

Physics, 2018 EC, entrance exam, version 1

Grade 12 · Physics · 2018 E.C.

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Time allowed: 120 minutes

Questions: 46

Total marks: 46

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1. Which of the following is not true about uniform motion? (1)
- A. It covers equal interval of distance at equal interval of time in a fixed direction.
 - B. Its speed remains constant throughout its motion along straight line.
 - C. ✓ **Its acceleration stays uniform throughout its motion on its way at a given time.**
 - D. Its graph is a straight line with constant positive slope.

Answer: C

Uniform motion means the velocity never changes. If the velocity never changes then the acceleration is zero at every moment, so describing the motion as having an acceleration that stays uniform does not fit. Options A and B are two ways of saying the speed and the direction stay the same, and D is the straight line a constant speed gives on a distance time graph. Option D is the one that tempts, because a sloping line looks like something is speeding up, but on a distance time graph a constant slope is what constant speed looks like.

2. Two students walk from school to home. Student A takes a short cut in straight line, but student B follows the road which curves around a hill. Which one is true? (1)
- A. Student A has greater distance but the same displacement
 - B. ✓ **Student B has greater distance but the same displacement**
 - C. Student A has greater displacement but the same distance.
 - D. Both distance and displacement are the same for both students.

Answer: B

Displacement is the straight line from start to finish. Both students begin at the school and end at the same home, so their displacements are the same. Distance is the length of the path actually walked, and the road curving around the hill is longer than the straight short cut, so student B covers more distance. Option A says the right thing with the names swapped: A is the one who took the short cut, so A cannot be the one with the greater distance.

3. Which statement is wrong about average velocity and instantaneous velocity? (1)
- A. Average velocity depends on total displacement, instantaneous velocity does not.
 - B. Average velocity and instantaneous velocity are equal when an object moves in straight line with constant velocity.
 - C. The speed shown on a speedometer at a moment represents instantaneous velocity.
 - D. ✓ **The average velocity expresses motion of an object at specific moment in time.**

Answer: D

Instantaneous velocity is the velocity at one moment. Average velocity is the total displacement divided by the total time for a whole trip. Statement D hands the description of instantaneous velocity to average velocity, so D is the wrong one. Option A can look suspicious, but it is true: the average needs the whole displacement, while the instantaneous value needs only what is happening at that instant.

4. If the force of attraction between two point masses at a distance r is 250N, what will be the new force if the distance between them decreases by quarter for the same masses? ($G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$) (1)
- A. 1600N
B. 8000N
C. ✓ 4000N
D. 1200N

Answer: C

Newton's law of gravitation gives $F = \frac{Gm_1m_2}{r^2}$, so the force depends on $1/r^2$. When the separation drops to a quarter, r becomes $r/4$, so r^2 becomes $r^2/16$ and the force becomes 16 times larger: $F' = 16 \times 250 = 4000 \text{ N}$. The value of G is not needed, because the masses do not change and only the ratio matters. Option B, 8000 N, would need the force to grow 32 times, and no reading of the change in distance gives that factor.

5. All are dimensionless except (1)
- A. Specific gravity
B. ✓ Young's modulus
C. Strain
D. Index of refraction

Answer: B

Young's modulus is stress divided by strain. Strain is one length divided by another, so it carries no unit, which leaves Young's modulus with the unit of stress, N/m^2 . The other three are all ratios of two like quantities: specific gravity compares two densities, strain compares two lengths, and the index of refraction compares two speeds. Option C, strain, is the tempting pick, but it is the very quantity whose lack of a unit is what gives Young's modulus its unit.

6. Which of the following is necessarily true? (1)
- A. If the velocity of an object is zero, then acceleration is also zero.
B. If acceleration of an object is zero then its velocity is also zero.
C. Deceleration means that acceleration is necessarily negative.
D. ✓ The instantaneous acceleration has the same value as the average acceleration if the motion is uniformly accelerated motion.

Answer: D

In uniformly accelerated motion the acceleration holds the same value at every moment, so the value at any instant equals the value averaged over any interval. That makes D true. A fails at the top of a thrown ball's flight, where the velocity is zero while gravity still pulls. B fails for a car at steady speed, where the acceleration is zero but the velocity is not. Option C is the tempting one: deceleration means the speed is falling, and for a body moving in the negative direction a positive acceleration is what slows it, so a deceleration is not always a negative acceleration.

