

Physics, 2012 EC, entrance exam

Grade 12 · Physics · 2012 E.C.

MARKING KEY — CONFIDENTIAL

Time allowed: 120 minutes

Questions: 41

Total marks: 41

1. Equilibrium is the state of an object when (1)
- A. ✓ **The net force and net torque are both zero.**
- B. The object has constant angular acceleration.
- C. The net force acting on it is constant.
- D. The object has constant linear acceleration.

Answer: A

An object is in mechanical equilibrium if and only if both the net external force and the net external torque acting on it are zero, which prevents any linear or angular acceleration.

2. The fulcrum of a uniform 20 Kg seesaw that is 4.0 m long is located 2.5 m from one end. A 30Kg child sits on the long end. The weight of a person sitting at the other end in order To balance the seesaw is _____ . (1)
- A. 433 N
- B. ✓ **567 N**
- C. 750 N
- D. 850 N

Answer: B

Taking torque about the fulcrum, the uniform seesaw's center of gravity (at 2.0 m) is 0.5 m from the fulcrum on the long end side. To balance, the torque from the person on the short end (1.5 m from the fulcrum) must equal the sum of torques from the child (at 2.5 m) and the seesaw itself: $1.5W_p = 30(10)(2.5) + 20(10)(0.5) = 850 \text{ N} \cdot \text{m}$, giving $W_p \approx 567 \text{ N}$.

3. A material rod that is 4.00 m long and 0.5 cm^2 in cross-sectional area is found to stretch 0.20cm under a tension of 5000N. The Young's Modulus for this material is _____ . (1)
- A. ✓ **$2.0 \times 10^{11} \text{ N/m}^2$**
- B. $5.0 \times 10^8 \text{ N/m}^2$
- C. $1.0 \times 10^4 \text{ N/m}^2$
- D. $1.0 \times 10^8 \text{ N/m}^2$

Answer: A

Young's Modulus is given by $Y = \frac{FL_0}{A\Delta L}$. Substituting the values $F = 5000 \text{ N}$, $L_0 = 4.0 \text{ m}$, $A = 0.5 \times 10^{-4} \text{ m}^2$, and $\Delta L = 2.0 \times 10^{-3} \text{ m}$ gives $Y = 2.0 \times 10^{11} \text{ N/m}^2$.

4. Which one of the following is NOT true about Pascal's principle and its application? (1)
- A. In pneumatic application, air is used for pressure transmission instead of liquid.
- B. ✓ **The hydraulic lift is a speed multiplying device in which a large force lifts a light object over a long distance.**
- C. It has applications in hydraulic brakes for vehicles, where confined oil connects a small piston (brake pedal) to a large piston connected to the brake drums on the wheel of the car.
- D. It has applications in hydraulic lift in which a small force is applied to a smaller piston is used to lift heavy object on large.

Answer: B

A hydraulic lift is a force-multiplying device, not a speed-multiplying device. It allows a smaller input force acting over a larger distance to lift a much heavier load over a shorter distance.

5. Which one of the following is NOT correct about factors that affecting the streamlining of objects moving in fluid? (1)

- A. ✓ **The mass of the object**
B. Shape and surface area of the object moving in fluid
C. Compressibility of the fluid
D. Density of the fluid

Answer: A

The streamlining of an object depends on the fluid's characteristics (density, viscosity, compressibility) and the object's geometry (shape and surface area), but is independent of the mass of the moving object itself.

6. Which of the following is correct? (1)

- A. Internal energy of a system is independent of its mass or the number of molecules in the system.
B. ✓ **Temperature is a measure of the average molecular kinetic energy of a gas.**
C. The temperature is a measure of the amount of energy that flows from hot to colder region.
D. Heat is energy that can be transferred from one object to another at equal temperature.

Answer: B

Temperature is directly proportional to the average translational kinetic energy of the molecules in an ideal gas ($KE_{\text{avg}} = \frac{3}{2}k_B T$), making Option B the correct statement.

