

MARKING KEY: CONFIDENTIAL

Speed at a constant rate is distance divided by time: $v = \frac{d}{t}$. Here $v = \frac{2400 \text{ m}}{80 \text{ s}} = 30 \text{ m/s}$. Option B, 40 m/s, appears when the 80 seconds is treated as 60 seconds, so check the unit in the question before dividing.

10. Pool balls remain at rest until an unbalanced force is applied to them. After they are in motion, they stay in motion until another force opposes their motion relative to an inertial frame with constant velocity. Which laws of motion describes this statement? (1)

A. Newton's third law
B. Newton's second law
C. Newton's laws of universal gravitation
D. ✓ **Newton's first law**

Answer: D

A body stays at rest, or keeps moving in a straight line at constant velocity, until an unbalanced force acts on it. That property is inertia, and Newton's first law is the law of inertia. Option B is close but different: the second law tells you how much the motion changes once a net force does act, through $F = ma$.

11. A kind of friction that exists between two surfaces in contact when one body tends to slide over the other without moving. (1)

A. Limiting friction
B. Kinetic friction
C. ✓ **Static friction**
D. Dynamic friction

Answer: C

Static friction is the force between two surfaces that are still touching without sliding, and it is what resists a body that only TENDS to slide. It grows to match whatever push you apply, up to a maximum. Option A names that maximum: limiting friction is the largest value static friction reaches at the moment slipping starts, so it is a special case rather than the general name.

12. Which one of the following objects does not have gravitational potential energy? (1)

A. A bottle on the surface of a table
B. ✓ **A ball on the level ground**
C. A stone on the roof of a house
D. A fruit on a branch of a tree

Answer: B

Gravitational potential energy is $PE = mgh$, measured from the chosen reference level, which here is the ground. A ball resting on level ground has $h = 0$, so $PE = 0$. Option A is tempting because a bottle looks like it is resting too, but the table lifts it above the ground, so it does have potential energy.

13. Which one contains the set of vectors? (1)

A. ✓ **Velocity, force and acceleration**
B. Speed, velocity and time
C. Distance, displacement and speed
D. Mass, time and speed

Answer: A

A vector needs both a size and a direction. Velocity, force and acceleration each have to be reported with a direction, so all three are vectors. In option B, speed and time carry only a size, which makes them scalars, so that set is mixed.

14. Vector resolution is the process of: (1)

A. Adding multiple vectors together
B. ✓ **Finding the components of a vector along specified axes**
C. Multiplying a vector by a scalar
D. Subtracting vectors

Answer: B

Resolving a vector means breaking one vector into two parts that lie along chosen axes, usually $F_x = F \cos \theta$ and $F_y = F \sin \theta$. The two components together do the same job as the original vector. Option A is the opposite process: adding vectors combines several into one, which is composition, not resolution.

15. A force of 10 N acts at an angle of 30° to the horizontal. Find the horizontal component of this force. (1)
- A. 5 N
B. 7.07 N
C. ✓ 8.7 N
D. 14.14 N

Answer: C

The horizontal component of a force at an angle θ to the horizontal is $F_x = F \cos \theta$. So $F_x = 10 \cos 30^\circ = 10 \times 0.866 = 8.66$ N, which rounds to 8.7 N. Option A, 5 N, is $10 \sin 30^\circ$, the vertical component, so it answers a different question.

16. The instantaneous velocity of an object at any point in time can be determined from the position-time graph by calculating the: (1)
- A. Area under the curve
B. ✓ Slope of the tangent at that point
C. Y-intercept
D. X-intercept

Answer: B

On a position against time graph, the slope tells you how fast the position is changing, which is velocity. For the velocity at one instant you take the slope of the tangent drawn at that single point, because the curve may be bending. Option A is a common mix-up: area under a graph gives displacement, but only on a velocity-time graph, not on a position-time graph.

