

Physics, 2010 EC, entrance exam

Grade 12 · Physics · 2010 E.C.

Time allowed: 120 minutes

Questions: 41

Total marks: 41

Name _____ Grade _____ ID No. _____ Date _____

1. Four vectors are listed below $\vec{A} = \begin{bmatrix} 4 \\ 10 \end{bmatrix}$, $\vec{B} = \begin{bmatrix} 2 \\ -5 \end{bmatrix}$, $\vec{C} = \begin{bmatrix} -6 \\ 15 \end{bmatrix}$, $\vec{D} = \begin{bmatrix} 15 \\ -6 \end{bmatrix}$, Which pair of the vectors is orthogonal? (1)

- A. $\vec{A}$ and $\vec{D}$ B. $\vec{B}$ and $\vec{C}$
C. $\vec{C}$ and $\vec{D}$ D. $\vec{A}$ and $\vec{B}$

2. A race car is moving at a constant speed of 35m/s . A security car was moving at a speed of 5m/s as the race car passes by it and was accelerating at constant rate of 5 m/s². What was the speed of the security car when it took over the race car ? (1)

- A. 35m/s B. 60m/s
C. 5m/s D. 65m/s

3. A car start moving from rest and its motion on a straight line is shown in the figure below. What is the average velocity of the car within the first 6 seconds? (1)

[Figure: Hand-drawn velocity-time graph. Vertical axis labelled v (m/s) with tick marks at 2, 4, 6, 8, 10 and 12; horizontal axis labelled t (s) with tick marks at 2, 4, 6 and 8. The trace consists of three straight segments: a line rising from the origin to a point labelled "2, 6" ($t = 2$ s, $v = 6$ m/s); a horizontal segment from that point to a point labelled "4, 6" ($t = 4$ s, $v = 6$ m/s); then a line rising from there to a point labelled "6, 10" ($t = 6$ s, $v = 10$ m/s), where the trace ends.]

- A. 5.67m/s B. 1.67 m/s
C. 5 m/s D. 6 m/s

4. Which one of the following statements is correct regarding the motion in a plane? (1)

- A. When a body moves in a horizontal circle, its velocity is constant
B. When a body moves in a vertical circle, its speed is constant
C. The centripetal force for a body moving in either vertical or horizontal circle is toward the center
D. In projectile motion the horizontal component of the motion is uniformly accelerated motion.

5. A bullet is fired at an angel of 30° above the horizontal. If air resistance is neglected, what should be the bullet's horizontal acceleration ($\vec{a}_x$) and vertical acceleration ($\vec{a}_y$) when it reaches its maximum height? (1)

- A. Both $\vec{a}_x$ and $\vec{a}_y$ are zero B. $\vec{a}_x$ is 10 m/s² downward, and $\vec{a}_y$ is zero
C. Both $\vec{a}_x$ and $\vec{a}_y$ are 10 m/s² downward D. $\vec{a}_x$ is zero, and $\vec{a}_y$ is 10 m/s² downward.

6. Two students A and B, with masses m_A and m_B respectively, stand on a wheeled trolleys as shown in the figure (1)
 below. If student A has larger mass and pushes student B, then what can be said about their accelerations?
[Figure: Line drawing of two boys facing each other, each standing on a small four-wheeled trolley (skateboard-like platform) resting on a hatched horizontal ground line. The boy on the left is labelled A, the boy on the right is labelled B. A leans forward with both arms extended, his hands pressing against B's hands, so A is pushing B to the right. Both boys are drawn about the same size; no forces or numerical values are marked.]
- A. The acceleration of student B is less than that of student A.
 B. Both boys will be accelerated by the same magnitude but in opposite directions.
 C. The acceleration of student A is less than that of student B.
 D. There would be no acceleration because the forces are equal and opposite.
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7. Two forces $\vec{F}_1 = (8\vec{i} + 3\vec{j})$ N and $\vec{F}_2 = (4\vec{i} + 6\vec{j})$ N are acting on an object. What is the magnitude and direction of the resultant force? (1)
- A. 225 N, 143°
 B. 5 N, -37°
 C. 5 N, 143°
 D. 15 N, 37°
-
8. The diagram below shows a path taken by a flying bird. Which one of the following vector may represent a resultant displacement? (1)
[Figure: Hand-drawn path made of four thick displacement arrows joined head to tail. Starting at the upper left, the first arrow runs horizontally to the right and ends with its head at the upper right. From that head the second arrow runs diagonally down and to the left, ending with its head at the lower left. From there the third, shorter arrow runs to the right and slightly downward, ending near the bottom middle. From that head the fourth arrow runs diagonally up and to the right, ending with its head at the right of the figure, roughly level with the middle. No lengths or labels are marked. The four answer choices are themselves small arrow drawings: A is an arrow pointing up-right, B a horizontal arrow pointing right, C an arrow pointing down-left, and D an arrow pointing down-right; the tick is beside D.]
- A. An arrow pointing up and to the right (north-east).
 B. A horizontal arrow pointing to the right (east).
 C. An arrow pointing down and to the left (south-west).
 D. An arrow pointing down and to the right (south-east).
-
9. A body that is released from the top of a tall building reaches the ground after six seconds. What is the ratio of the kinetic energy acquired by it at the end of the first three seconds to the increment in the kinetic energy during the next three seconds? (1)
- A. $3/2$
 B. 1
 C. $1/3$
 D. 2
-
10. A boy pushes a block over 12m distance within 6 seconds. The force applied by the boy varies as shown in the diagram below. What is the average power loss by the boy? (1)
[Figure: Hand-drawn force-displacement graph. Vertical axis labelled F_x (N) with three unlabelled tick marks and the value 4 marked on the second tick; horizontal axis labelled x (m) with tick marks at 3, 6, 9 and 12. The trace is a trapezium: a straight line rises from the origin to the point labelled (3,4); a horizontal segment runs from (3,4) to the point labelled (9,4); then a straight line falls from (9,4) down to the x axis at $x = 12$, where it meets the axis.]
- A. $4w$
 B. $8w$
 C. $7w$
 D. $6w$

