IVC – PHYSICAL SCIENCE 110
STUDY GUIDE # 2

Answer the following problems:

1) An 80.-kilogram skater and a 60.-kilogram skater stand at rest in the center of a skating rink. The two skaters push each other apart. The 60.-kilogram skater moves with a velocity of 10. meters per second east. What is the velocity of the 80.-kilogram skater? [Neglect any frictional effects.]
   A) 7.5 m/s west  B) 13. m/s east  C) 0.13 m/s west  D) 10. m/s east

2) Two disk magnets are arranged at rest on a frictionless horizontal surface as shown in the diagram below. When the string holding them together is cut, they move apart under a magnetic force of repulsion. When the 1.0-kilogram disk reaches a speed of 3.0 meters per second, what is the speed of the 0.5-kilogram disk?
   [Diagram of two disk magnets with a string connecting them.]
   A) 0.50 m/sec  B) 1.0 m/sec  C) 6.0 m/sec  D) 3.0 m/sec

3) The diagram below shows two carts on a horizontal, frictionless surface being pushed apart when a compressed spring attached to one of the carts is released. Cart A has a mass of 3.0 kilograms and cart B has a mass of 5.0 kilograms. The speed of cart A is 0.33 meter per second after the spring is released.
   [Diagram of two carts separated by a compressed spring.]
   If the carts are initially at rest, what is the approximate speed of cart B after the spring is released?
   A) 0.20 m/s  B) 0.33 m/s  C) 0.12 m/s  D) 0.55 m/s

4) A 2-kilogram car and a 3-kilogram car are originally at rest on a horizontal frictionless surface as shown in the diagram below. A compressed spring is released, causing the cars to separate. The 3-kilogram car reaches a maximum speed of 2 meters per second. What is the maximum speed of the 2-kilogram car?
   [Diagram of two cars separated by a compressed spring.]
   A) 2 m/s  B) 6 m/s  C) 3 m/s  D) 1 m/s
5) The diagram below represents two identical carts, attached by a cord, moving to the right at speed \( V \). If the cord is cut, what would be the speed of cart \( A \)?

A) \( 2V \)  
B) \( \frac{V}{2} \)  
C) 0  
D) \( V \)

6) A spring is compressed between two stationary blocks as shown in the diagram below. Block \( A \) has a mass of 6.0 kilograms. After the spring is released, block \( A \) moves west at 8.0 meters per second and block \( B \) moves east at 16 meters per second.

What is the mass of block \( B \)? [Assume no frictional effects.]

A) 16 kg  
B) 6.0 kg  
C) 3.0 kg  
D) 12 kg

7) Two rocks weighing 5 newtons and 10 newtons, respectively, fall freely from rest near the Earth's surface. After 3 seconds of free-fall, compared to the 5-newton rock, the 10-newton rock has greater

A) momentum  
B) acceleration  
C) speed  
D) height

8) In the diagram below, a 0.4-kilogram steel sphere and a 0.1-kilogram wooden sphere are located 2.0 meters above the ground. Both spheres are allowed to fall from rest.

Which statement best describes the spheres after they have fallen 1.0 meter? [Neglect air resistance.]

A) The steel sphere has greater speed than the wooden sphere and both spheres have the same momentum.  
B) The steel sphere has greater speed and has less momentum than the wooden sphere.  
C) Both spheres have the same speed and momentum.  
D) Both spheres have the same speed and the steel sphere has more momentum than the wooden sphere.

9) A 2.0-kilogram ball traveling north at 4.0 meters per second collides head on with a 1.0-kilogram ball traveling south at 8.0 meters per second. What is the magnitude of the total momentum of the two balls after collision?

A) 0 kg \( \cdot \) m/s  
B) 32 kg \( \cdot \) m/s  
C) 16 kg \( \cdot \) m/s  
D) 8.0 kg \( \cdot \) m/s

10) A rocket with a mass of 1,000 kilograms is moving at a speed of 20 meters per second. The magnitude of the momentum is

A) 50 kg \( \cdot \) m/s  
B) 400,000 kg \( \cdot \) m/s  
C) 200 kg \( \cdot \) m/s  
D) 20,000 kg \( \cdot \) m/s
11) The diagram below represents a 20-newton force pulling an object up a hill at a constant rate of 2 meters per second.

![Diagram showing a 20 N force pulling an object up a hill]

The magnitude of the momentum of the moving object is
A) 100 kg·m/s  B) 600 kg·m/s  C) 10 kg·m/s  D) 0 kg·m/s

Questions 12 and 13 refer to the following:

The graph below represents the velocity-time relationship for a 2.0-kilogram mass moving along a horizontal frictionless surface.

![Graph showing velocity-time relationship]

12) The net force on the mass during interval DE is
A) 2.0 N  B) 1.0 N  C) 0 N  D) 4.0 N

13) The momentum of the mass during interval BC is
A) 12 kg·m/s  B) 0 kg·m/s  C) 8.0 kg·m/s  D) 4.0 kg·m/s

14) A 1,000-kilogram car traveling with a velocity of +20. meters per second decelerates uniformly at -5.0 meters per second² until it comes to rest.

What is the magnitude of the impulse applied to the car to bring it to rest?
A) $2.0 \times 10^4$ N·s  B) $9 \times 10^4$ N·s  C) $4.0 \times 10^4$ N·s  D) $3 \times 10^4$ N·s

15) Which graph best represents the relationship between the mass of an object and its distance from the center of the Earth?
16) Which graph best represents the relationship between the masses of different objects and the gravitational force acting on them as they fall freely near the Earth’s surface?