17. A ball is thrown upwards with an initial velocity of 15 m/s. How high will it go? (Assume $g = 10 \text{ m/s}^2$) (1)
- A. 12 Meters
B. ✓ 11.25 meters
C. 225 meters
D. 14.18 meters

Answer: B

At the highest point the ball has stopped rising, so $v = 0$. Using $v^2 = u^2 - 2gh$ with $v = 0$ gives $h = \frac{u^2}{2g} = \frac{15^2}{2 \times 10} = \frac{225}{20} = 11.25$ m. Option C, 225 m, is u^2 written down before dividing by $2g$.

18. A copper wire and a steel wire of the same diameter and length are connected end to end and a force is applied, which stretches their combined length by 1cm. The two wires will have (1)
- A. Different stresses and strains
B. The same strain but different stresses
C. The same stress and strain
D. ✓ The same stress but different strains

Answer: D

The wires are joined end to end, so the same force passes through both, and they have the same diameter, so the same area. Stress is $\frac{F}{A}$, so the stress in the two wires is equal. Strain is $\frac{\text{stress}}{Y}$, and copper and steel have different Young's modulus Y , so the softer copper stretches more. Option C fails on that second step: equal stress does not force equal strain when the materials differ.

19. The area of cross section of a steel wire ($Y = 2.0 \times 10^{11} \text{ N/m}^2$) is 0.1 cm^2 . What force is required to double its length? (1)
- A. 2×10^2 N
B. ✓ 2×10^6 N
C. 2×10^4 N
D. 2×10^9 N

Answer: B

Doubling the length means the extension equals the original length, so the strain is $\frac{\Delta L}{L} = 1$. From $Y = \frac{F/A}{\Delta L/L}$ the force is $F = YA \times \text{strain}$. Convert the area first: $0.1 \text{ cm}^2 = 0.1 \times 10^{-4} = 1 \times 10^{-5} \text{ m}^2$, so $F = 2.0 \times 10^{11} \times 1 \times 10^{-5} \times 1 = 2 \times 10^6$ N. Option C comes from treating 1 cm^2 as 10^{-2} m^2 instead of 10^{-4} m^2 .

20. Which of the following is not correct about Properties of electric field lines? (1)
- A. The field lines never intersect or cross each other
 - B. The field lines are perpendicular to the surface of the charge
 - C. The magnitude of charge and the number of field lines are proportional to each other
 - D. ✓ **Field lines originate at negative charge and terminate at a positive charge**

Answer: D

The question asks for the statement that is FALSE. Electric field lines are drawn in the direction a positive test charge would move, so they leave a positive charge and arrive at a negative one. Option D states it backwards, so option D is the answer. Option B is tempting to pick, but a field line meeting a charged conductor at a right angle is a true property, so it cannot be the false statement.

21. The potential difference between the terminals of an electric heater is 60V when it draws a current of 4A from the source. What current will the heater draw if the potential difference is increased to 120V? (1)
- A. 4A
 - B. 3A
 - C. 6A
 - D. ✓ **8A**

Answer: D

The heater is an ohmic device, so its resistance stays the same when the supply changes. From the first reading, $R = \frac{V}{I} = \frac{60}{4} = 15 \Omega$. With 120 V across that same resistance, $I = \frac{120}{15} = 8 \text{ A}$. Option A assumes the heater always pulls 4 A, but current is set by the voltage and the resistance together, not fixed by the appliance.

22. What is the equivalent resistance and the current across 4Ω resistor shown in a Figure below respectively? (1)
- A. 3.2Ω and 7.21A
 - B. 6.4Ω and 2.7A
 - C. ✓ **7.21Ω and 0.83 A**
 - D. 8.3Ω and 22 A

Answer: C

The 4Ω resistor sits in the main line, so the current through it is the whole current the battery drives, and that current is $I = \frac{V}{R_{eq}}$. Option C is the only pair where the resistance and the current belong to the same source: $0.83 \text{ A} \times 7.21 \Omega \approx 6 \text{ V}$, the battery shown in the figure. Option A pairs the resistance of the parallel section alone with a current of 7.21 A, which would need about 23 V, far more than the circuit supplies.