7. Two moles of an ideal gas at a temperature of 308 K is confined in a volume of $5.00 \times 10^{-3} \text{ m}^3$. The pressure of the gas is (Universal gas constant $R = 8.314 \text{ J/mol}\cdot\text{K}$). (1)

- A. $1.23 \times 10^6 \text{ Pa}$
B. $5.12 \times 10^6 \text{ Pa}$
C. ✓ $1.02 \times 10^6 \text{ Pa}$
D. $1.00 \times 10^6 \text{ Pa}$

Answer: C

Using the ideal gas law $P = \frac{nRT}{V}$, with $n = 2$, $R = 8.314 \text{ J/(mol} \cdot \text{K)}$, $T = 308 \text{ K}$, and $V = 5.00 \times 10^{-3} \text{ m}^3$, we calculate $P = 1.024 \times 10^6 \text{ Pa}$.

8. A glass contains 12 mole of water molecule (H_2O). The number of water molecules, the mass of water, and the mass of each water molecules in the glass are, respectively (Molar mass of H is 1.0g and O is 16.0 g). (1)

- A. 96.32×10^{23} molecules, 0.036 Kg, $0.009 \times 10^{-26} \text{ Kg}$.
B. 102×10^{23} molecules, 0.024Kg, $6.02 \times 10^{-26} \text{ Kg}$.
C. 90.32×10^{23} molecules, 0.192 Kg, $18 \times 10^{-26} \text{ Kg}$.
D. ✓ 72.24×10^{23} molecules, **0.216 Kg**, $35.9 \times 10^{-26} \text{ Kg}$.

Answer: D

The number of molecules is $12 \times 6.02 \times 10^{23} = 72.24 \times 10^{23}$ and the mass of 12 moles of H_2O is $12 \text{ mol} \times 18 \text{ g/mol} = 216 \text{ g} = 0.216 \text{ kg}$. This uniquely matches the values in Option D.

9. Three resistors are connected across a battery as shown below. The potential difference across the resistors R_1 , R_2 , and R_3 are, respectively, (1)

[Figure: A circuit diagram showing a DC voltage source labeled $V = 110\text{ V}$ connected in series with a resistor labeled $R_1 = 2\ \Omega$ on the upper rail. Following R_1 , the circuit splits into two parallel branches: the first branch contains a resistor labeled $R_2 = 3\ \Omega$, and the second branch contains a resistor labeled $R_3 = 6\ \Omega$. Both parallel branches connect back to the bottom rail returning to the negative terminal of the voltage source.]

- A. 110V, 25V, 30V
B. ✓ 55V, 55V, 55V
C. 55V, 82.5V, 165V
D. 50V, 30V, 30V

Answer: B

The equivalent resistance of the parallel branch is $R_{23} = (3 \times 6)/(3 + 6) = 2\ \Omega$, making the total resistance $R_{\text{eq}} = 2 + 2 = 4\ \Omega$. The total current is $I = 110\text{ V}/4\ \Omega = 27.5\text{ A}$, which gives a potential difference of $V_1 = 27.5 \times 2 = 55\text{ V}$ and $V_2 = V_3 = 27.5 \times 2 = 55\text{ V}$.

10. According to Kirchhoff's junction rule, (1)

- A. ✓ **The amount of electric charge entering a junction is equal to the amount leaving the junction.**
B. Charges can disappear or appear at the junction.
C. The amount of electric charge flowing into a junction is less than the amount flowing out of the junction.
D. The amount of electric charge flowing into a junction is greater than the amount flowing out of the junction.

Answer: A

Kirchhoff's junction rule is a statement of the law of conservation of charge, meaning that the total charge (or current) entering any junction must equal the total charge leaving it.

11. Which of the following is true about galvanometer? (1)

- A. **A galvanometer can be converted to an ammeter that can read large currents by connecting a small ✓ resistance in parallel with it, and can be converted to a voltmeter by connecting a large resistance in series with the galvanometer**
B. To use a galvanometer as an ammeter that can read voltages, we connect a small resistance in series with the galvanometer
C. Galvanometer can be converted to a voltmeter by connecting a small resistance in parallel with the galvanometer
D. To use a galvanometer as an ammeter that can measure large currents, we need to measure its resistance by connecting a large resistance in series with the galvanometer.

Answer: A

To convert a galvanometer into an ammeter, a small shunt resistance is connected in parallel to bypass excess current, whereas to convert it into a voltmeter, a large multiplier resistance is connected in series to limit the current through the device.