A) 

B) 

C) 

D) 

17) The diagram below represents a satellite in an elliptical orbit around the Earth. The highest point, A, is four Earth radii (4R) from the center of the Earth. The lowest point, B, is two Earth radii (2R) from the center of the Earth. The mass of the satellite is 3.0 x 10^6 kilograms.

Compared to the magnitude of the force of the satellite on the Earth, the magnitude of the force of the Earth on the satellite is

A) greater  
B) less  
C) the same

18) If the distance between a spaceship and the center of the Earth is increased from one Earth radius to four Earth radii, the gravitational force acting on the spaceship becomes approximately

A) \( \frac{1}{4} \) as great  
B) 4 times greater  
C) \( \frac{1}{16} \) as great  
D) 16 times greater

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B) \( \frac{1}{16} \) as great  
C) 4 times greater  
D) 16 times greater

20) Work is being done when a force

A) is exerted while pulling a wagon up a hill  
B) of gravitational attraction acts on a person standing on the surface of the Earth  
C) acts vertically on a cart that can only move horizontally  
D) is exerted by one team in a tug-of-war when there is no movement

21) A net force of 5.0 newtons moves a 2.0-kilogram object a distance of 3.0 meters in 3.0 seconds. How much work is done on the object?

A) 10. J  
B) 15 J  
C) 30. J  
D) 1.0 J

22) Which term is a unit of power?

A) joule  
B) watt  
C) hertz  
D) newton
23) Which quantity and unit are correctly paired?

A) energy \( \frac{\text{kg} \cdot \text{m}^2}{s^2} \)  
B) velocity \( \text{m/s}^2 \)  
C) momentum \( \frac{\text{kg} \cdot \text{m}}{s^2} \)  
D) work \( \text{kg/m} \)

24) Which graph best represents the relationship between potential energy \((PE)\) and height above ground \((h)\) for a freely falling object released from rest?

A) \(PE\) \(h\)  
B) \(PE\) \(h\)  
C) \(PE\) \(h\)  
D) \(PE\) \(h\)

25) Which cart shown below has the greatest kinetic energy?

A) \(v = 2 \text{ m/s}\) \(3 \text{ kg}\)  
B) \(v = 3 \text{ m/s}\) \(2 \text{ kg}\)  
C) \(v = 4 \text{ m/s}\) \(1 \text{ kg}\)  
D) \(v = 1 \text{ m/s}\) \(4 \text{ kg}\)

Questions 26 and 27 refer to the following:

The graph below represents the velocity-time relationship for a 2.0-kilogram mass moving along a horizontal frictionless surface.

26) The kinetic energy of the mass is greatest during interval

A) \(DE\)  
B) \(AB\)  
C) \(BC\)  
D) \(CD\)

27) Work is not being done on the mass during interval

A) \(DE\)  
B) \(EF\)  
C) \(AB\)  
D) \(CD\)
Questions 28 through 30 refer to the following:

The diagram below represents a 2.0-kilogram mass placed on a frictionless track at point $A$ and released from rest. Assume the gravitational potential energy of the system to be zero at point $E$.

28) The gravitational potential energy of the system at point $A$ is approximately
   A) 20 joules
   B) $8.0 \times 10^2$ joules
   C) 80 joules
   D) $7.0 \times 10^2$ joules

29) Compared to the kinetic energy of the mass at point $B$, the kinetic energy of the mass at point $E$ is
   A) the same
   B) twice as great
   C) 4 times greater
   D) $\frac{1}{2}$ as great

30) If the mass were released from rest at point $B$, its speed at point $C$ would be
   A) 14 m/sec
   B) 0 m/sec
   C) 0.50 m/sec
   D) 10. m/sec

31) The diagram below represents a 1.00-kilogram object being held at rest on a frictionless incline.

   The object is released and slides the length of the incline. When it reaches the bottom of the incline, the object's kinetic energy will be closest to
   A) 2.00 J
   B) 4.00 J
   C) 19.6 J
   D) 9.81 J

32) Which quantities are measured in the same units?
   A) power and work
   B) heat and temperature
   C) mass and weight
   D) work and energy

33) A force is applied to a block, causing it to accelerate along a horizontal, frictionless surface. The energy gained by the block is equal to the
   A) work done on the block
   B) impulse applied to the block
   C) momentum given to the block
   D) power applied to the block

34) The work done in raising an object must result in an increase in the object's
   A) heat energy
   B) gravitational potential energy
   C) kinetic energy
   D) internal energy

35) As an object is raised above the Earth's surface, the gravitational potential energy of the object-Earth system
   A) decreases
   B) remains the same
   C) increases

36) As an object falls freely near the Earth's surface, the loss in gravitational potential energy of the object is equal to its
   A) loss of height
   B) gain in velocity
   C) loss of mass
   D) gain in kinetic energy
37) At what point in its fall does the kinetic energy of a freely falling object equal its potential energy?
   A) at the start of the fall  
   B) halfway between the start and the end  
   C) at all points during the fall  
   D) at the end of the fall

38) As the pendulum swings freely from A to B as shown in the diagram below, the gravitational potential energy of the pendulum

   A) remains the same  
   B) increases  
   C) decreases

39) In the diagram below, an ideal pendulum released from point A swings freely through point B.

   Compared to the pendulum's kinetic energy at A, its potential energy at B is
   A) twice as great  
   B) half as great  
   C) the same  
   D) four times as great

40) As the pendulum swings from position A to position B as shown in the diagram below, what is the relationship of kinetic energy to potential energy? [Neglect friction.]

   A) The kinetic energy decrease is equal to the potential energy increase.  
   B) The kinetic energy increase is more than the potential energy decrease.  
   C) The kinetic energy increase is equal to the potential energy decrease.  
   D) The kinetic energy decrease is more than the potential energy increase.