Midterm 2, Chapters 11-21

Take a deep breath, read carefully and answer the questions by filling correct answers IN THE SCANTRON. All of the equations you need are provided on the last page.

1. You have two atoms, one with 2 protons and 3 electrons, and another one with 2 protons and 1 electron. Are they the same element?
   A) Yes, they are the same element.
   B) No, they are different elements.

2. An atom with 2 protons and 1 electron would be an example of
   A) a negative ion
   B) a positive ion
   C) an isotope
   D) a positron

3. A Carbon-12 atom is a standard carbon atom with 6 protons and 6 neutrons, how many neutrons does the Carbon-14 isotope has?
   A) 2
   B) 8
   C) 14
   D) 7

4. All of the matter that we know (dark matter excluded) is made out of quarks and leptons. HINT: The electron is a type of lepton, protons and neutrons are made out of quarks.
   A) True
   B) False

5. What is the charge of the anti-proton?
   A) Negative
   B) Positive

6. Can we say that Dark Matter produces positive (attractive) gravity and Dark Energy negative (repulsive) gravity?
   A) True
   B) False

7. The *liter* is a unit measure for
   A) Volume
   B) Mass
   C) Density
   D) Area

8. If the density of water is 1 g/cm^3 how many liters do you need to get 3 kg of water? (1 liter = 1000 cm^3)
   A) 3 liters
   B) 3000 liters
   C) .3 liters
   D) .003 liters

9. When you hang a 100 g mass from a spring, the spring stretches 2 cm. If you remove the 100 g mass and hang another object of unknown mass, the spring stretches 6 cm. What is the mass of the object? (Assume the spring obeys Hooke's law and doesn't stretches beyond its elastic limit).
   A) 200 g
   B) 100/3 g
   C) 600 g
   D) 300 g

10. What is the value of the force constant *k* of the spring in the above problem? HINT: Remember that the force of gravity on a mass (the weight) is given by F = mg, where g = 10 m/s^2. Also remember that 1 N = 1 kg m/s^2.
   A) 50 N/cm
   B) 5 N/cm
   C) .05 N/cm
   D) 0.5 N/cm

11. If you are standing with both feet and suddenly lift one foot off the ground, what happens to the pressure between your feet and the ground?
   A) The pressure doubles
   B) The pressure halves
   C) The pressure stays the same

12. An object displaces 3 liters of water and weights 4 kg. Does the object floats on water? (water density = 1 g/cm^3 = 1 kg/liter)
   A) Yes
   B) No

13. _____ is the average translational kinetic energy of the molecules in a substance/object.
   A) Heat
   B) Temperature
   C) Specific heat capacity
   D) Latent heat

14. _____ is the transfer of energy due to differences in Temperature?
   A) Heat
   B) Temperature
   C) Specific heat capacity
   D) Latent heat

15. The energy absorbed by an object through heat goes all into raising the translational kinetic energy of the object's molecules.
    A) True B) False

16. When an object absorbs energy through heat, the _____ of the object tells you how much energy goes into temperature v.s. other types of internal energy.
    A) Heat C) Specific Heat Capacity
    B) Temperature D) Latent heat

17. The Specific Heat Capacity of object A is twice the Specific Heat Capacity of object B. When object A absorbs 10 Joules of energy through heat, its temperature raises 2°C. How much energy does object B needs to absorb to raise its temperature by 2°C. (A and B have the same mass)
    A) 5 Joules C) 100
    B) 20 Joules D) 0.1 Joules

18. Imagine yourself on the beach in a hot sunny day, most (if not all) of the heat you are absorbing comes from the sun. Which is the dominant heat transfer mechanism making you gain energy?
    A) Conduction C) Radiation
    B) Convection

19. You still at the beach and you feel a cooling onshore breeze. Which heat transfer mechanism is taking energy away from you?
    A) Conduction C) Radiation
    B) Convection