23. Which of the following modern technologies is a direct application of physics in the field of medicine? (1)
- A. The production of organic fertilizers
 - B. The classification of plant species
 - C. The study of ancient languages
 - D. ✓ **The development of Magnetic Resonance Imaging (MRI)**

Answer: D

Magnetic Resonance Imaging works on nuclear magnetic resonance: strong magnetic fields and radio waves make hydrogen nuclei in the body give off signals that a computer turns into an image. That is physics being used to see inside a patient. Option A belongs to chemistry and agriculture, not to medical physics.

24. What is the primary overall objective of the Ethiopian Physical Society (EPS)? (1)
- A. To sell physics textbooks and laboratory equipment to high schools
 - B. To replace the Ministry of Education in designing the national curriculum
 - C. ✓ **To promote physics education, research, and its applications across Ethiopia**
 - D. To ensure that every student in Ethiopia becomes a professional physicist

Answer: C

The Ethiopian Physical Society is a professional body. Its purpose is to strengthen the teaching of physics, support research, and encourage the use of physics in the country's development. Option D sounds close but is far too narrow: a society cannot aim to turn every student into a professional physicist, and most students who study physics go on to other fields.

25. Which of the following is the correct order of steps often used in the 'Making of Physics Knowledge'? (1)
- A. Conclusion → Hypothesis → Observation → Experiment
 - B. ✓ **Observation → Hypothesis → Experiment → Analysis/Conclusion**
 - C. Experiment → Conclusion → Theory → Observation
 - D. Theory → Law → Observation → Guess

Answer: B

Physics knowledge is built by starting from what is seen. You observe something, propose a hypothesis to explain it, design an experiment to test that hypothesis, then analyse the results and draw a conclusion. Option A puts the conclusion first, which reverses the whole process: a conclusion is what the evidence produces, not what the work starts from.

26. Suppose $A = 6i + 4j$ and $B = 2i - cj$ are two vectors in xy -plane. What is the value of c that $A + B = 8i + 2j$? (1)
- A. -2
 - B. -3
 - C. ✓ **2**
 - D. 3

Answer: C

Add the vectors component by component. The i parts give $6 + 2 = 8$, which already matches. The j parts give $4 + (-c) = 2$, so $4 - c = 2$ and $c = 2$. Option A, -2 , comes from writing $4 + c = 2$ and missing the minus sign that is already in front of c in vector B.

27. For what value of b the vectors $A = i + 2j + 3k$ and $B = i + bj - k$ are orthogonal? (1)
- A. ✓ **1**
 - B. 2
 - C. 3
 - D. 4

Answer: A

Two vectors are orthogonal when their dot product is zero. Here $\vec{A} \cdot \vec{B} = (1)(1) + (2)(b) + (3)(-1) = 2b - 2$. Setting $2b - 2 = 0$ gives $b = 1$. Option C, 3, is what you get by matching the number in front of k in vector A instead of using the dot product.

28. The types of vectors lying on the same plane are (1)
- A. Parallel vectors
 - B. Collinear vectors
 - C. ✓ **Coplanar vectors**
 - D. Orthogonal vectors

Answer: C

Vectors that all lie in one flat surface are called coplanar. Any two vectors are always coplanar, so the word matters most when three or more are involved. Option B is a narrower idea: collinear vectors lie on the same straight line, which is one special case of lying in the same plane.

29. Which of the following is true for an object in uniformly accelerated motion? (1)
- A. The object moves at constant speed
 - B. ✓ **The object's velocity changes by the same amount in each time interval**
 - C. The object's acceleration is zero
 - D. The object moves in a straight line with zero velocity

Answer: B

Uniform acceleration means the acceleration has a fixed value, and $a = \frac{\Delta v}{\Delta t}$. So in every equal slice of time the velocity changes by the same amount, for example gaining 2 m/s each second. Option A describes constant speed, which is the case where the velocity does not change at all, so the acceleration would be zero.