11. A thin rod when rotated about an axis at the end of the rod has a moment of inertia $\frac{1}{3}ML^2$. The rod has a mass of 1.5kg and length of 1.0 m. if the rod initially at rest gains a rotational kinetic energy of 1000.0 J, at what speed does it rotate? (1)
- A. $10\sqrt{5} \text{ rad/s}$ B. $20\sqrt{10} \text{ rad/s}$
C. 10 rad/s D. 18.8 rad/s

12. A ring a solid cylinder and a solid sphere, all having the same mass and the same radius, are held at the top of an inclined plane as shown in the figure below. If the objects roll with out slipping and the coefficient of static friction between each object and the plane is 0.3, which one of the following shows the order in which they will get to the bottom of the inclined plane? (1)

[Figure: Shaded drawing of an inclined plane: a flat rectangular ramp drawn in perspective, rising from the lower right to the upper left, with a right-angled triangular support beneath it; the angle between the ramp and the horizontal base at the bottom right is marked 20° . Three objects sit near the top edge of the ramp, each named by a leader line drawn from a label on the left: "sphere" points to a ball at the top, "Solid cylinder" points to a short cylinder just below it, and "ring" points to an annulus (a ring seen edge-on with a hole) at the lower left of the three.]

- A. All will reach the bottom at the same time
B. Ring, solid cylinder, sphere
C. Solid cylinder, sphere, ring
D. Sphere, solid cylinder, ring
13. If in a given rotational system of a body the angular momentum is increased with time, which one of the following statement is not correct? (1)
- A. The radius of rotation may increase B. There is no torque exerted on the system
C. The moment of inertia may increase D. There is a torque exerted on the system

14. Which of the following is a correct statement about the first condition of equilibrium? (1)
- A. The sum of all torques must be zero
B. Clockwise moments should balance counter clockwise moments
C. The net force on an object must be zero
D. The torque produced by a force should be perpendicular to the force.

15. For a constant force F, if the impulse imparted to the system is large, then what can you conclude about the collision? (1)
- A. Linear momentum is conserved B. The contact or impact time is large
C. Kinetic energy is conserved D. The change in velocity is small

16. An open trolley is rolling on a level surface without frictional loss through a vertical downpour of rain, as shown in the figure below. As the trolley rolls, an appreciable amount of rainwater accumulates in the cart. What will be the speed of the cart? (1)

[Figure: Solid dark silhouette of an open-topped trolley or cart seen from the side: a rounded rectangular body with two round wheels beneath it, the open top drawn as a lighter band across the upper part of the body. A horizontal arrow leaves the right-hand side of the cart and points to the right, labelled V above it. No rain, ground line or numerical values are drawn.]

- A. It increases because of conservation of mechanical energy
B. It decreases because of conservation of mechanical energy
C. It remains the same because the raindrops are falling perpendicular to the direction of the cart's motion
D. It decreases because of conservation of momentum

- 17.** An object of mass 1kg moving with a speed of 2m/s was acted on by a force that produces an acceleration of 2 m/s^2 . What is the change in kinetic energy of the object if the force is exerted on the object for 2seconds in its direction of motion? (1)
- A. 1 J B. 16 J
C. 8 J D. 4 J

19. An electric immersion water heater is rated at 400w. how long will it take to heat one kilogram of water from 10 to 30 ? (the specific heat of water is 4.2 J/g k.)
- A. 45 min
B. 1 min
C. 15 min
D. 3.5 min

21. Which of the following statement is not correct? (1)
- A. A system can absorb heat from a hot reservoir and can convert it entirely in to workout additional changes in the system and its surroundings.
 - B. The spontaneous transfer of energy from a cooler body to hotter body is quite possible.
 - C. No process is possible in which there is an overall decrease in the entropy of the universe.
 - D. The complete conversion of energy from hot source in to work is not possible.