12. According to the kinetic theory of gases, the (1)

- A. **Diffusion rate of a gas is inversely proportional to the square root of the molar mass because it is ✓ directly proportional to the molecular speed.**
B. Particles of an ideal gas undergo inelastic collision between themselves and with the walls of the container.
C. Average translational kinetic energy of the particles of an ideal gas increases as gas gets cooled.
D. Internal energy of an ideal gas is equal to the potential energy due to interaction between the particles of the gas.

Answer: A

According to Graham's law of effusion/diffusion, the rate of diffusion of a gas is inversely proportional to the square root of its molar mass because the root-mean-square speed of the gas molecules is inversely proportional to the square root of the molar mass.

13. At $t = 0$, an object undergoing SHM has maximum displacement of 0.650 m and angular frequency of 7.40 rad/s. Which of the following is correct about the motion of the oscillator? (1)
- A. The frequency of the oscillator is 7.40 Hz and its period is 0.135 s.
 - B. ✓ **The position of the object is $x = 0.65 \cos(7.40t)$ and its acceleration is $a = -35.59 \cos(7.40t)$.**
 - C. The position of the object is $x = 0.650 \cos(7.40t)$ and acceleration is $a = -3.59 \sin(7.40t)$.
 - D. The position of the object is $x = 0.650 \sin(7.40t)$ and its velocity is $V = 4.81 \cos(7.40t)$.

Answer: B

At $t = 0$, $x(0) = A = 0.65 \text{ m}$, which yields the position function $x(t) = 0.65 \cos(7.40t)$. Differentiating twice gives the acceleration $a(t) = -\omega^2 x(t) = -(7.40)^2 \times 0.65 \cos(7.40t) = -35.59 \cos(7.40t)$.

14. A 0.35 Kg mass attached to the end of a spring oscillates 2.5 times per second with amplitude of 0.15 m. which of the following is true about the motion of the mass? (1)
- A. The acceleration when it is 0.10 m from equilibrium is 25.00 m/s^2 .
 - B. The velocity when its 0.10m from equilibrium is 3.0m/s.
 - C. The total energy of the system is 97.0 J.
 - D. ✓ **The velocity when it passes the equilibrium is 2.355m/s.**

Answer: D

The maximum velocity (velocity at equilibrium) is $v_{\max} = \omega A = (2\pi f)A = 2 \times 3.14 \times 2.5 \times 0.15 = 2.355 \text{ m/s}$.
Option C is incorrect because the total energy is 0.97 J, not 97.0 J.

15. Identify a true statement about a mechanical wave (1)
- A. **The speed of a wave traveling along a string increases as the tension in the string increases and as the linear density of the string decreases.**
 - B. The speed of a wave traveling across a thin string is equal to its speed when traveling across a thick string of the length and tension.
 - C. The velocity of traveling wave is equal to the velocity of the particles through which the wave propagates.
 - D. As a wave travels from one point too another along a medium, it transmits energy and particles of the medium from point to point.

Answer: A

The speed of a transverse wave on a string is given by $v = \sqrt{T/\mu}$, which shows that wave speed increases with higher tension T and decreases with a larger linear mass density μ .

16. Which one of the following is correct statements about the intensity of sound? (1)
- A. ✓ **It is inversely proportional to the square of the distance between from the source of sound.**
 - B. It is directly proportional to the square of the distance between from the source of sound.
 - C. It is energy transmitted per unit time.
 - D. It is the product of the a sound and area through which the sound is transmitted.

Answer: A

The intensity of sound from a point source is inversely proportional to the square of the distance from the source ($I = P/4\pi r^2$), because the sound energy spreads over the surface area of a sphere which grows as r^2 .

17. Which of the following is correct about Doppler effect? (1)
- A. **Doppler effect is the change in the frequency of a wave due to relative motion between the wave ✓ source and an observer.**
 - B. When a sound source moves away from stationary observer, the frequency detected by the observer increases, where as the wavelength decreases.
 - C. When a source of sound wave moves toward stationary observer, the wavelength of the wave increases while its frequency decreases.
 - D. It is the change in the velocity of a wave due to relative motion between the source of the wave and an observer.