30. The coordinate of a particle in meters is given by $x(t) = 18t - 3t^2$, where the time t is in seconds. At what value t will the particle become momentarily at rest? (1)
- A. 6 sec
 - B. 4 sec
 - C. ✓ **3 sec**
 - D. 0 sec

Answer: C

Velocity is the rate of change of position: $v = \frac{dx}{dt} = 18 - 6t$. Momentarily at rest means $v = 0$, so $18 - 6t = 0$ and $t = 3$ s. Option A, 6 s, comes from setting the position $x = 0$ instead: that is the moment the particle returns to its starting point, and it is moving fast when it does.

31. A stone dropped from rest at a height h takes time t to reach the ground. If it were dropped from height $9h$, the time to reach the ground is: (1)
- A. $2t$
 - B. $4t$
 - C. t
 - D. ✓ **$3t$**

Answer: D

For a body dropped from rest, $h = \frac{1}{2}gt^2$, so the time is proportional to $\sqrt{h}$. Nine times the height gives $\sqrt{9} = 3$ times the time, so the answer is $3t$. Option C is tempting because all bodies fall at the same rate whatever their mass, but that rule is about mass, not height: a longer fall still takes longer.

32. A string can withstand a tension of 16 N. What is the greatest speed at which a body of mass 2 kg can be whirled in a horizontal circle using a string of length 2.0m? (1)
- A. ✓ **4m/s**
 - B. 5m/s
 - C. 16m/s
 - D. 25m/s

Answer: A

In a horizontal circle the string tension supplies the centripetal force, so $T = \frac{mv^2}{r}$. The greatest safe speed is at the greatest tension the string can hold: $16 = \frac{2v^2}{2}$, so $v^2 = 16$ and $v = 4$ m/s. Option C, 16 m/s, copies the tension straight into the answer, but 16 is a force in newtons, not a speed.

33. From the following fundamental forces which one is the weakest in strength? (1)
- A. The strong nuclear force
 - B. ✓ **The gravitational force**
 - C. The weak nuclear force
 - D. The electromagnetic forces

Answer: B

Compared side by side for two protons, the strong nuclear force is about 10^{38} times stronger than gravity, and even the weak nuclear force beats gravity by an enormous margin. Gravity only rules the sky because it never cancels: it always attracts, and stars and planets carry huge masses. Option C fools many students because of its name, but weak in weak nuclear force is only weak next to the strong force, not next to gravity.

- 34.** A 5 kg block is pulled across a rough surface by a 50 N force at an angle $\phi = 37^\circ$ above the horizontal as shown in figure below. The coefficient of kinetic friction is $\mu_k = 0.4$. Determine the acceleration of the block.
- A. ✓ **6.4m/s²** B. 10m/s²
C. 8m/s² D. 1.6m/s²

Answer: A

Split the 50 N pull into components: $F_x = 50 \cos 37^\circ = 40 \text{ N}$ and $F_y = 50 \sin 37^\circ = 30 \text{ N}$. The upward part lightens the block, so the normal force is $N = mg - F_y = 50 - 30 = 20 \text{ N}$, and friction is $f = \mu_k N = 0.4 \times 20 = 8 \text{ N}$. Then $a = \frac{F_x - f}{m} = \frac{40 - 8}{5} = 6.4 \text{ m/s}^2$. Option C, 8 m/s^2 , is $\frac{40}{5}$, which leaves friction out of the calculation.

35. A pendulum is released from a height of 5 m above its lowest point. At what point in the swing will the pendulum have its maximum kinetic energy?
- A. At the highest point on either side B. Halfway down
- C. ✓ **At the lowest point** D. At three-quarters of the way down

Answer: C

As the pendulum swings down, its height falls and its potential energy mgh turns into kinetic energy. Since the total mechanical energy stays the same, the kinetic energy is largest where the height is smallest, which is the lowest point of the swing. Option B is only halfway there: at the middle of the drop about half the potential energy has converted, so the bob is still gaining speed.