23. From the figures given below, which one is in equilibrium?

(1)

[Figure: Four hand-drawn free-body sketches, one per answer choice, each a circle with force arrows. A: 2F up from the top of the circle and 2F down from the bottom, both collinear through the centre. B: 2F up along the right-hand edge and 2F down along the left-hand edge, the two arrows parallel but not collinear (a couple). C: F up from the top, F up along the right-hand edge, and 2F down along the left-hand edge. D: 3F up from the top of the circle, with 2F down on the left and F down on the right below it. The tick is beside A.]

- A. A circle with an arrow labelled 2F pointing straight up from the top of the circle and an arrow labelled 2F pointing straight down from the bottom, both along the same vertical line through the centre.
- B. A circle with an arrow labelled 2F pointing up along its right-hand edge and an arrow labelled 2F pointing down along its left-hand edge, the two lines of action offset on opposite sides of the centre.
- C. A circle with an arrow labelled F pointing up from the top, a second arrow labelled F pointing up along the right-hand edge, and an arrow labelled 2F pointing down along the left-hand edge.
- D. A circle with an arrow labelled 3F pointing up from the top, and two downward arrows below it, labelled 2F on the left and F on the right.

24. Which of the following figure indicates tensile deformation?

(1)

[Figure: Four hand-drawn deformation sketches, one per answer choice, each labelled with its letter beneath it. A: an oval with a dashed inner outline and eight straight arrows pointing inward at it from all directions. B: a tall upright cylinder with a dashed line down its face, a curved arrow over the top curling to the left and a curved arrow under the bottom curling to the right (a twist about the cylinder's long axis). C: a rectangular block sitting on a horizontal ground line, an arrow pushing right against its upper left edge and an arrow pushing left against its lower right edge, with the sheared parallelogram shape drawn in dashes. D: a tall upright cylinder with a straight arrow pointing up out of its top and a straight arrow pointing down below its bottom, the stretched portion below the cylinder drawn in dashes. The tick is beside D.]

- A. An oval body with a dashed outline drawn inside it and eight arrows pointing inward toward it from all around (uniform compression from every side).
- B. An upright cylinder with a dashed line running down its curved surface, a curved arrow at the top turning one way and a curved arrow at the bottom turning the opposite way (twisting).
- C. A rectangular block standing on a horizontal surface, with a horizontal arrow pushing to the right at its top edge and a horizontal arrow pushing to the left at its bottom right; the deformed, leaning shape is drawn dashed (shearing).
- D. An upright cylinder with an arrow pointing straight up out of its top and an arrow pointing straight down below its bottom; the stretched extension at the bottom is drawn dashed.

25. An object with a mass of 150 kg and a volume of 0.75 m^3 is floating in a liquid of density 0.8 g/cm^3 . What percentage of the objects volume will be submerged below the surface of the fluid?

(1)

- | | |
|----------|---------|
| A. 100 % | B. 50 % |
| C. 75 % | D. 25 % |

26. Why is an interference pattern not observed between the lights produced from a pair of car headlights?

(1)

- A. The light sources are not collimated.
- B. Interference is observed only in laboratory conditions
- C. The light sources are not coherent
- D. The spread of light as it travels out of the source

