

Physics, 2009 EC, entrance exam

Grade 12 · Physics · 2009 E.C.

Time allowed: 120 minutes

Questions: 45

Total marks: 45

Name _____ Grade _____ ID No. _____ Date _____

1. The range of cannon-ball fired horizontally from a laboratory table is equal to $8/3$ times the height of the table. (1)
What is the direction of velocity vector of the projectile as it strikes the ground?

- A. 45° from the horizontal
B. 53° from the horizontal
C. 60° from the horizontal
D. 37° from the horizontal

2. Galileo carried out a thought experiment on motion. The line between A and B represents a surface and the center of the ball is placed at A. what would happen in each of the three situations shown in the figure below, without friction when the ball is released? (1)

[Figure: Three hand-drawn panels labelled a, b and c. In each, a small shaded ball sits at a point labelled A on the left, and a horizontal dashed line runs from A rightwards to a point labelled B. Panel (a): from the ball a solid curve dips below the dashed line as a symmetric U-shaped valley and rises back up to meet the dashed line exactly at B on the right. Panel (b): the solid curve dips below the dashed line in a shallower valley, crosses the dashed line at B and continues rising steeply upward past B (the far side of the valley is much less steep, so the rising track carries on above and beyond B). Panel (c): the solid curve drops from the ball and then runs flat and horizontal to the right indefinitely, with a straight arrow above it pointing right; the label at the right reads "B at ∞ " (B at infinity).]

- A. The ball would never reach point B in all instances.
B. The ball would reach B in all instances even if point B keeps on receding to infinity in (c).
C. The ball would reach point B in (a) and (b) and not in (c).
D. The ball would reach point B only in (a).

3. A uranium atom initially at rest has a mass of 2 units and spontaneously disintegrated into two fragments. One of the fragments has a mass of 0.8 units and moves at a speed of 24m/s as shown in figure below. What is the speed of the second fragments? (1)

[Figure: A photographed hand-drawn sketch. On the left a shaded oval (the parent nucleus) sits on a long horizontal reference line, labelled above as $M = 2$ units, $u = 0$. The horizontal line runs to the right. At a point on that line the two fragment tracks cross it. One arrow goes up and to the right, making an angle of 30° above the horizontal line, ending in a shaded oval labelled m_2, v_2 . The other arrow goes down and to the left-of-vertical, making an angle of 53° below the horizontal line on the left side, passing through a shaded oval labelled $m_1 = 0.8$ units, $v_1 = 24$ m/s and continuing to an arrowhead at the lower left.]

- A. 25.6m/s
B. 21.3m/s
C. 16m/s
D. 14.8m/s

4. A 1kg object explodes and breaks up into three pieces. One piece has a mass of 400g and has a velocity of $(15\mathbf{i} + 10\mathbf{j})\text{m/s}$. a second piece has a mass of 250g and has a velocity of $(25\mathbf{i} + 10\mathbf{j})\text{m/s}$. What is the velocity of the third piece? (1)

- A. $(-4.3\mathbf{i} + 35\mathbf{j})\text{m/s}$
B. $(-35\mathbf{i} + 4.3\mathbf{j})\text{m/s}$
C. $(35\mathbf{i} + 4.3\mathbf{j})\text{m/s}$
D. $(-35\mathbf{i} - 4.3\mathbf{j})\text{m/s}$