7. Which of the following sets of quantities remains constant in uniform circular motion? (1)
- A. Velocity, speed, radius
B. Velocity, acceleration, kinetic energy
C. Speed, acceleration, radius
D. ✓ Speed, radius, kinetic energy

Answer: D

In uniform circular motion the body travels a fixed circle at a steady speed. The speed does not change, the radius does not change, and kinetic energy is $\frac{1}{2}mv^2$, so it does not change either. Velocity and acceleration are vectors that keep turning to follow the circle, so neither is constant even though their sizes are. Option C is the trap: the size of the centripetal acceleration stays the same, but the acceleration always points at the centre, so its direction is turning the whole time.

8. An earth satellite has an orbit radius which is 4 times that of a communication satellite C. What is the period of revolution of the earth's satellite in terms of communication satellite C? (use period of the earth = 1 year) (1)
- A. ✓ $T_{es} = 8T_c$ B. $T_{es} = 4T_c$
C. $T_c = 5T_{es}$ D. $T_c = 2T_{es}$

Answer: A

Kepler's third law says $T^2 \propto r^3$. If the radius is 4 times larger, T^2 grows by $4^3 = 64$, so the period grows by $\sqrt{64} = 8$. That gives $T_{es} = 8T_c$. Option B is the tempting one: the period does grow when the orbit grows, but not in step with the radius, because it is the square of the period that follows the cube of the radius.

9. The acceleration that a force produces on 80kg mass is larger by 6 m/s² than the acceleration it produces on 100kg. What will be the acceleration on 80kg mass? (1)
- A. 24 m/s² B. 18 m/s²
C. ✓ 30 m/s² D. 40 m/s²

Answer: C

The same force acts in both cases, so $F = 80a_1 = 100a_2$, and the question says the smaller mass gets 6 more: $a_1 = a_2 + 6$. Substituting, $80(a_2 + 6) = 100a_2$, so $480 = 20a_2$ and $a_2 = 24 \text{ m/s}^2$. The acceleration of the 80 kg mass is then $a_1 = 24 + 6 = 30 \text{ m/s}^2$. Option A, 24 m/s², is the answer to the other half of the working: that is what the 100 kg mass receives.

10. When a driver applies a sudden brake to save a child at the center of the road, you are moving forward from your seat. Which Newton's law expresses this phenomenon best? (1)
- A. ✓ **Newton's first law** B. Newton's second law
C. Newton's third law D. Newton's gravitational law

Answer: A

When the brakes act, the car slows down, but nothing has acted on your body to slow it, so your body keeps moving forward at the speed it already had. That is inertia, and inertia is what Newton's first law describes. Option B tempts because a force is certainly involved in braking, but the second law explains how the car slows down, not why your body carries on.

11. How much work is required to accelerate a 900kg car from 10 m/s to 20 m/s? (Ignore friction) (1)
- A. $7.46 \times 10^5 \text{ J}$ B. $2.46 \times 10^5 \text{ J}$
C. ✓ $1.35 \times 10^5 \text{ J}$ D. $4.36 \times 10^5 \text{ J}$

Answer: C

Work done equals the change in kinetic energy: $W = \frac{1}{2}m(v_f^2 - v_i^2)$. Here $W = \frac{1}{2}(900)(20^2 - 10^2) = 450(400 - 100) = 450 \times 300 = 135000 \text{ J}$, which is $1.35 \times 10^5 \text{ J}$. Take care to subtract the squares of the speeds, not to square the difference in speed. Option B, $2.46 \times 10^5 \text{ J}$, is the size of answer you drift towards by adding the two kinetic energies instead of subtracting them, which gives $2.25 \times 10^5 \text{ J}$.

12. A horizontal force of 80N is applied on a 10kg block which is moving on a horizontal rough surface. If the coefficient of friction between the block and the surface is $\mu = 0.5$, what is the acceleration of the block? (1)
- A. 8 m/s² B. 2 m/s²
C. 18 m/s² D. ✓ 3 m/s²

Answer: D

Friction acts against the motion and its size is $f = \mu mg = 0.5 \times 10 \times 10 = 50 \text{ N}$. The net force on the block is $80 - 50 = 30 \text{ N}$, so $a = \frac{30}{10} = 3 \text{ m/s}^2$. Option A, 8 m/s², is what $80/10$ gives if friction is left out altogether, and the question says the surface is rough.