Answer: A

The Doppler effect is defined as the change in the observed frequency (or wavelength) of a wave due to the relative motion between the source of the wave and the observer.

18. Huygens's principle states that (1)
- A. The secondary wavelets are parallel to the original wave front.
 - B. **All points along a wave front behave as a source of spherical secondary wavelets that have the same ✓ frequency and speed as the original wave front.**
 - C. The secondary wavelets combine to produce a new wave front which has a shape different from the original wave front.
 - D. All points along a wave front acts as a source of plane secondary wavelets that travel at speeds and frequencies greater than that of the original wave.

Answer: B

Huygens's principle states that every point on a wavefront acts as a source of tiny, spherical secondary wavelets that propagate forward with the same speed and frequency as the wave itself.

19. Which one of the following is correct about the law of reflection and the law of refraction? (1)
- A. **The ratio of the sine incident angle to the sine of the refracted angle is equal to the ratio of the speed of ✓ incident wave to the speed of the refracted wave.**
 - B. If the speed of the incident wave is less than the speed of the refracted wave, the refracted wave bends towards the normal line.
 - C. The speed and wave length of a reflected wave are different from that of an incident wave.
 - D. The incident and refracted rays make equal angles with the boundary of the two interface.

Answer: A

According to Snell's law of refraction, $\frac{\sin \theta_i}{\sin \theta_r} = \frac{v_i}{v_r}$, meaning the ratio of the sine of the incident angle to the sine of the refracted angle is equal to the ratio of the speeds in the respective media.

20. Choose the correct statement about interference pattern due to diffraction of light through single and double slits. (1)
- A. The light intensity of interference pattern due to double and single slits remain the same as the distance from the central bright fringe increases.
 - B. The central bright fringes in both double and single slits interference are twice as wide as the first order bright fringes.
 - C. Constructive interference due to double slit and single slit interference occur when the path difference between interfering waves is half-integer multiple of the wavelength.
 - D. **The bright and dark fringes formed when light passes through double slit have equal widths, where as ✓ the central bright fringe formed in single slit diffraction is twice wider as the first order maxima.**

Answer: D

In double-slit interference, the bright and dark fringes have approximately equal widths. In contrast, in a single-slit diffraction pattern, the central bright fringe (maximum) is twice as wide as the subsequent higher-order maxima.

21. In order for interference of light waves to occur, the interfering light waves should (1)
- A. Be incoherent.
 - B. Be in phase.
 - C. **✓ Have constant phase difference and the same frequency and speed.**
 - D. Be of different.

Answer: C

For sustained and observable interference of light waves to occur, the sources must be coherent, meaning they must have a constant phase difference, and the same frequency and speed (wavelength).

22. Which one of the following is true about fundamental forces? (1)
- A. A weak nuclear force is an extremely short-range force that binds protons and neutrons together in a nucleus.
 - B. Electromagnetic force is a long-range attractive force between particles due to their mass.
 - C. Gravitational force is a long-range attractive force between particles due to their charge.
 - D. **✓ Strong nuclear force is a short-range force that holds protons and neutrons to form atomic nucleus.**

Answer: D

The strong nuclear force is a short-range fundamental force (operating over distances of about 10^{-15} m) that overcomes electrostatic repulsion to hold protons and neutrons together in the nucleus.

23. Three blocks of mass $M_1 = 1\text{Kg}$, $M_2 = 2\text{Kg}$, and $M_3 = 3\text{Kg}$, placed on a horizontal frictionless table, are connected with strings and pulled to the right by a force $F = 9\text{N}$, as shown below. The acceleration a , tensions T_1 , and T_2 are, respectively (1)

[Figure: Three rectangular blocks labeled from left to right as M_1 , M_2 , and M_3 rest on a horizontal surface. A horizontal string connects M_1 to M_2 with tension labeled T_1 and arrows pointing inward. A second horizontal string connects M_2 to M_3 with tension labeled T_2 and arrows pointing inward. A force labeled F pulls block M_3 horizontally to the right with an arrow.]

