x:y = 1:1. (D) Octahedral sites are occupied by anions. (E) Sphalerite is a type of such structures, and is a wide-bandgap semiconductor material.

6. A copper wire of a length of 10 m is cooled from 50 °C to -10 °C. It is known that the volumetric coefficient of thermal expansion is 51 × 10^{-6} K^{-1}.
(A) The length contraction is about 30 mm. (B) The density of the wire will increase. (C) The volume of the wire decreases because the vacancy density decreases. (D) If the cooling rate is extremely fast (10^5 K/s), martensite will form. (E) If the cooling rate is extremely fast, the inner part of the wire will experience a compressive stress.

7. About glass transition temperature (T_g),
(A) Rubber like polyisobutylene is used above T_g. (B) T_g is normally measured by a scanning electron microscope. (C) T_g is a function of composition. (D) The glassy state of atomic arrangements cannot be made nor observed in metallic materials. (E) Glass transition is generally not regarded as first-order phase transition.

8. Considering atoms and electrons orbiting atomic nuclei:
(A) Bohr model describes that electron positions are probabilistic. (B) The electron configuration of P^{4+} is $1s^22s^22p^63s^2$. (C) CdTe has predominantly covalent bonding. (D) For a neutral atom which has an electron configuration of $1s^22s^22p^63s^23p^63d^64s^2$, it is from a transition metal.

9. The wavelengths of visible light range from 380 nm to 750 nm. Estimate the energy (× 10^{-19} J) of a photon from a violet light source.
(A) 0.8 (B) 1 (C) 3 (D) 5 (E) 7

10. What is (are) correct about hardenability?
(A) Normally, Charpy tests are conducted to evaluate the hardenability of

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materials. (B) 4340 steel has higher hardenability than 1010 plain carbon steel. (C) Water quenching gives higher cooling rates than air cooling does. (D) Generally speaking, hardenability is a measure of materials' ability to form cementite. (E) Hardenability curve is done by making a series of hardness tests.

11. What is (are) correct about corrosion?

(A) Aluminum is said to be corrosion resistant because it tends not to react with oxygen. (B) Polytetrafluoroethylene (PTFE) is an ideal choice to contain dilute nitric acid. (C) Zinc is usually coated to protect iron because it can serve as an anode. (D) Hydrogen embrittlement (HE) is a type of corrosion where atomic hydrogen penetrates metals/alloys, causing failure. (E) The picture below shows a typical example of intergranular corrosion (IGC).

12. About cast irons, which statement(s) is/are correct?

(A) Normally, cast iron has carbon contents 0.3 – 0.45 wt.%. (B) Graphite formation can be promoted by Si addition and ultra-fast cooling. (C) White cast iron is the most commonly-used one thanks to its large and connected cementite. (D) Adding Mg and/or Ce to gray cast iron makes nodular (ductile) cast iron. (E) Cast iron is very effective in damping vibrational energy, compared to steels.

13. Regarding magnetism:

(A) Mn has 5 spin-up electrons in the 3d orbital, so it is ferrimagnetic. (B) Néel temperature is defined as the transition temperature between paramagnetism and antiferromagnetism. (C) The Stern-Gerlach experiment could explain the spin properties of electrons. (D) From a hysteresis loop, coercivity is defined to be the applied magnetic field when magnetic induction is 0. (E) Under a well-designed and controlled circumstance, magnetic monopole can exist.

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14. About heat treatments of metals (9 points):

(A) Spheroidizing is to make cementite become round particles and thus more suitable for machining. (B) In order to obtain the best precipitation hardening effect, over-aging condition is desired. (C) Stress relief is commonly used to reduce residual stresses resulting from plastic deformation. (D) Normalization heat treatments aim at making uniformly smaller grains. (E) Tempered martensite leads to precipitation, thus will make martensite more brittle. (F) Spinodal decomposition is a congruent type of phase transformation. (G) Alloys being "heat-treatable" means they are precipitation hardenable.

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