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5. Which of the following statements is not correct? (1)
- A. Dynamic equilibrium is an equilibrium in which a body is moving at steady velocity without net force or torque acting on it.
 - B. Static equilibrium is an equilibrium in which a body is at rest without net force or torque acting on it.
 - C. Couples are set of forces with a resultant torque but no net force.
 - D. The necessary and sufficient condition for equilibrium of a rigid body is to have the sum of all torques acting on it is zero.
-
6. A spring with a spring constant of 300N/m is stretched 20cm in 2 seconds. What is the power applied to stretch the spring? (1)
- A. 3W
 - B. 6W
 - C. 30KW
 - D. 60KW
-
7. A 50KW machine is used to lift heavy objects to the top of a building under construction. If this machine is replace with a new machine of 100KW power, then which of the following statements is not true about the new machine? (1)
- A. The new machine can raise objects with the same mass at twice the speed of the old machine.
 - B. The new machine can raise objects with twice as much mass at the same speed as the old machine.
 - C. The new machine takes twice as much time to do the same work as the old machine.
 - D. The new machine can do twice as much work in the same time as the old machine.
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8. Which of the following is correct about a work done for dissipative force? (1)
- A. Path dependent
 - B. The same as the loss in kinetic energy.
 - C. The same as the gain in potential energy.
 - D. The same as the potential energy stored in spring.
-
9. A disk of radius R with uniform distribution of mass M rotates about an axis perpendicular to its plane at the rim with angular speed ω the moment of inertia of the disc about the axis through the center is $\frac{1}{2}MR^2$. What is the kinetic energy of the disk? (1)
- A. $\frac{1}{4}MR^2\omega^2$
 - B. $\frac{1}{3}MR^2\omega^2$
 - C. $\frac{1}{2}MR^2\omega^2$
 - D. $\frac{4}{4}MR^2\omega^2$
-
10. A pulley is rotating at a frequency of 20rev/min. a motor speeds up the wheel so that 30s later the frequency of the motion is 60rev/min. How far a point on the pool 0.30m from its center will has travelled during that period? (1)
- A. 125.7m
 - B. 0.13m
 - C. 37.68m
 - D. 4.2m
-
11. Which of the following statements is correct about the first condition of equilibrium? (1)
- A. The net force on an object must be zero.
 - B. The sum of all torques must be zero.
 - C. Clockwise moments should balance counter clockwise moments.
 - D. The torque produced by a force should be perpendicular to the force.

12. A 4m long uniform board of mass 10kg hinged on the ground at one end is hanging by a string at the other end. (1)
A block of mass 8kg is placed at 1m from the hinge on the ground as shown in the diagram below. What is the tension in the string?

[Figure: A hand-drawn sketch, tall and narrow. At the bottom is hatched horizontal ground; a long straight board (drawn as a narrow rectangle) is hinged at its lower end on that ground and leans up and slightly to the left, making an angle marked 60° with the ground on the right-hand side. From the top end of the board a string runs upward and slightly left to a hatched ceiling/support at the top of the figure. Leaning against the lower left part of the board is a small block labelled 8kg; a short dimension line at the bottom left marked 1m indicates its distance from the hinge.]

- A. 10N
B. 50N
C. 70N
D. 110N

13. Which of the following refers to the definition of strain as a ratio? (1)

- A. Extension to the original length.
B. Force applied to area of the object normal to the force.
C. Stress to Young modulus.
D. Tensile to applied force.

14. Which of the following is the application of Pascal's law? (1)

- A. Hydraulic brake in vehicles.
B. Siphon to remove fluids.
C. Working of submarines.
D. Sucking of liquid into a syringe.

15. If a precision of surveyor measured a distance of 500 meters /between two points in a village/ using a meter (1)
that has centimetre division on it, then what is the measurement result?

- A. 500m
B. 500.0m
C. 500.00m
D. 500.000m

16. From the figures given below, which one of them shows precise but not accurate measurements? T represents (1)
the true value.

[Figure: Four photographed hand-drawn distribution graphs, one per option. Every graph has the same axes: the vertical axis is labelled "Number of readings" and the horizontal axis is labelled "Reading", with a single letter T marked as a tick position on the horizontal axis. Graph A: T is marked near the left of the axis; a tall, narrow, sharply peaked curve rises well to the right of T, clearly separated from it (narrow spread, displaced from the true value). Graph B: T is marked on the axis and the tall, narrow, sharply peaked curve sits directly over T (narrow spread, centred on the true value). Graph C: a broad, low, wide hump whose maximum lies a little to the left of T, its tail spreading past T to the right (wide spread, roughly straddling the true value). Graph D: a broad, low, wide hump whose maximum lies well to the left of T, dying away just before T (wide spread, displaced from the true value).]