- A. $a = 2/3 \text{ m/s}^2$, $T_1 = 2/3 \text{ N}$ and $T_2 = 2\text{N}$.
- B. **✓ $a = 3/2 \text{ m/s}^2$, $T_1 = 3/2 \text{ N}$ and $T_2 = 9/2 \text{ N}$.**
- C. $a = 3/2 \text{ m/s}^2$, $T_1 = 3\text{N}$ and $T_2 = 9/2 \text{ N}$.
- D. $a = 3\text{m/s}^2$, $T_1 = 3\text{N}$ and $T_2 = 9\text{N}$.

Answer: B

The total mass is $1 + 2 + 3 = 6 \text{ kg}$, so the acceleration is $a = F/M = 9/6 = 1.5 = 3/2 \text{ m/s}^2$. The tension T_1 pulling block 1 is $T_1 = M_1 a = 1 \times 1.5 = 3/2 \text{ N}$, and the tension T_2 pulling both blocks 1 and 2 is $T_2 = (M_1 + M_2)a = 3 \times 1.5 = 9/2 \text{ N}$.

24. which of the following is correct about an astronaut inside an international space station orbiting the earth? (1)
- A. **The astronaut experiences weightlessness because the space station and the astronaut are freely falling towards the center of the earth.**
 - B. Because the earth exerts a larger force on the astronaut than on the space station, the astronaut experienced weightlessness.
 - C. Since the earth exerts equal force on both the astronaut and the space station, the astronaut experiences weightlessness.
 - D. The astronaut experiences weightlessness since the earth's gravitational force on the astronaut is less than the earth's forces on the space station.

Answer: A

An astronaut inside an orbiting space station experiences weightlessness because both the station and the astronaut are in a state of continuous free fall towards the Earth, meaning there is no normal contact force between them.

25. Two masses of m_1 and m_2 are balanced on a horizontal stick of negligible mass pivoted at the center of mass of the system. If the distance from m_1 to the center of mass is 3.0m and the distance from the mass m_2 to the center of mass is 1.0m, the ratio of m_1 to m_2 (m_1/m_2) is? (1)
- A. 3
 - B. **$1/3$**
 - C. $4/3$
 - D. $3/4$

Answer: B

For a balanced system pivoted at its center of mass, the torque must balance: $m_1 d_1 = m_2 d_2$. Substituting the given distances yields $3.0 m_1 = 1.0 m_2$, which gives a ratio of $m_1/m_2 = 1/3$.

26. Identify the correct statement about energy, work, and force. (1)
- A. Machines can multiply energy but not force.
 - B. Energy cannot be possessed by an object at rest.
 - C. Work is said to be done by a force whenever the force is exerted on an object.
 - D. **Force is a vector quantity, where as work and energy are scalars.**

Answer: D

Force has both magnitude and direction, making it a vector, while work and energy are scalar quantities that do not depend on direction.

27. Distinguish between conservative and non-conservative forces. (1)
- A. Friction force is an example of conservative force, whereas spring force and gravitational force are typical examples of non-conservative force.
 - B. A conservative force dissipates energy, whereas a non-conservative force does not.
 - C. **Work done by conservative force along any closed path is zero, whereas the work done by non-conservative force along a closed path is not zero.**
 - D. Work done by a conservative force is path dependent, whereas work done by non-conservative force does not depend on the path followed.

Answer: C

By definition, a conservative force is one for which the work done along any closed path is zero (i.e., path-independent), whereas a non-conservative force (such as friction) does non-zero net work over a closed path.

28. A crane raises 75.0Kg of bricks from the ground to a height of 45.0m in 52.0s at a constant speed. The average power of the crane is? (1)
- A. 14.4 W
B. ✓ 649 W
C. 3,375 W
D. 144 W

Answer: B

The work done is $W = mgh = 75.0 \text{ kg} \times 10 \text{ m/s}^2 \times 45.0 \text{ m} = 33750 \text{ J}$. Dividing by the time $t = 52.0 \text{ s}$ gives an average power of approximately 649 W.

29. For a rigid body rotating about a fixed axis, (1)
- A. For the same time interval, a point closer to the axis and a point farther from the axis travel the same linear distance.
B. For the same time interval, a point closer to the axis turn through a smaller angle than a point farther from the axis.
C. ✓ **A point closer to the axis has smaller linear speed than a point farther from the axis.**
D. A point closer to the axis has greater linear speed than a point farther from the axis.