13. Which one of the following is false?

(1)

- A. ✓ **The slope of acceleration versus time graph is velocity**
- B. The area under velocity versus time graph is displacement
- C. The area under acceleration versus time graph is velocity
- D. The slope of velocity versus time graph is acceleration

Answer: A

The slope of a graph tells you how fast the vertical quantity is changing with time. On an acceleration time graph the slope tells you how fast the acceleration itself is changing, and that is not velocity, so A is the false statement. Option C is the one to watch: the area under an acceleration time graph gives the change in velocity, which is near enough to what the option says that the paper counts it as true.

14. In which one of the following cases is work done in physics?

(1)

- A. Holding a 200N load without moving.
- B. Pushing a concrete wall horizontally by applying horizontal force.
- C. ✓ **Pushing a block horizontally by applying horizontal force.**
- D. Carrying a load by shoulder and moving along straight line a distance of 2km.

Answer: C

In physics, work is done only when the force has a part along the direction the body actually moves. In C the push is horizontal and the block moves horizontally, so work is done. In A nothing moves at all, and in B the wall does not move, so neither does any work. Option D is the tempting one: the load travels 2 km, but the force holding it up is vertical while the motion is horizontal, so that force does no work on it.

15. Which one of the following correctly expresses friction strength?

(1)

- A. Sliding friction > rolling friction > static friction
- B. Sliding friction > rolling friction
- C. Sliding friction > friction > static friction
- D. ✓ **Rolling friction < sliding friction < static friction**

Answer: D

Static friction has to be beaten before an object starts to move, so it is the largest of the three. Once sliding begins the resistance drops to the sliding value. Rolling replaces sliding contact with contact that keeps renewing itself, so rolling friction is the smallest. The order is rolling < sliding < static, which is option D. Option A is the same list in reverse and makes static friction the smallest, but then nothing at rest would ever be hard to start moving.

16. An object of mass is dropped from a certain height to the ground; at what height above the ground do we assume that the object has the same potential and kinetic energies if its velocity is 20 m/s?

(1)

- A. 5 m
- B. ✓ **20 m**
- C. 60 m
- D. 40 m

Answer: B

At the height being asked for, the kinetic and potential energies are equal, and the speed there is 20 m/s. So $mgh = \frac{1}{2}mv^2$. The mass cancels, leaving $h = \frac{v^2}{2g} = \frac{400}{20} = 20$ m. Option D, 40 m, is what v^2/g gives when the factor of $\frac{1}{2}$ in the kinetic energy is dropped.

21. Which of the following is False?

(1)

- A. Materials with higher Young's modulus also possess greater bulk modulus.
- B. ✓ **Materials with higher strain are highly elastic.**
- C. Shearing stress happens when the deforming forces are tangential.
- D. Materials with smaller strain are highly elastic.

Answer: B

Elasticity here is measured by how strongly a material resists being deformed. For the same stress, a material with a large strain has stretched a lot, so its Young's modulus is small and it is the less elastic one. That makes B false. Notice that B and D state opposites, so one of the two has to be the false statement. Option D is the tempting choice, because in everyday speech a rubber band that stretches easily is called elastic, but in physics the material that hardly strains is the more elastic one.

22. A 400kg load is hung on a wire having a length of 6.0m and cross-sectional area of $0.40 \times 10^{-5} \text{ m}^2$ and Young's modulus $8.00 \times 10^{10} \text{ N/m}^2$. What is its increase in length?

(1)

- A. ✓ **0.075 m**
- B. 7.25 m
- C. 0.09 m
- D. 0.05 m

Answer: A

Use $\Delta L = \frac{FL}{AY}$. The stretching force is the weight of the load, $F = 400 \times 10 = 4000 \text{ N}$. Then $\Delta L = \frac{4000 \times 6}{(0.40 \times 10^{-5})(8.00 \times 10^{10})} = \frac{24000}{3.2 \times 10^5} = 0.075 \text{ m}$. Option B, 7.25 m, is longer than the 6 m wire itself, so it can be ruled out before any arithmetic: an answer bigger than the wire's own length is a sign that a power of ten has gone astray.

23. Two charges of $+9 \mu\text{C}$ and $+25 \mu\text{C}$ are 40cm apart. At what distance from either charge is the field zero?