20. Although the cooling breeze felt nice it wasn't enough and you decide to take a dip in the ocean. As soon as you touch the water you instantly feel cooler, which heat transfer mechanism is cooling you off?
    A) Conduction C) Radiation
    B) Convection

21. We and all objects are constantly loosing small amounts of heat in the form of _____ as we emit electromagnetic waves in the infrared range of the electromagnetic spectrum?
    A) Conduction C) Radiation
    B) Convection

22. What variable/s play a role in determining how and when phase transitions happen?
    A) Temperature
    B) Pressure
    C) Properties of the Material/ Substance
    D) All of the above

23. Evaporation can only happen on the surface of liquids.
    A) True
    B) False

24. What is the heat transfer required to freeze 2 liters of water at 50°C to ice at 0°C? (The specific heat capacity and latent heat of melting for water are $c_{\text{water}} = 1\frac{cal}{g°C}$ and $L_{\text{ice-water}} = 80\ \frac{cal}{g}$ respectively)
    A) 100 kilo calories
    B) 180 kilo calories
    C) 160 kilo calories
    D) 260 kilo calories

25. In the above problem energy is being removed from _____.
    A) water into the environment.
    B) the environment into water.

26. After you drive for a while your tires will gain some energy via friction and heat up. If the air inside the tires absorbs 150 Joules of energy by heat, and does 100 Joules of work by expanding and lifting your car a fraction of a millimeter, what is the net change in the internal energy of the air inside the tires? (Hint: Use the first law of thermodynamics)
    A) 100 Joules
    B) 50 Joules
    C) 250 Joules
    D) 150 Joules

27. A surfer wants to know the period of the incoming swell (wave train). When a set of waves comes she counts 3 waves passing by in one minute, what is the period between waves?
    A) 60 seconds
    B) 30 seconds
    C) 20 seconds
    D) 10 seconds

28. For the above question, what is the frequency of the swell?
    A) .05 Hz
    B) 0.1 Hz
    C) .03 Hz
    D) 1/3 Hz

29. If the wavelength of the swell (in questions 27-28) is 200 meters, what is the speed of the waves?
    A) 20 m/s
    B) 10 m/s
    C) 67 m/s
    D) 3 m/s

30. Ocean waves are an example of
    A) transverse waves.
    B) longitudinal waves.

31. Sound waves are an example of
    A) transverse waves.
    B) longitudinal waves.

32. When astronomers observe far away galaxies they see the light being redshifted (i.e. the frequency of the observed light waves is lower — more towards the red — than expected). That is an indication that far away galaxies are
    A) moving away from us.
    B) moving towards us.
    C) not moving.

Equations Sheet

Density:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Hooke's Law:

$$F = \text{k} \times \Delta x$$

$$F = mg$$

$$g = 9.8 \ \frac{m}{s^2} \simeq 10 \ \frac{m}{s^2}$$

Pressure:

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

Specific Heat Capacity :

$$\Delta T = \frac{\text{Heat Transferred}}{\text{mass} \times \text{Heat Capacity}} = \frac{Q}{mc}$$

$$Q = mc\Delta T$$

$$\text{Water's heat capacity} = c_{\text{water}} = 1\frac{cal}{g^{\circ}C}$$

Heat Required for Phase Transitions (Latent Heat):

$$L = \text{Latent Heat}$$

$$Q = mL$$

$$L_{\text{ice-water}} = 80 \ \frac{cal}{g},$$

$$L_{\text{water-steam}} = 540 \ \frac{cal}{g}$$

First Lay of Thermodynamics:

$$\Delta U = Q - W$$

Change in Internal Energy = Heat added – Work

Vibrations and Waves:

$$\text{Frequency} = \frac{1}{\text{Period}}$$

$$\text{Wave Speed} = \text{Frequency} \times \text{Wave Length}$$

$$\text{Wave Speed} = \frac{\text{Wave Length}}{\text{Period}}$$