- A. Graph A: a tall narrow peak located well to the right of T.
B. Graph B: a tall narrow peak centred on T.
C. Graph C: a broad low hump whose maximum lies just to the left of T.
D. Graph D: a broad low hump whose maximum lies well to the left of T.

17. If vector $\vec{P}$ is 6m in the x-direction and vector $\vec{Q}$ is 8m in the y-direction. Then what is the value of the vector (1)
 $\vec{P} + \vec{Q}$?

- A. 10m at 53° from x-direction.
B. $\sqrt{136}m$ at 45° from x-direction.
C. 10m at 37° from x-direction.
D. $\sqrt{136}m$ at 30° from x-direction.

18. Given vectors $\vec{A} = \sqrt{3}\vec{i} + \vec{j}$ and $\vec{B} = \sqrt{3}\vec{i} - \vec{j}$. What is the smaller angle between the vectors? (1)
- A. 60° B. 53°
C. 45° D. 30°
-
19. If $\vec{A} = x \frac{m}{s} + 3 \frac{m}{s} \vec{z}$ and $\vec{B} = 2 \frac{m}{s} y + 3 \frac{m}{s} \vec{z}$, then what is the value of $|\vec{A} \times \vec{B}|$? (1)
- A. $\sqrt{10} \frac{m}{s}$ B. $\sqrt{13} \frac{m}{s}$
C. $7 \frac{m}{s}$ D. $\sqrt{130} \frac{m}{s}$
-
20. A cricketer throws a ball vertically upwards with initial speed of 20m/s. How long is it in the air before it returns to the cricketer's hands? (1)
- A. 2s B. 10s
C. 1.5s D. 4s
-
21. A fun making boy swings a blinking ball tied to the end of a string in a vertical circle. If the radius of the circle is 0.5m, then what should be the minimum speed of the ball at the bottom of the circle to make a complete circular motion at the top? (1)
- A. 5m/s B. $\sqrt{5}$ m/s
C. $\sqrt{15}$ m/s D. $2\sqrt{5}$ m/s
-
22. The activity of radioactive substance reduces from 2000Bq to 1000Bq in 10^6 seconds. What is the decay constant? (1)
- A. 6.93×10^5 , decay/s B. 6.93×10^{-7} , decay/s
C. 2.00×10^6 , decay/s D. 5.00×10^{-7} , decay/s
-
23. Which of the following phenomena clearly demonstrates the particle nature of light? (1)
- A. Refraction of light by prism. B. The photoelectric effect.
C. Diffraction of light by double slit. D. Dispersion of white light.
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24. Which of the following statements is correct? (1)
- A. Irreversible process is a process that can be reversed through finite change in the system.
B. Complete conversion of energy from a hot source into work is possible.
C. There are processes in which there is an overall decrease in entropy.
D. Entropy is a measure of the amount of disorder.
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25. A certain heat engine draws 500cal/s from a water bath at 27°C and rejects 400 calories to a reservoir at a lower temperature. What is the efficiency of this engine? (1)
- A. 80% B. 75%
C. 25% D. 20%
-
26. Three metals are in contact and in thermal equilibrium. The metals have different specific heat capacity. What can be concluded about the temperature of the metals? (1)
- A. Since they have different specific heat capacity, they must have different temperature at thermal equilibrium.
B. They must have the same temperature at thermal equilibrium.
C. They must have different internal energy.
D. They must have different kinetic energy.

- 27.** Metal A has a coefficient of linear expansion that is three times the coefficient of linear expansion of metal B. How does their coefficient of areal expansion, γ , compare?