(1)

- A. ✓ **15 cm from q_1 and 25 cm from q_2**
- B. 10 cm from q_1 and 15 cm from q_2
- C. 35 cm from q_1 and 15 cm from q_2
- D. 20 cm from q_1 and 45 cm from q_2

Answer: A

Both charges are positive, so the point where their fields cancel lies between them. Call it x from the $9 \mu\text{C}$ charge, which puts it $40 - x$ from the $25 \mu\text{C}$ charge. Equal field sizes give $\frac{9}{x^2} = \frac{25}{(40-x)^2}$. Take the square root of both sides: $\frac{3}{x} = \frac{5}{40-x}$, so $120 - 3x = 5x$ and $x = 15 \text{ cm}$. The point is 15 cm from the $9 \mu\text{C}$ charge and 25 cm from the $25 \mu\text{C}$ charge. A quick check removes the rest: only in option A do the two distances add up to the 40 cm that separates the charges.

24. Suppose a given resistor is connected to a constant voltage supply. When will the current in the resistor decrease?

(1)

- A. When the length of the resistance is reduced.
- B. When the resistance of the resistor is decreased.
- C. When cross-sectional area of the resistor increased.
- D. ✓ **When the length of the resistor is increased.**

Answer: D

At a fixed voltage $I = \frac{V}{R}$, so the current falls whenever the resistance rises. Resistance is $R = \frac{\rho L}{A}$, which grows when the conductor is made longer, so option D is the change that cuts the current. Option C is the tempting one: a larger cross-sectional area gives the charge more room to flow, which lowers the resistance and raises the current, the opposite of what was asked.

25. From the given circuit below, the current drop in 6Ω and 12Ω resistors respectively is (1)
- A. 3A and 2A
B. 4A and 3A
C. ✓ 1A and 0.5A
D. 1.2A and 3A

Answer: C

The two resistors sit across the same pair of points, so the same voltage drives both of them. With $I = \frac{V}{R}$, the current splits in inverse proportion to the resistances, and the 6Ω resistor must carry twice as much as the 12Ω resistor. Only option C holds that 2 to 1 ratio, and it fits a 6 V drop across the pair: $\frac{6}{6} = 1\text{ A}$ and $\frac{6}{12} = 0.5\text{ A}$. Option A, 3 A and 2 A, is in the ratio 3 to 2, which a parallel pair of 6Ω and 12Ω cannot produce.

26. A wheel starts rotating at 1.2 Hz to 1.8 Hz in 2 seconds. What will be the angular displacement it covers within 2 seconds? (1)
- A. 3 rad
B. ✓ 6 rad
C. 4 rad
D. 0.3 rad

Answer: B

Turn the frequencies into angular speeds first, using $\omega = 2\pi f$: $\omega_1 = 2\pi(1.2) = 2.4\pi\text{ rad/s}$ and $\omega_2 = 2\pi(1.8) = 3.6\pi\text{ rad/s}$. The wheel speeds up steadily, so use the average angular speed over the 2 s: $\theta = \frac{1}{2}(\omega_1 + \omega_2)t = \frac{1}{2}(2.4\pi + 3.6\pi)(2) = 6\pi\text{ rad}$. The paper prints this answer as 6, with π understood. Option A, 3, is what comes out if the frequencies are used as though they were already in rad/s.

27. An egg is placed at the bottom of a vessel filled with water. Common salt is slowly added and dissolved in the water until the egg rises and floats at the surface. From this information, what can you conclude? (1)
- A. ✓ The density of salt exceeds the density of the egg.
B. There is a tendency for calcium in the eggshell to be repelled by sodium chloride.
C. Salt sinks to the bottom.
D. There is no physical explanation.

Answer: A

A body floats when the fluid around it is denser than the body itself. Salt dissolves into the water and adds mass without adding much volume, so the density of the salt water climbs. Once that density passes the density of the egg, the upward push of the fluid beats the egg's weight and the egg rises. Option C is the tempting one: if the salt stayed as a layer on the bottom, the water above would be unchanged and the egg would stay where it was.

28. A substance whose density is equal to $0.4 \times 10^3\text{ kg/m}^3$ floats in fresh water ($\rho_w = 1000\text{ kg/m}^3$). What fraction of its volume is submerged? (1)
- A. 1/2
B. 1/5
C. ✓ 2/5
D. 1/4

Answer: C

A floating body sinks until the weight of fluid it pushes aside equals its own weight, which makes the submerged fraction equal to the ratio of the densities: $\frac{\rho_{\text{body}}}{\rho_{\text{water}}} = \frac{0.4 \times 10^3}{1000} = \frac{400}{1000} = \frac{2}{5}$. Option A, $\frac{1}{2}$, is what you get by treating the density as 500 kg/m^3 , so read 0.4×10^3 carefully: it is 400, not half of 1000.