27. Suppose that three point charges are placed along a straight line and electrostatic force exerted on the middle charge is zero. What can we conclude about the charges? (1)
- A. The signs of the three charges should be the same
 - B. The charges at the ends must have the same sign
 - C. The middle charge should be placed at the center between the two charges
 - D. The charge at the middle and at the left end should have the same sign
28. Two parallel plates are kept at 3 V and 5 V as shown in the diagram below. If an electron is released at O, then which way will the electron move? (1)
- [Figure: Hand-drawn sketch of two horizontal parallel plates, each a long straight line with a small filled dot marked at its midpoint. The upper plate is labelled +5V at its right end; the lower plate is labelled +3V at its right end. Midway between the plates, slightly left of centre, is the letter O followed by a small filled dot and then the label e^- , marking the released electron at point O. The letter A is written just above the dot on the lower plate. No label is legible beside the dot on the upper plate.]*
- A. Towards B
 - B. Towards A
 - C. Remains at O
 - D. Parallel to the plates
29. A copper wire of cross sectional area 2 mm^2 carrying a current of 1.5 A. if the drift velocity of the electron is 0.00028 m/s , what is the number of charge carriers (free electrons) per unit volume in the copper wire? (1)
- A. $1.5 \times 10^{25} / \text{m}^3$
 - B. $1.88 \times 10^{28} / \text{m}^3$
 - C. $1.5 \times 10^{32} / \text{m}^3$
 - D. $1.67 \times 10^{32} / \text{m}^3$
30. Which of the following statement is correct? (1)
- A. Galvanometer can be converted to voltmeter of different scale by connecting low valued resistance in parallel
 - B. Low valued internal resistance increases accuracy of voltmeter
 - C. High valued internal resistance increases accuracy of ammeter
 - D. Galvanometer can be converted to ammeter of different scale by connecting variety of low value shunt resistance in parallel.
31. What makes the oscillatory motion a simple harmonic motion? (1)
- A. The acceleration of the motion is directly proportional to the velocity
 - B. The acceleration of the motion is directly proportional in magnitude but opposite in direction to the displacement
 - C. The velocity of the motion is directly proportional to the displacement
 - D. The velocity of the motion is inversely proportional to the displacement
32. The two end fixed string of length 0.5m has a mass per unit length 2 g/m . if the tension in the string is 80 N, what is the second harmonic frequency? (1)
- A. 400 Hz
 - B. 200 Hz
 - C. $100\sqrt{2} \text{ Hz}$
 - D. 600 Hz
33. Which one of the following is not the use of Doppler effect? (1)
- A. Astronomy
 - B. Energy transmission
 - C. Radar
 - D. Blood flow measurement
34. A 632.8 nm laser light produces an interference pattern on a screen of 4.0 m from a pair of slits. The slit space is equal to 0.2 mm . calculate the fringe width. (1)
- A. 15.3 cm
 - B. 25.3 mm
 - C. 6.33 mm
 - D. 12.7 mm

35. An inductor has a self inductance of 12 mH. The current in the circuit decreases at a rate of 2.0 A/s. what is the magnitude of the induced electromotive force?

A. 2.4π V
B. 1.2π V
C. 1.2×10^{-2} V
D. 2.4×10^{-2} V

36. Which of the following is correct about the characteristics of current and voltage in A.C circuits?

A. If the current leads the voltage, its capacitive reactance is greater than the inductive reactance
B. If the current is in phase with the voltage, the circuit is inductive
C. If the current leads the voltage, it is inductive circuit
D. If the current lags the voltage, the circuit is capacitive

37. An RLC circuit is designed to have a resistance of 400 Ω , capacitive reactance of 350 Ω and inductive reactance of 50 Ω . The circuit is connected to an alternative voltage source of effective (rms) value 50 V and frequency of 50 Hz. What is the average output power?

A. 62.5 W
B. 4.0 W
C. 400 W
D. 40 W

38. In Rutherford experiment, a beam of positively charged alpha particles was projected in to a thin piece of a gold foil. One of the observation of this experiment is that some charged particles deflected through a large angle (10° to 90°) are those concentrated in one place. What conclusion can be drawn from this observation?

A. Most of the mass and all positive charge is in tiny central nucleus
B. Most of the atom is empty space
C. All the atom is positive charge
D. All the atom is negative charge

39. In the circuit shown below, each resistor has a value of 3 Ω . What is the value of the current through R_4 ?
[Figure: Hand-drawn two-loop circuit built on a rectangle with a horizontal middle branch. Top branch: running from the top-right corner to the top-left corner there is a battery labelled 6V, and an arrowhead on the wire to the left of the battery marks a current I_1 flowing to the left. Left side: a vertical resistor R_1 between the top-left corner and the left middle node; below that node an arrowhead on the left wire points upward, marking a current I_3 . Right side: a vertical resistor R_2 between the top-right corner and the right middle node, and a vertical resistor R_3 between the right middle node and the bottom-right corner. Middle branch: from the left middle node to the right middle node, an arrowhead pointing right marks a current I_2 , followed by a battery cell (drawn but carrying no value label) and then a horizontal resistor R_4 . Bottom branch: from the bottom-left corner to the bottom-right corner, a horizontal resistor R_5 followed by a battery labelled 9V.]

A. 0.75 A
B. 1.0 A
C. 0.625 A
D. 0.125 A

40. If a charged particle enters in to a uniform magnetic field perpendicular to its direction, then what will happen?

A. It moves in an elliptical path
B. The radius of its path is proportional to the magnetic field strength
C. The charged particle will not be affected by magnetic field
D. The period of the motion is inversely related to the magnetic field strength

41. Two parallel wires each carrying 5 A current in the same direction are separated by 2.5cm. what is the magnitude of the force per unit length acting on the wires? Is the force attractive or repulsive?

A. 2×10^{-4} N/m, attractive
B. 4×10^{-6} N/m, repulsive
C. 8×10^{-5} N/m, repulsive
D. 5×10^{-6} N/m, attractive

— END OF EXAMINATION —

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