Answer: C

For a rigid body rotating about a fixed axis, all points share the same angular speed ω . Since the linear speed is given by $v = r\omega$, a point closer to the axis (smaller r) will have a smaller linear speed.

30. A disk of radius 0.10m and mass 0.1Kg is set into motion by a tangential force of 2.0 N applied at the edge of the disk. If the angular acceleration of the disk is 400 rad/s^2 , the torque and angular velocity at 2.0 s are, respectively (1)
- A. 0.5 Nm and 100 rad/s.
B. ✓ **0.2 Nm and 800 rad/s.**
C. 0.2 Nm and 400 rad/s.
D. 0.1 Nm and 200 rad/s.

Answer: B

Torque is $\tau = rF = 0.10 \text{ m} \times 2.0 \text{ N} = 0.2 \text{ Nm}$. Assuming the disk starts from rest, the angular velocity at 2.0 s is $\omega = \alpha t = 400 \text{ rad/s}^2 \times 2.0 \text{ s} = 800 \text{ rad/s}$.

31. Identify the correct statement about torque and angular momentum. (1)
- A. No torque acts on an object when its angular momentum increases.
B. The change in angular momentum is inversely proportional to the torque exerted for a given time interval.
C. For the same time interval, a small torque and a large torque change angular momentum by the same amount.
D. ✓ **A small torque applied for a longer time and a large torque exerted for a shorter time have the same effect on the change of angular momentum.**

Answer: D

The change in angular momentum is given by $\Delta L = \tau \Delta t$. Therefore, a smaller torque applied over a longer duration can produce the exact same change in angular momentum as a larger torque applied over a shorter duration.

32. A scientific method

(1)

- A. Is a scientific procedure where a researcher first predicts the result of a problem before proposing the possible hypothesis.
- B. Begins from an accepted scientific theory and concludes with designing an experiment.
- C. **Is a scientific procedure which ensures a rigorous evidence-based structure in which only ideas that have been carefully tested are accepted as scientific theory.**
- D. Is scientific procedure in which a researcher begins with performing experiments.

Answer: C

The scientific method is a systematic, evidence-based process that involves forming hypotheses, testing them through rigorous experimentation, and only accepting well-tested ideas as theories.

33. Which one of the following is correct about accuracy and precision of a measurement?

(1)

- A. Accuracy is related to the number of significant figures, whereas precision describes how well we minimize random errors.
- B. A more accurate measurement has larger uncertainty, whereas a more precise data has smaller uncertainty.
- C. Accuracy describes the closeness of repeatedly measured data to each other, whereas precision describes about the closeness of a data to a true value.
- D. **Accuracy refers to the closeness of repeatedly measured data to a true value, whereas precision is related to the closeness of the measured data to each other.**

Answer: D

Accuracy refers to how close a measured value is to the true or accepted value, whereas precision refers to how close repeated measurements of the same quantity are to each other.

34. In an experiment to measure the velocity of a ball rolling along x-axis, a student recorded the distance traveled and time taken by the ball. Which of the following data represent constant velocity of the ball?

(1)

- A. | x(m) | 0 | 4 | 5 | 6 | 7 | 9 | | t(s) | 0 | 1 | 2 | 3 | 4 | 4 |
- B. **| x(m) | 0 | 2 | 4 | 6 | 8 | 10 | | t(s) | 0 | 1 | 2 | 3 | 4 | 5 |**
- C. | x(m) | 0 | 3 | 5 | 6 | 9 | | t(s) | 0 | 1 | 2 | 3 | 5 |
- D. | x(m) | 0 | 2 | 3 | 4 | 6 | 7 | | t(s) | 0 | 1 | 2 | 2 | 3 | 4 |

Answer: B

For constant velocity, the ratio of change in position to change in time must be constant. In option B, for every 1-second interval, the distance increases by exactly 2 meters, representing a constant velocity of 2 m/s.

35. A position vector of an object

(1)

- A. Is independent of the origin from which it is measured.
- B. Is a measure of how fast it is moving relative to stationary reference frame.
- C. **Describes its distance from a point in a specified direction.**
- D. Describes its distance from a given point in all directions.