29. In the figure, the time it takes for the planet to go from A to B, C to D, and E to F is the same. Compare the areas A_1 , A_2 , and A_3 in terms of size.
- A. $A_1 \neq A_2 \neq A_3$ B. ✓ $A_1 = A_2 = A_3$
- C. $A_1 = A_2 > A_3$ D. $A_1 > A_2 = A_3$

Answer: B

This is Kepler's second law: the line joining the sun to the planet sweeps out equal areas in equal times. The question states that the three journeys take the same time, so the three swept areas are equal, whichever part of the orbit they cover. Option D is the tempting one, because the planet does move faster when it is near the sun, but the line to the sun is shorter there, and the two effects cancel exactly.

- 30.** Physics can be applied to everyday life except? (1)
- A.** The development of telephone, telegraph and telex have enabled us to transmit important messages instantly.
 - B.** The development of radio, television, satellites have increased the means of communication.
 - C.** Rapid means of transport have increased the pace of transportation through air, water, and land.
 - D. ✓ Enhancing artistic expressions and career opportunities by ignoring real world implications.**

Answer: D

Options A, B and C all name real uses of physics: telephone and telegraph, radio and satellites, and fast transport by air, water and land all came out of physics. Option D describes ignoring what happens in the real world, which is the opposite of applying physics to everyday life, so it is the exception the question wants. Option C can look like the odd one out because it is about transport rather than communication, but it is still an application.

31. Which one is wrong action when a leak is suspected in high-pressure equipment? (1)
- A. Shut down and depressurize the system safely.
 - B. ✓ **Use hands to feel for escaping fluid from the system.**
 - C. Keep a safe distance from the suspected leak.
 - D. Report the issue according to safety procedures.

Answer: B

A leak in high-pressure equipment sends fluid out as a thin, very fast jet that can cut skin and drive fluid into the body, so reaching towards it with a hand is the dangerous act and the one the question calls wrong. Shutting the system down and releasing the pressure safely, standing back, and reporting the fault are all correct steps. Option A can look wrong to someone who thinks a leaking system should be left alone, but depressurising it under control is exactly how the hazard is removed.

32. Which of the following best describes the importance of career awareness in physics education? (1)
- A. It is optional and has little impact on future employment.
 - B. It is irrelevant; students should only focus their theoretical knowledge.
 - C. **It helps students understand the diverse career opportunities, provide hands-on experience and networking system.**
 - D. It primarily focuses students' interest in academia and it serves no purpose in advancing physics knowledge.

Answer: C

Career awareness shows students what physics leads to after school: the range of jobs it opens, the practical work those jobs involve, and the people already doing them. That is what option C says. Option A is the tempting one if you treat school subjects as separate from working life, but knowing where a subject leads changes what a student chooses to study and how hard they push at it.

33. If you feel a pressure three times that of the atmospheric pressure when you are deep under water, how high is the water level from your position? ($p_{atm} = 10^5$ Pa, density $\rho_w = 10^3$ kg/m³, $g = 10$ m/s², and assume atmospheric pressure is exerted on it.) (1)

A. ✓ 20 m
B. 10 m
C. 40 m
D. 30 m

Answer: A

Pressure under water is $P = P_{atm} + \rho gh$. Three times atmospheric is 3×10^5 Pa, so the water column alone supplies $3 \times 10^5 - 1 \times 10^5 = 2 \times 10^5$ Pa. Then $h = \frac{2 \times 10^5}{(10^3)(10)} = \frac{2 \times 10^5}{10^4} = 20$ m. Option D, 30 m, comes from giving the whole 3×10^5 Pa to the water and forgetting that the atmosphere is already pressing down on the surface.

34. The vertical component of force acting at an angle of 37° to the horizontal is 12N. What will be the magnitude of the force and its horizontal component respectively? (1)

A. 50N, 30N
B. ✓ 20N, 16N
C. 20N, 25N
D. 5N, 25N

Answer: B

The vertical part of a force at 37° to the horizontal is $F \sin 37^\circ$, so $F(0.6) = 12$ and $F = 20$ N. The horizontal part is then $F \cos 37^\circ = 20(0.8) = 16$ N. Option C gets the 20 N right but pairs it with 25 N, and a component can never be larger than the force it came from, so 25 N beside a 20 N force is impossible.