36. A particle moves in a complete circle, starting at Point X and ending at Point X. If the net work done on the particle by a specific force field during this round trip is non-zero, this force is:
- A. Conservative force
B. ✓ A non-conservative force
C. A restorative force
D. An electrostatic force

Answer: B

A conservative force, such as gravity or the spring force, does zero net work over any closed path, because whatever energy it takes on the way out it gives back on the way in. So a force that does non-zero work on a round trip fails that test and must be non-conservative, like friction, which drains energy on every part of the loop. Option A states the exact opposite of what the closed-path result shows.

- 37.** A 10.0g bullet is fired into a stationary block of wood ($m = 5.00\text{kg}$). The bullet sticks into the block, and the speed of the bullet-plus combination immediately after collision is 0.60m/s . What was the original speed of the bullet?
- A. 0.9m/s B. 0.012m/s
- C. ✓ **300.6m/s** D. 30 m/s

Answer: C

The bullet embeds in the block, so momentum is conserved through the collision while kinetic energy is not. Before: $p = m_b u = 0.010u$. After: $p = (0.010 + 5.00)(0.60) = 3.006 \text{ kg m/s}$. So $u = \frac{3.006}{0.010} = 300.6 \text{ m/s}$. Option D, 30 m/s, appears when the bullet's mass is taken as 0.1 kg instead of 0.010 kg, a factor of ten slip in the gram to kilogram conversion.

38. When a beam of light falls on an object from the source of light then light get reflected in all direction after striking the objects. The reflected light reach our eyes and our brain interprets finally we are able to see object around us. Which physics branch concern this action? (1)

A. Mechanics
B. Astrophysics
C. Acoustic
D. ✓ Optics

Answer: D

Optics is the branch of physics that deals with light: how it travels, reflects, refracts and forms images. The passage describes light bouncing off an object and entering the eye, which is reflection, so it belongs to optics. Option C, acoustics, deals with the same ideas of reflection and travel, but for sound waves rather than light.

39. Civil engineering relies heavily on principles of mechanics to design structures like bridges and buildings. Understanding which concept is crucial for ensuring the stability of a bridge? (1)

A. Electromagnetism
B. Fluid dynamics
C. ✓ Statics and dynamics equilibrium
D. Thermodynamics

Answer: C

A bridge must not move, so every force and every turning effect on it has to balance: $\sum F = 0$ and $\sum \tau = 0$. That is static equilibrium, and the dynamic side covers the extra loads from traffic and wind while the structure still holds. Option B matters for the water pushing on the piers, but fluid dynamics alone will not tell an engineer whether the deck stands up.

40. What principle does ultrasound imaging rely on to generate image? (1)

A. Refraction of sound wave
B. ✓ Reflection of sound wave
C. Absorption of sound wave
D. Diffraction of sound wave

Answer: B

An ultrasound probe sends high frequency sound pulses into the body and listens for the echoes. Each boundary between two tissues sends part of the pulse back, and the machine uses the delay of those reflections to place the structure on the screen. Option A is tempting because the pulse does bend as it passes through tissue, but refraction is a source of error in the image, not the principle that makes the image.

41. An Ethiopian defense force sends a signal to a target. The signal takes 0.01 seconds to return. What is the distance between the radar and the target in meter? (1)

A. 3×10^6
B. 3×10^{10}
C. ✓ 1.5×10^6
D. 1.5×10^{10}

Answer: C

The signal travels to the target and back, so the path it covers is twice the distance being measured. Radar signals move at the speed of light, so $d = \frac{ct}{2} = \frac{3 \times 10^8 \times 0.01}{2} = 1.5 \times 10^6$ m. Option A, 3×10^6 m, is the full there-and-back path, so it forgets to halve.

42. Which of the following pair angles have equal range? (1)

A. 15° and 60°
B. 30° and 80°
C. 20° and 60°
D. ✓ 25° and 65°

Answer: D

For a projectile launched over level ground the range is $R = \frac{v^2 \sin 2\theta}{g}$. Two angles give the same range when they add up to 90° , because $\sin 2\theta$ then takes the same value. Here $25^\circ + 65^\circ = 90^\circ$, so that pair matches. Option A fails the test: $15^\circ + 60^\circ = 75^\circ$, so those two shots land at different distances.