Answer: C

A position vector specifies the position of a point relative to a chosen origin, describing both its straight-line distance and the specific direction from that origin.

36. Consider two force vectors in x-y plane: $F_1 = 10\text{N}$ making a 30° angle above the horizontal and $F_2 = 20\text{ N}$ making a 60° angle above the horizontal. Which of the following is true? (1)
- A. The direction of their resultant vector is 45° above the horizontal.
B. The magnitude of their resultant is 42 N .
C. ✓ **The horizontal and vertical components of their resultant are 18.66N and 22.32N , respectively.**
D. The horizontal and vertical components of their resultant are 15N and 26N , respectively.

Answer: C

The horizontal component of the resultant is $R_x = 10 \cos(30^\circ) + 20 \cos(60^\circ) = 8.66 + 10 = 18.66\text{ N}$, and the vertical component is $R_y = 10 \sin(30^\circ) + 20 \sin(60^\circ) = 5 + 17.32 = 22.32\text{ N}$.

37. Given four vectors $A = 2i - j$, $B = 4i - 2j$, $C = i - j$, $D = 2i + 3j$, which pair of these vectors are collinear? (1)
- A. C and D
B. ✓ **A and B**
C. B and C
D. A and C

Answer: B

Two vectors are collinear if they are scalar multiples of each other. Here, vector $B = 4i - 2j$ is exactly twice vector $A = 2i - j$, so they are collinear.

38. While going to school, a student travels 3km , East and then 4km , North in 2 hrs . the magnitude of student's average velocity and average speed are, respectively (1)
- A. ✓ **2.5 km/hr and 3.5km/hr .**
B. 2km/hr and 7km/hr/ .
C. 5km/hr and 7km/hr .
D. 3.5km/hr and 2.5km/hr .

Answer: A

The displacement magnitude is $\sqrt{3^2 + 4^2} = 5\text{ km}$, so the magnitude of average velocity is $5\text{ km}/2\text{ h} = 2.5\text{ km/h}$. The total distance is $3 + 4 = 7\text{ km}$, so the average speed is $7\text{ km}/2\text{ h} = 3.5\text{ km/h}$.

39. A boy throws a ball vertically upward with an initial speed of 20 m/s . Neglecting air resistance, which of the following is true about the motion of the? (1)
- A. The time taken to reach the maximum height is 4s .
B. Its velocity after 3s is 50m/s , downward.
C. ✓ **Its maximum height is 20m .**
D. Its velocity after 1s is 30 m/s , upward.

Answer: C

Using $g = 10\text{ m/s}^2$, the maximum height reached by the ball is $h = v_0^2/(2g) = 20^2/(2 \times 10) = 20\text{ m}$.

40. Choose a correct statement about centripetal force and centripetal; acceleration. (1)
- A. ✓ **For an object moving in a circular path, its centripetal force and centripetal acceleration are parallel and directed toward the centre of the path.**
B. Centripetal acceleration and centripetal force are constant in direction, but vary in magnitude.
C. Centripetal force on an object moving in a circular path is perpendicular to the radius of the path.
D. Centripetal force on an object moving in a circular path tends to pull the object outward from its path.

Answer: A

Both centripetal force and centripetal acceleration are vector quantities that point radially inward toward the center of the circular path, meaning they are parallel to each other. Their direction changes continuously as the object moves, making option B incorrect, and they point along the radius rather than perpendicular to it, making option C incorrect.

41. According to Newton's law of Universal Gravitation,

(1)

- A. The speed of a satellite moving around the Earth in a circular orbit depends on the mass of the satellite.
- B. For two interacting objects, gravitational force exerted on a light object is less than the force on the heavy one.
- C. **The period of a satellite orbiting the Earth in a circular orbit increases as the radius of its orbit increases.**
- D. The gravitational attraction between two objects is directly proportional to the square of the distance between them.

Answer: C

According to Kepler's third law, which is derived from Newton's law of gravitation, the square of the orbital period is proportional to the cube of the orbital radius ($T^2 \propto r^3$), meaning the period increases as the radius increases. Option B is incorrect because the gravitational force between two objects is equal in magnitude by Newton's third law, and option D is incorrect because the force is inversely proportional to the square of the distance.

— END OF MARKING KEY —

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