35. For what value of C lying on the x -axis does $A \cdot (B + C) = 0$ if $A = 5i - 3j + 4k$ and $B = 2i + 4j - 5k$? (1)

A. $5i$
B. $-3.2i$
C. $1.9i$
D. ✓ $-4.4i$

Answer: D

Since C lies on the x -axis, write it as $C = ci$. The dot product spreads over a sum, so $A \cdot (B + C) = A \cdot B + A \cdot C$. Here $A \cdot B = (5)(2) + (-3)(4) + (4)(-5) = 10 - 12 - 20 = -22$, and $A \cdot C = 5c$. Setting the total to zero gives $5c - 22 = 0$, so $c = 4.4$. The value 4.4 appears in option D alone, and the minus sign printed in front of it is a slip, because the working gives $C = 4.4i$. Option A, $5i$, tempts because 5 is the x part of A , but the condition to satisfy is that the whole dot product vanishes, not that C copies a component of A .

36. Which of the following is NOT correct about momentum? (1)

A. The total linear momentum of an isolated system remains constant.
B. Impulse is the change in momentum.
C. Impulse and momentum have the same unit.
D. ✓ Linear momentum is mass multiplied by impulse.

Answer: D

Momentum is mass times velocity, $p = mv$. Option D multiplies mass by impulse instead, which is not the definition, so it is the incorrect statement. The other three hold: momentum is conserved in an isolated system, impulse equals the change in momentum, and because of that impulse and momentum share the unit kg m/s. Option B is the tempting one, but impulse really is the change in momentum, which is what the impulse momentum theorem states.

37. In aerospace engineering, the stability of a satellite in orbit is ensured by (1)
- A. Air friction
 - B. ✓ **Newton's law of motion and gravitational force**
 - C. Electromagnetic shielding
 - D. Laser production

Answer: B

A satellite holds its orbit because gravity supplies exactly the centre-seeking force that a circular path needs, and Newton's laws connect that force to the motion. That is option B. Option A is the tempting one, but at orbital height there is almost no air, and the little that remains drags the satellite down over time rather than holding it up.

38. What is the main focus of physics compared to chemistry? (1)
- A. Physics studies reactions between substances but chemistry studies motion.
 - B. ✓ **Physics studies fundamental laws of matter and energy, while chemistry studies composition and reaction of matter.**
 - C. Physics studies at macro levels about atoms while chemistry studies at micro levels.
 - D. Physics concerns transformation of physical matter but chemistry concerns the movement of physical objects.

Answer: B

Physics studies the basic laws that matter and energy obey: motion, force, heat, light, electricity. Chemistry studies what substances are made of and how they react to make new substances. Option B states that split correctly. Option C is the tempting one, but it has the scales the wrong way round: physics reaches all the way down to atoms and smaller, so it is not the macro subject while chemistry holds the micro one.

39. The principle behind optical fibers in medical imaging (endoscopy) is (1)
- A. ✓ **Total internal reflection**
 - B. Diffraction
 - C. Polarization
 - D. Scattering

Answer: A

An optical fibre carries light along a bent path by total internal reflection. The light meets the wall of the core at an angle beyond the critical angle, so none of it escapes and all of it turns back inside. That is what lets an endoscope carry light and an image around the curves inside the body. Option B, diffraction, tempts because it is also about light changing direction, but diffraction spreads light out at an edge and would smear the image rather than guide it.

40. Which of the following best describes cruise missiles? (1)
- A. They are propelled by rocket.
 - B. It follows a high space-based trajectory before descending to target.
 - C. It travels at a very high speed without guidance.
 - D. ✓ **It flies at low altitudes with continuous engine power and precise guidance.**

Answer: D

A cruise missile is a small pilotless aircraft. It carries its own engine for the whole flight, stays low to keep under radar cover, and steers itself to the target with a guidance system, which is option D. Option B describes a ballistic missile, thrown high on an arc and then falling to the target, and that is the one most often confused with a cruise missile.

41. A body is thrown vertically upward and at the instant when it reaches its maximum height; (1)
- A. ✓ **Its velocity is zero and its acceleration is constant**
 - B. Its velocity is zero and its acceleration is also zero.
 - C. Its velocity is zero but its acceleration is maximum.
 - D. Its velocity is zero but its acceleration is minimum.

