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TEN-YEAR SERIES · ANSWERS AND WORKED SOLUTIONS

2025 A-Level H1 Physics Paper 1

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ANSWER KEY

1 **D**	2 **C**	3 **A**	4 **B**	5 **B**	6 **A**	7 **B**	8 **B**	9 **A**	10 **D**
11 **C**	12 **C**	13 **C**	14 **C**	15 **B**	16 **C**	17 **A**	18 **A**	19 **A**	20 **C**
21 **A**	22 **B**	23 **B**	24 **C**	25 **D**	26 **D**	27 **A**	28 **B**	29 **D**	30 **B**

WORKED SOLUTIONS

Q1 Answer D

$$V = (6)(12)(0.5) = 36\ \text{cm}^3 = 3.6 \times 10^{-5}\ \text{m}^3 \approx 4 \times 10^{-5}\ \text{m}^3$$

Convert to each unit (the prefix is cubed along with the metre):

- $1\ \text{pm}^3 = (10^{-12})^3 = 10^{-36}\ \text{m}^3$, so $V = 4 \times 10^{31}\ \text{pm}^3$
- $1\ \text{dm}^3 = (10^{-1})^3 = 10^{-3}\ \text{m}^3$, so $V = 4 \times 10^{-2}\ \text{dm}^3$
- $1\ \mu\text{m}^3 = (10^{-6})^3 = 10^{-18}\ \text{m}^3$, so $V = 4 \times 10^{13}\ \mu\text{m}^3$
- $1\ \text{Mm}^3 = (10^{6})^3 = 10^{18}\ \text{m}^3$, so $V = 4 \times 10^{-23}\ \text{Mm}^3$ ■

Q2 Answer C

$$\rho = \frac{m}{V} = \frac{4m}{\pi d^2 L}$$

The percentage uncertainties add, with the diameter counted twice because it is squared:

$$\frac{\Delta\rho}{\rho} = 2\% + 2(2\%) + 2\% = 8\%$$

Q3 Answer A

From $F = BIL$, $B = F/(IL)$, so the tesla is $\text{N A}^{-1}\ \text{m}^{-1}$.

Check each option:

- A: $\text{J A}^{-1}\ \text{m}^{-2} = (\text{N m})\text{A}^{-1}\ \text{m}^{-2} = \text{N A}^{-1}\ \text{m}^{-1}$ ■
- B: $\text{N A}^{-1}\ \text{m}^{-2}$ has an extra m^{-1}.
- C: $\text{N C}^{-1}\ \text{m}^{-1} = \text{N A}^{-1}\ \text{s}^{-1}\ \text{m}^{-1}$ has an extra s^{-1}.
- D: $\text{T A}^{-1}\ \text{m}^{-1}$ is not the tesla.

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Q4 Answer **B**

The force on a bent wire in a uniform field is the same as the force on a straight wire joining its two ends, carrying the same current.

The two arms of length L meet at $60°$, so the triangle formed with the line joining the ends is equilateral, and the ends are a distance L apart. The current flows overall from the left end to the right end.

$$F = BIL$$

Direction: current to the right, field into the page. By Fleming's left-hand rule, the force is towards the top of the page.

Q5 Answer **B**

Temperature has magnitude only, so it is a scalar.

- A: speed has magnitude only, so it is a scalar.
- C: time is a scalar, but because it has no direction.
- D: weight is a vector because it has both magnitude and direction.

Q6 Answer **A**

Take upwards as positive.

- At the start the only force is the weight, so $a = -g$. As the speed increases, air resistance increases and the magnitude of the acceleration decreases, approaching zero gradually as the skydiver approaches terminal velocity.
- When the parachute opens, the air resistance suddenly becomes much larger than the weight. The resultant force and the acceleration are upwards (positive) and large. As the skydiver slows, the air resistance decreases and the acceleration again falls gradually to zero.

So the acceleration changes sign when the parachute opens, and each section approaches zero gradually. A shows this.

B has both sections with the same sign. C and D show the acceleration reaching zero abruptly at a definite time, but terminal velocity is approached gradually.

