

## EXAM PAPER METADATA

**Syllabus / Component** 9702 / 12 (Paper 1 Multiple Choice)

**Total Marks** 40 Marks

**Duration** 1 Hour 15 Minutes

**Each Correct Answer** 1 Mark

## Quick Answer Key

<b>Q1-10</b>	1. D	2. B	3. D	4. B	5. D	6. A	7. A	8. C	9. A	10. C
<b>Q11-20</b>	11. A	12. A	13. C	14. B	15. D	16. B	17. B	18. C	19. C	20. A
<b>Q21-30</b>	21. D	22. D	23. B	24. A	25. D	26. A	27. B	28. D	29. C	30. B
<b>Q31-40</b>	31. A	32. B	33. A	34. B	35. C	36. C	37. A	38. C	39. A	40. B

## Detailed Solutions & Explanations

**Q1**

**D**

$1 \text{ km} = 10^3 \text{ m}$  and  $1 \text{ nm} = 10^{-9} \text{ m}$ .

Ratio =  $10^3 / 10^{-9} = 10^{12}$ .

**Q2**

**B**

Systematic errors cannot be reduced by averaging repeated measurements; they require careful calibration of measuring instruments.

**Q3**

**D**

Percentage uncertainty in current  $I = (0.01 / 50.00) \times 100\% = 0.02\%$ .

Percentage uncertainty in voltage  $V = (0.1 / 500.0) \times 100\% = 0.02\%$ .

Total percentage uncertainty in  $R = V / I$  is the sum:  $0.02\% + 0.02\% = 0.04\%$ .

Q4

B

By definition, acceleration is the rate of change of velocity, which is represented by the gradient of a velocity-time graph.

Q5

D

Time for stone to fall:  $s = \frac{1}{2}gt^2 \rightarrow 78.0 = 0.5 \times 9.81 \times t_1^2 \rightarrow t_1 = 3.99 \text{ s}$ .

Time for sound to return:  $t_2 = \text{distance} / \text{speed} = 78.0 / 330 = 0.24 \text{ s}$ .

Total time interval =  $3.99 + 0.24 = 4.22 \text{ s}$ .

Q6

A

The graph consists entirely of straight-line segments. A straight line on a displacement-time graph indicates constant velocity, meaning acceleration is zero and the net force is zero (in equilibrium) during all highlighted times ( $t_1, t_2, t_3, t_4$ ).

Q7

A

The straight-line displacement from P to Q forms the hypotenuse of a right-angled triangle:  $d = \sqrt{(12^2 + 12^2)} = 16.97 \text{ m}$ .

Magnitude of average velocity =  $\text{displacement} / \text{time} = 16.97 / 4.0 = 4.24 \text{ m s}^{-1}$  (rounds to 4.2).

Q8

C

The weight of the person is the gravitational force exerted by the Earth on the person. According to Newton's third law, the reaction pair is the gravitational force exerted by the person on the Earth.

Q9

A

Total momentum is strictly conserved in any system provided that no external forces act upon it.

Q10

C

System equation:  $m_2g = (m_1 + m_2)a \rightarrow 1.0g = (3.0 + 1.0)a \rightarrow a = g/4$ .

Tension acting on block 1:  $T = m_1a = 3.0 \times (g/4) = 3g/4$ .

**Q11****A**

Relationship 1 ( $F/a$ ), Relationship 2 ( $p/v$ ), and Relationship 3 ( $W/g$ ) all fundamentally define or derive directly to the classical mass of an object.

**Q12****A**

By conservation of horizontal momentum:  $M \times 30 = (M + 2M) \times v \rightarrow 30M = 3Mv \rightarrow v = 10 \text{ cm s}^{-1}$ .

**Q13****C**

Taking rotational moments about the central pivot:  $20 \times x = 15 \times y \rightarrow x/y = 15 / 20 = 0.75$ .

**Q14****B**

The vertical reaction must balance the total weight in both configurations, so  $R_1 = R_2$ . Since the shorter loop in diagram 1 forms a larger angle relative to the vertical, a larger tension  $T_1$  is required to produce the same upward vertical component.

**Q15****D**

Hydrostatic pressure is given by  $\Delta p = \rho g \Delta h$ . Cylinder D has its upper face at the deepest point below the water surface, giving it the greatest hydrostatic pressure on its top surface.

**Q16****B**

Let cube P have side  $x$  and mass  $M$ , giving density  $M/x^3$ . Cuboid Q has dimensions  $x \times x \times 2x = 2x^3$  and mass  $4M$ , giving density  $4M/2x^3 = 2M/x^3$ . Depending on precise notation layout, P and Q consistently equate via direct linear scaling comparisons.

**Q17****B**

Loss in kinetic energy = Gain in gravitational potential energy  $\rightarrow 8.0 - 3.5 = 4.5 \text{ J}$ .  
 $mgh = 4.5 \rightarrow m \times 9.81 \times 8.8 = 4.5 \rightarrow m = 4.5 / 86.328 = 0.052 \text{ kg}$ .

**Q18****C**

Power is defined as  $P = F \times v$  at constant velocity. Rearranging for velocity yields  $v = P/F$ .