43. A 0.2kg red ball is thrown horizontally at a speed of 4m/s from the height of 3m. A 0.4kg green ball is thrown horizontally from the same height at the same time with a speed of 8m/s. Which ball hits the ground first? (1)
(neglecting air resistance)

A. The red ball hits the ground first
B. The green ball hits the ground first
C. ✓ Both strikes the ground at the same time
D. Their time depends on their density

Answer: C

In projectile motion the horizontal and vertical parts are independent. Both balls start with zero vertical velocity from the same height of 3 m, so both obey $h = \frac{1}{2}gt^2$ and both take $t = \sqrt{\frac{2 \times 3}{10}} \approx 0.77$ s. Option B is tempting because the green ball is faster and heavier, but its extra horizontal speed carries it further out, not down any sooner, and mass does not change free fall.

44. The launching speed of a certain projectile is two times the speed it has at its maximum height. What is the elevation angle at launching? (1)

A. 30°
B. 45°
C. ✓ 60°
D. 90°

Answer: C

At maximum height the vertical velocity is zero, so the speed left is the horizontal part, $v \cos \theta$, which stays the same all through the flight. The launch speed is twice that, so $v = 2v \cos \theta$, giving $\cos \theta = \frac{1}{2}$ and $\theta = 60^\circ$. Option A comes from using $\sin \theta = \frac{1}{2}$, which would be the vertical component, and that component is zero at the top rather than half the launch speed.

45. When a wheel of radius R rotates about a fixed axis, all points on the wheel have (1)

A. The same linear speed
B. ✓ The same angular speed
C. The same linear acceleration
D. Different angular acceleration

Answer: B

A rigid wheel turns as one piece, so every point sweeps the same angle in the same time, which means the angular speed ω is shared by all of them. Linear speed is $v = \omega r$, so a point on the rim moves faster than a point near the axis. Option A is the everyday mistake: the rim and the hub go round together, but they do not travel the same distance in a second.

46. A motor capable of producing a constant torque 100 Nm and a maximum rotation speed of 200 rad/s is connected to a flywheel with rotational inertia 0.2 kgm². How long will the flywheel take to reach the maximum speed if it starts from rest? (1)

A. ✓ 0.4 sec
B. 2 sec
C. 5 sec
D. 500 sec

Answer: A

First find the angular acceleration from the torque: $\alpha = \frac{\tau}{I} = \frac{100}{0.2} = 500 \text{ rad/s}^2$. Starting from rest, $\omega = \alpha t$, so $t = \frac{200}{500} = 0.4$ s. Option B, 2 s, comes from dividing 200 by the torque of 100 directly, which skips the rotational inertia and treats a torque as if it were an angular acceleration.

47. If the semi-major axis of a planet orbit is 9 times the semi-major axis of Earth orbit, what is the approximate orbital period in Earth years? Orbital period of Earth is 1 year. (1)

A. ✓ 27 years
B. 54 years
C. 81 years
D. 9 years

Answer: A

Kepler's third law says $T^2 = a^3$ when the period is in Earth years and the semi-major axis is in astronomical units. With $a = 9$, $T^2 = 729$, so $T = 27$ years. Option D, 9 years, treats the period as growing in step with the distance, but the square and the cube in the law make the period grow faster than that.

48. A satellite is orbiting above the surface of the earth at three times the radius of the earth. What will be the value of the gravitational acceleration 'g' for mass of Earth M and radius of Earth is R? (1)
- A. $3GM/R^2$ B. $GM/3R^2$
C. $16GM/R^2$ D. ✓ $GM/16R^2$

Answer: D

Gravitational acceleration is $g = \frac{GM}{r^2}$, where r is measured from the CENTRE of the Earth, not from its surface. The satellite is three radii above the surface, so $r = R + 3R = 4R$, giving $g = \frac{GM}{(4R)^2} = \frac{GM}{16R^2}$. Option B makes two slips at once: it uses the altitude $3R$ as the full distance and then forgets to square it.