 - $\gamma_A = 2\gamma_B$
 - $\gamma_A = 3\gamma_B$
 - $\gamma_A = 4\gamma_B$
 - $\gamma_A = 6\gamma_B$

28. On an unknown scale x, the ice point temperature is 50°x and the steam-point temperature is 200°x . If the temperature is 60°C , then what is the reading in $^\circ\text{x}$?

 - 90°x
 - 140°x
 - 15°x
 - 333°x

29. A block of mass 5kg hanging at the end of spring scale is totally submerged in a breaker of water. The beaker is large enough to avoid overflow of water. If the density of the block is $2.5 \times 10^3 \text{ kg/m}^3$, then what is the reading of the scale?

 - 3kg
 - 2kg
 - 1kg
 - 0kg

30. An electric generator has a coil of 400 turns and cross-sectional area 5m^2 rotating at angular frequency 0.524 rad/s in a uniform magnetic field of 0.2T , what is the induced e.m.f produced from the electric generator in each second?

 - 209.6V
 - 104.8V
 - 200V
 - 182.4V

31. Which of the following statement is correct?

 - The direction of induced e.m.f is in such a direction as to reinforce the change produces it.
 - Self-inductance of a coil is e.m.f divided by a magnitude of rate change of current with time.
 - The induced e.m.f in a coil is inversely proportional to its number of turns.
 - Self-inductance of a coil is inversely proportional to the cross sectional area of the coil.

32. A positively charged particle of charge $q=3.2 \times 10^{-19}\text{C}$ is moving parallel to x-axis with speed 1000m/s in a magnetic field of 0.5T parallel to y-axis as shown in the diagram below. What is the magnetic force on the charge?
[Figure: A photographed hand-drawn set of three-dimensional axes meeting at a common origin at the left. One arrow points straight up and is labelled Z. A second arrow points to the upper right (diagonally) and is labelled y. A third arrow points to the lower right (diagonally) and is labelled X. Two extra shorter arrows are drawn from near the origin: one lying along the y direction, drawn just above the y axis and labelled B (the magnetic field, parallel to y), and one lying along the X direction, drawn just above the X axis and labelled V (the velocity, parallel to x).]

 - $8.0 \times 10^{-16}\text{N}$ in ? ve Z
 - $3.2 \times 10^{-16}\text{N}$ in $\diamond$ ve x
 - $8.0 \times 10^{-17}\text{N}$ in + ve x
 - $1.6 \times 10^{-16}\text{N}$ in + ve Z

33. A charged particle moves perpendicular to a uniform magnetic field. Which statement is correct about the motion of the particle?

 - Both kinetic energy and linear momentum of the particle change.
 - The kinetic energy of the particle change but not its linear momentum.
 - The linear momentum of the particle changes but not its kinetic energy.
 - Both the energy and momentum do not change.