Q7 Answer **B**

The displacement is the area under the velocity–time graph, with areas below the axis counted as negative.

$$\text{0–10 s: } \frac{1}{2}(10)(10) = 50 \text{ m}, \qquad \text{10–20 s: } (10)(10) = 100 \text{ m}, \qquad \text{20–25 s: } \frac{1}{2}(5)(10) = 25 \text{ m}$$

$$\text{25–30 s: } -\frac{1}{2}(5)(10) = -25 \text{ m}, \qquad \text{30–40 s: } -(10)(10) = -100 \text{ m}$$

$$s = 50 + 100 + 25 - 25 - 100 = 50 \text{ m}$$

Q8 Answer **B**

The spheres have the same weight. Air resistance increases with speed and with size. The larger sphere has more air resistance at any given speed, so its air resistance equals its weight at a lower speed: its terminal velocity is lower.

The smaller sphere accelerates for longer and reaches a higher terminal velocity, so it hits the ground first.

Q9 Answer **A**

At a distance R above the surface, the spacecraft is $2R$ from the centre of the Earth, so the gravitational field strength is

$$g\prime = g\left(\frac{R}{2R}\right)^2 = \frac{g}{4}$$

The mass is also halved:

$$W\prime = \left(\frac{m}{2}\right)\left(\frac{g}{4}\right) = \frac{mg}{8} = \frac{W}{8}$$

Q10 Answer **D**

By conservation of momentum:

$$(1500)(4.0) + (1000)(2.0) = (1500 + 1000)v$$

$$v = \frac{8000}{2500} = 3.2 \text{ m s}^{-1}$$

Q11 Answer **C**

XY is perpendicular to the side of the table. The component of the velocity along XY is $v\sin 30^\circ$, towards the side before the collision and away from it afterwards.

$$v\sin 30^\circ = (0.080)(0.5) = 0.040 \text{ m s}^{-1}$$

$$\Delta p = m\left(0.040 - (-0.040)\right) = (0.40)(0.080) = 0.032 \text{ kg m s}^{-1}$$

$$F = \frac{\Delta p}{\Delta t} = \frac{0.032}{0.20} = 0.16 \text{ N}$$

(The components parallel to the side are unchanged, so there is no force along the side.)

Q12 Answer **C**

Let W be the weight and d the distance of the centre of gravity from X.

Lifting X (the plank pivots about Y):

$$12(6.0) = W(6.0 - d)$$

Lifting Y (the plank pivots about X):

$$15(6.0) = Wd$$

Adding the two equations: $W(6.0) = 162$, so $W = 27$ N.

$$d = \frac{90}{27} = 3.3 \text{ m}$$

Q13 Answer **C**

When the force is removed, the wire returns along QR. The energy it gives back during unloading is the area under QR, between QR and the extension axis: area Z. This is the elastic potential energy stored at Q.

Area Y, between the loading and unloading lines, is the work done in permanently deforming the wire, which is not recovered.

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Q14 Answer **C**

- PQ and RS are parallel to the field, so there is no force on them.
- QR and SP (30 cm) are perpendicular to the field. The currents in them are in opposite directions, so they experience equal and opposite vertical forces, forming a couple.

$$F = BIL = (4.0 \times 10^{-2})(2.0)(0.30) = 0.024 \text{ N}$$

The pivots are at the midpoints of PQ and RS, so each force acts 0.25 m from the axis, and the two forces are 0.50 m apart:

$$\tau = Fd = (0.024)(0.50) = 1.2 \times 10^{-2} \text{ N m}$$

Q15 Answer **B**

- At first the total momentum is zero.
- From 0 to t, one mass is still held. The holding force is an external force on the system, so the total momentum changes: it increases as the spring pushes the released mass.
- After t, both masses are free and no external horizontal force acts (the surface is frictionless). The total momentum stays constant, even though the masses move towards and away from each other.

Q16 Answer **C**

Take right as positive. For an elastic collision, the relative speed of separation equals the relative speed of approach, $6.0 - 1.0 = 5.0$ m s^{-1}.

- A: $6.0 - 1.0 = 5.0$ ✓, but momentum gives $6m + M = m + 6M$, so $m = M$. ✗
- B: separation speed 0. ✗
- C: $2.0 - (-3.0) = 5.0$ ✓. Momentum: $6m + M = -3m + 2M$, so $M = 9m$. Since $m < M$, this is possible.
- D: $3.0 - (-4.0) = 7.0$. ✗

Q17 Answer **A**

Hooke's law holds where the extension is proportional to the force, which is the straight-line section through the origin. The line stops being straight at A, so beyond A the wire no longer obeys Hooke's law.

Q18 Answer **A**

At first the upward electric force balances the weight, so $qE = mg$.

When the p.d. is reversed, the field reverses, so the electric force on the drop is now downwards with the same magnitude. The resultant force is $mg + qE = 2mg$, downwards and constant.