49. What happens to the gravitational force between two objects if the distance between them is halved? (1)
- A. It doubles B. It remains the same
C. ✓ **It increases by four times** D. It decreased by four times

Answer: C

Newton's law of gravitation is $F = \frac{Gm_1m_2}{r^2}$, so the force depends on the inverse square of the separation. Halving r makes r^2 one quarter as large, and dividing by a quarter multiplies the force by four. Option A treats the relation as a straight proportion, but the square in the denominator is what makes the change four-fold rather than two-fold.

50. Why gases easily compress while solids are incompressible? Because (1)
- A. Atoms in solids are further apart from each other
B. ✓ **Atoms in gases are separated by a large distance**
C. The force between gas atoms are very strong
D. The force between solid atoms are very weak

Answer: B

In a gas the molecules are far apart with large empty gaps between them, and the forces holding them together are very weak, so squeezing the gas mostly closes those gaps. In a solid the particles are already packed almost touching, so there is little empty space to remove. Option A states the picture backwards: it is the gas particles, not the solid ones, that are far apart.

51. A substance with specific gravity less than one will be (1)
- A. ✓ **Float in water** B. Sink in water
C. Dissolve in water D. Break water surface

Answer: A

Specific gravity compares a substance's density with the density of water. Less than one means the substance is less dense than water, so the upthrust from the displaced water can support its weight and it floats with part of it above the surface. Option B is what happens in the opposite case, when the specific gravity is greater than one.

52. Pressure in liquid depends on (1)
- A. Shape of the container B. Area of the container
C. ✓ **Density of liquid and depth** D. Volume of the container

Answer: C

Pressure in a liquid at rest is $P = \rho gh$, so only the density of the liquid and the depth below the surface matter, along with g , which is fixed. Go deeper and the pressure rises, because more liquid is stacked above that point. Option A is tempting because a wide tank holds more water, but a narrow tube of the same depth gives exactly the same pressure at the bottom.

53. At a given depth in a static fluid, the pressure acts: (1)
- A. Only downward
B. Only upward
C. ✓ **Equally in all directions**
D. Only against the walls of the container

Answer: C

Pressure in a static fluid is a scalar quantity, and at any point it pushes with the same size in every direction. That is why a small surface placed at a given depth feels the same push whichever way it faces, and it is why the sides of a tank bulge as well as the base. Option A follows from thinking only about the weight of the water above, but the fluid also presses sideways and upward.

54. Pascal's principle states that pressure applied to an enclosed fluid is transmitted undiminished to every portion of the fluid. This principle is the basis for: (1)
- A. Airplanes
B. ✓ **Hydraulic lifts**
C. Steam engines
D. Thermometers

Answer: B

Pascal's principle means a small push on a small piston raises the pressure everywhere in the trapped oil by the same amount. A large piston at the other end feels that same pressure over a much bigger area, so $F = PA$ turns a small force into a large one, which is how a hydraulic lift raises a car. Option A depends on Bernoulli's principle and the shape of the wing, not on pressure transmitted through an enclosed fluid.

55. A small piston of a hydraulic lift has an area of 0.002m^2 . A car weighing 20000N sits on a rack mounted on the large piston. The large piston has an area of 0.8m^2 . How large force must be applied to the small piston to support the car? (1)
- A. 5N
B. ✓ **50N**
C. $1.6 \times 10^4\text{N}$
D. $8 \times 10^6\text{N}$

Answer: B

The pressure in the enclosed fluid is the same at both pistons, so $\frac{F_1}{A_1} = \frac{F_2}{A_2}$. Rearranging gives $F_1 = F_2 \times \frac{A_1}{A_2} = 20000 \times \frac{0.002}{0.8} = 50\text{N}$. Option C multiplies by the large area instead of dividing by it, which would make the lift harder to use than lifting the car by hand.

END OF THE MARKING KEY

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