34. Which of the following is not correct about magnetic field? (1)
- A. Magnetic field lines are closed.
 - B. Magnetic monopoles exist.
 - C. The closer the field lines are, the stronger the magnetic field.
 - D. Magnetic field is produced by moving charge.
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35. Which of the following is not correct about the circuit shown below? (1)
- [Figure: A hand-drawn single-loop circuit. On the left, enclosed inside an ellipse (marking the real cell), are a battery symbol labelled ε and, directly below it in the same branch, a small rectangular resistor labelled r (the internal resistance). Wires run from the ellipse along the top and the bottom of a rectangular loop to the right-hand branch, which carries a vertical rectangular resistor labelled R_L .]
- A. Voltage across R_L is $\frac{R_L}{r+R_L} \varepsilon$
 - B. Current flowing through R_L is $\frac{\varepsilon}{r+R_L}$
 - C. Current flowing through r is $\frac{r}{r+R_L} \varepsilon$
 - D. Power drop in R_L is $\frac{R_L}{(r+R_L)} \varepsilon^2$
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36. A galvanometer of full-scale deflection 10mA is to be converted into a 0 $\rightarrow$ 10.0A ammeter. If its coil has a resistance of 100Ω , then what value of shunt resistance must be fitted? (1)
- A. 0.1Ω
 - B. 10Ω
 - C. 9.99Ω
 - D. 0.999Ω
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37. If a cell supplies a current of 0.9A when connected to a 2Ω resistor and a current of 0.3A, then what will be the internal resistance of the cell when connected to a 7Ω resistor? (1)
- A. 2Ω
 - B. 1.2Ω
 - C. 1Ω
 - D. 0.5Ω
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38. The capacitance of a parallel plate capacitor is 10. If the distance between the plates is halved, keeping all other quantities constant, then what is the new capacitance of the capacitor? (1)
- A. $0.2\mu\text{F}$
 - B. $5\mu\text{F}$
 - C. $10\mu\text{F}$
 - D. $20\mu\text{F}$
-
39. Two positive charges of magnitude $2.4 \times 10^{-9}\text{C}$ and $1.6 \times 10^{-9}\text{C}$ are separated in air by a distance of 2.0cm. (1)
- How much electrostatic potential is produced by the two charges at midway between them?
- A. 3.6KV
 - B. 0.72 KV
 - C. 2.16 KV
 - D. 1.44 KV
-
40. A charge of $q_1 = -10.0 \times 10^{-9}\text{C}$, $q_2 = +10.0 \times 10^{-9}\text{C}$ and $q_3 = -2.5 \times 10^{-8}\text{C}$ are placed on x-y plane as shown in the figure below. What is the electric force on q_3 by q_1 and q_2 ? (1)
- [Figure: A photographed hand-drawn set of x-y axes: a vertical axis with an arrowhead at the top and a horizontal axis with an arrowhead at the right, labelled "x (in m)". Three small circled dots mark the charges. At the origin, on the horizontal axis at the left, is a circled dot labelled q_1 with the coordinates "(0,0)" written beneath it. High on the vertical axis is a circled dot labelled q_2 with the coordinates (0,6) written beside it. Out in the first quadrant, between the two, is a circled dot with the coordinates (4,3) beside it and the label q_3 written just below. Short tick marks are drawn on both axes.]
- A. $1.08 \times 10^{-7}\text{N}$ in +ve y direction
 - B. $9.00 \times 10^{-7}\text{N}$ in -ve y direction
 - C. $1.42 \times 10^{-7}\text{N}$ in +ve x direction
 - D. $1.42 \times 10^{-7}\text{N}$ in -ve x direction

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41. In a Young's experiment, there are two slits, rather than one. What do you think the reason? (1)
- A. To increase the intensity.
 - B. One slit is for frequency the other for wavelength.
 - C. To create a path length difference.
 - D. One slit is for electric fields and the other is for magnetic fields.
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42. A light of wavelength 590nm is incident normally on a grating with spacing 1.67×10^{-6} m. How many orders of diffraction maxima can be obtained (including the zero order)? (1)
- A. 1
 - B. 2
 - C. 3
 - D. 4
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43. Which of the following statements is correct? (1)
- A. Interference is not superposition of waves.
 - B. Constructive interference results in decrease in the intensity.
 - C. Destructive interference results in an increases in the intensity.
 - D. Path difference which is integer multiple of wavelength results in constructive interference.
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44. Which of the following is not correct about a simple harmonic oscillator? (1)
- A. Total mechanical energy is conserved.
 - B. The acceleration is directly proportional to and opposite in direction to displacement
 - C. The period of small oscillation of a pendulum with string length l , a bob mass m attached to its end is $T = 2\pi\sqrt{\frac{l}{g}}$.
 - D. The frequency of an oscillating mass attached to a massless spring is independence of the spring constant.
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45. Which one of the following indicates the wavelength of a travelling wave? (1)
- A. The distance between an adjacent trough and a peak.
 - B. The amplitude of the wave.
 - C. The distance between a node and antinodes.
 - D. The distance between two adjacent points which are in phase.

— END OF EXAMINATION —