The drop is in a vacuum, so there is no air resistance. It accelerates downwards with a constant acceleration of $2g$.

Q19 Answer **A**

The gain in gravitational potential energy is mgh, the weight multiplied by the vertical distance moved. A is correct.

- B: kinetic energy is $\frac{1}{2}mv^2$, and its change is $\frac{1}{2}m(v^2 - u^2)$, not $\frac{1}{2}m(\Delta v)$.
- C: the work done by the force goes into both kinetic and potential energy, so the kinetic energy gained is not equal to the potential energy gained.
- D: the work done by the force is the force multiplied by the distance moved along the slope (the direction of the force), not the vertical distance.

Q20 Answer **C**

Newton's law of gravitation:

$$P = \frac{GmM}{R^2}$$

Rearranging: $Gm = \frac{R^2 P}{M}$.

Q21 Answer **A**

A geostationary satellite completes one orbit in the same time as the Earth rotates once, so it has the same angular velocity as a point on the Equator.

- B: its orbital radius is much larger than the Earth's radius, so with the same angular velocity ($v = r\omega$) its speed is much larger.
- C: the resultant force (gravity) is towards the centre of the Earth, perpendicular to its motion.
- D: the satellite has weight. Its weight provides the centripetal force.

Q22 Answer **B**

As R increases, the total resistance increases, so the current decreases.

The terminal p.d. is $E - Ir$. A smaller current means smaller lost volts, so the terminal p.d. increases.

Q23 Answer **B**

R_2 and R_3 are connected in parallel with each other, between the two junctions. The cell and R_1 form the third branch, which drives the current $I_1 = I_2 + I_3$.

Going round the loop containing the cell, R_1 and R_2, the e.m.f. equals the sum of the p.d.s:

$$E = I_1 R_1 + I_2 R_2 \quad \Rightarrow \quad E - I_2 R_2 = I_1 R_1$$

(The same is true with R_3: $E = I_1 R_1 + I_3 R_3$.) D is wrong because R_2 and R_3 are in parallel, not in series.

Q24 Answer **C**

The 4.0 A divides between the lower branch (10 Ω) and the upper branch ($R + 10$ Ω). The branches have the same p.d., so the current in the lower branch is

$$I = 4.0 \times \frac{R + 10}{R + 20}$$

- $R = 0$: $I = 4.0 \times \frac{10}{20} = 2.0$ A, not 4.0 A
- $R = 10$: $I = 4.0 \times \frac{20}{30} = 2.7$ A, not 3.5 A
- $R = 20$: $I = 4.0 \times \frac{30}{40} = 3.0$ A ✓
- $R = 30$: $I = 4.0 \times \frac{40}{50} = 3.2$ A, not 2.5 A

Q25 Answer **D**

- A particle moving parallel to the field experiences no magnetic force, so its motion does not change at all. A and C are wrong.
- A particle moving perpendicular to the field experiences a force perpendicular to its velocity. The force does no work, so the speed stays the same and only the direction changes.

Q26 Answer **D**

Isotopes of the same element have the same number of protons (but different numbers of neutrons). The number of nucleons is different for different isotopes, so C is wrong.

Q27 Answer **A**

Most of the α-particles passed straight through the gold foil undeflected, and only a small proportion were deflected. This showed that most of the atom is empty space.

D (deflection through more than 90°) is the evidence for a small, dense, positively charged nucleus, not for empty space.

Q28 Answer **B**

$$E_{\text{B}} = \Delta mc^2 = (0.008286)(1.66 \times 10^{-27})(3.00 \times 10^{8})^2 = 1.24 \times 10^{-12} \text{ J}$$

The nuclide ^{3}He has 3 nucleons:

$$\frac{E_{\text{B}}}{A} = \frac{1.24 \times 10^{-12}}{3} = 4.13 \times 10^{-13} \text{ J}$$

Q29 Answer **D**

The binding energy is the energy released when a nucleus is assembled from its separate nucleons. For iron-56:

$$E_{\text{B}} = (8.8)(56) = 493 \text{ MeV}$$

This energy is released when the nucleus is formed.

Q30 Answer **B**

- No radiation passed through the person, so γ-rays (which are very penetrating) were not involved.
- α-particles are absorbed in the outer dead layer of the skin, so they cannot damage the tissue below the surface.
- β-particles penetrate a few millimetres into the body. They can redden the skin and damage the cells just below the surface, but they do not pass right through the body.

The damage was caused by β-particles only.

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