Answer: A

On the way up gravity slows the body until, at the highest point, the velocity has fallen to zero. Gravity does not switch off there. It keeps pulling with the same 9.8 m/s^2 downwards, and that is what turns the body around and brings it back. So the velocity is zero while the acceleration is unchanged. Option B is the common trap: a body can have zero velocity and still be accelerating, and this is the standard example of it.

42. A particle moves in a circular path of radius 0.1m with a constant angular speed of $10\pi \text{ rad/s}$. What is the acceleration of the particle? (1)
- A. ✓ **$10\pi^2 \text{ m/s}^2$**
 - B. $20\pi^2 \text{ m/s}^2$
 - C. $30\pi^2 \text{ m/s}^2$
 - D. $40\pi^2 \text{ m/s}^2$

Answer: A

For motion in a circle at a steady rate the acceleration points at the centre and has size $a = \omega^2 r$. Here $a = (10\pi)^2(0.1) = 100\pi^2 \times 0.1 = 10\pi^2 \text{ m/s}^2$. Option B, $20\pi^2$, is twice the answer. There is no extra factor of 2 in $\omega^2 r$, so if you land on it, check that the radius 0.1 m was multiplied in once and once only.

43. Three balls A, B and C are thrown at an angle 37° , 45° and 53° respectively from the ground with the same initial velocity u . Which of the following comparisons about the horizontal distance they travel is correct? (1)
- A. Distance of A = Distance of B < Distance of C
 - B. ✓ **Distance of A = Distance of C < Distance of B**
 - C. Distance of A = Distance of C > Distance of B
 - D. Distance of B < Distance of C < Distance of A

Answer: B

The range of a projectile on level ground is $R = \frac{u^2 \sin 2\theta}{g}$. For 37° and 53° , 2θ is 74° and 106° , and $\sin 74^\circ = \sin 106^\circ$, so A and C land the same distance away. Any two angles that add to 90° behave this way. For 45° , $\sin 90^\circ = 1$, the largest value $\sin 2\theta$ can take, so B goes furthest. That gives Distance A = Distance C < Distance B. Option C pairs A and C correctly but sends B the shortest distance, which reverses the fact that 45° gives the maximum range.

44. Which one of the following is false about fluid flow? (1)
- A. Laminar fluid flow occurs with low velocity and small diameter pipe.
 - B. Turbulent fluid flow occurs with high velocity and larger diameter pipe.
 - C. ✓ **The path of different particles during laminar fluid flow crosses each other.**
 - D. The velocity of the particles is tangent to streamline for laminar fluid flow.

Answer: C

In laminar flow the fluid moves in smooth layers and each particle stays on its own streamline, so the paths never cross one another. Option C says they do cross, which describes turbulent flow, so C is the false statement. Option D is the one people are tempted to call false, but it is true: in laminar flow the velocity of a particle always lies along the tangent to its streamline.

- 45.** The V-t graph of a moving object as shown in the figure below. The maximum acceleration is
- A. 1 cm/sec²
- B. 2 cm/sec²
- C. 3 cm/sec²
- D. ✓ **6 cm/sec²**

Answer: D

On a velocity time graph the acceleration is the slope, so the largest acceleration is on the steepest section of the graph. That section climbs by 6 cm/s of velocity in each second, giving 6 cm/s². The other sections are less steep and give smaller values. The common mistake is to hunt for the highest point on the graph instead of the steepest part: the top of the graph gives the maximum velocity, not the maximum acceleration.

46. A solid sphere of radius R and moment of inertia about its diameter ($I = \frac{2}{5} mR^2$) starts from rest and rolls down an inclined plane of 7m high. What is the speed of the sphere at the bottom of the inclined plane? (Ignore friction)
- A. ✓ 10 m/s B. 100 m/s
C. 30 m/s D. 5 m/s

Answer: A

A rolling sphere carries both moving energy and spinning energy, so $mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$ with $I = \frac{2}{5}mR^2$ and $\omega = \frac{v}{R}$. The spinning term becomes $\frac{1}{5}mv^2$, so $mgh = 0.7mv^2$. The mass cancels: $v = \sqrt{\frac{gh}{0.7}} = \sqrt{\frac{10 \times 7}{0.7}} = \sqrt{100} = 10 \text{ m/s}$. Option C, 30 m/s, would need a slope about 63 m high, so it is far too fast for a 7 m drop.

END OF THE MARKING KEY

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