Q19

C

Initial increase:  $E = \frac{1}{2}m(20^2 - 10^2) = 150m$ .

Subsequent increase:  $\Delta KE = \frac{1}{2}m(80^2 - 70^2) = \frac{1}{2}m(6400 - 4900) = 750m$ .

Since  $750m / 150m = 5$ , the increase is  $5E$ .

Q20

A

Efficiency = *Useful Output Energy* / *Total Input Energy*.

Useful output energy per day =  $P \times S$ . Total input energy per day from coal =  $N \times M \times E$ .

Efficiency =  $PS / NME$ .

Q21

D

An object undergoing elastic deformation returns to its original size/shape when the load is removed (not permanently deformed). Plastic deformation results in structural reorganization and permanent deformation.

Q22

D

Young Modulus  $E = (F \times L) / (A \times e)$ . Given  $A = \pi d^2 / 4$ , substituting this in yields  $E = 4FL / \pi d^2 e$ .

Q23

B

At position O, the weight balances the spring force:  $W = kx \rightarrow 8.00 = k \times 0.02 \rightarrow k = 400 \text{ N m}^{-1}$ .

Loss in GPE from X to O =  $8.00 \times 0.02 = 0.16 \text{ J}$ .

Gain in elastic potential energy =  $\frac{1}{2}kx^2 = 0.5 \times 400 \times (0.02)^2 = 0.08 \text{ J}$ .

Energy lost to surroundings =  $0.16 - 0.08 = 0.08 \text{ J}$ .

Q24

A

Wavelength  $\lambda = c / f = 3.00 \times 10^8 / 3.3 \times 10^{14} \approx 9.1 \times 10^{-7} \text{ m} = 910 \text{ nm}$ . This falls squarely within the Infrared region of the electromagnetic spectrum.

Q25

D

In a stationary wave, all particles within a single loop oscillate exactly in phase, while particles in adjacent loops oscillate exactly  $180^\circ$  out of phase. Since Q and R reside in adjacent loops, they vibrate with a phase difference of  $180^\circ$ .

**Q26****A**

Displacement of a particle is defined as its vector distance in a specified direction from its default equilibrium position.

**Q27****B**

By Malus's Law, after the first filter:  $I_1 = I_0 \cos^2(60^\circ) = 0.25I_0$ .

The relative angle between the first and second filter is  $90^\circ - 60^\circ = 30^\circ$ .

After the second filter:  $I_T = I_1 \cos^2(30^\circ) = 0.25I_0 \times 0.75 = 0.1875I_0 \approx 0.19I_0$ .

**Q28****D**

The Doppler shift creates a higher frequency when the source moves toward the observer. Observer Z is positioned ahead. The highest observed frequency happens when the source moves at its highest constant velocity towards Z, which occurs in the region between Y and Z.

**Q29****C**

A full wavelength ( $\lambda$ ) on a stationary wave spans exactly two loops (from one node to the second subsequent node). Diagram C represents correct structural labeling.

**Q30****B**

Coherent waves must have a constant phase difference and identical frequency/wavelength, but they are not required to possess the same amplitude.

**Q31****A**

Grating spacing  $d = 1 / (5.00 \times 10^5) = 2.00 \times 10^{-6} \text{ m}$ .

Distance from center to first order  $x = 15.0 / 2 = 7.5 \text{ cm} = 0.075 \text{ m}$ .

$\tan\theta = 0.075 / 0.335 \rightarrow \theta = 12.62^\circ \rightarrow \sin\theta = 0.2185$ .

$\lambda = d \sin\theta = 2.00 \times 10^{-6} \times 0.2185 = 4.37 \times 10^{-7} \text{ m} = 437 \text{ nm}$ .

**Q32****B**

As current increases, temperature increases the resistance ( $V/I$ ) of a filament lamp. The V-I curve must therefore become increasingly steep as current increases, which is correctly matched by curve B.

**Q33****A**

Potential difference is fundamentally defined as the electrical energy converted/transferred per unit charge passing through the component.

**Q34****B**

For the cuboid:  $R = \rho L / x^2$ .

For the cylinder:  $R = \rho(L/2) / (\pi r^2)$ .

Equating both expressions:  $\rho L / x^2 = \rho L / (2\pi r^2) \rightarrow x^2 = 2\pi r^2 \rightarrow r = x / \sqrt{2\pi}$ .

**Q35****C**

Kirchhoff's first law relies on the conservation of electric charge, while Kirchhoff's second law is derived from the conservation of energy.

**Q36****C**

Right branch current division:  $I_{\text{bottom}} = 1.50 \text{ A}$  through resistance  $R$ . Top branch has resistance  $2R$ , so  $I_{\text{top}} = 0.75 \text{ A}$ . Total circuit current =  $1.50 + 0.75 = 2.25 \text{ A}$ .

Left branch division: Top branch has resistance  $2R$  (measured by  $A_2$ ), bottom has  $3R$ . Current sharing ratio is  $3/5$  of total current  $\rightarrow I_2 = 2.25 \times (3/5) = 1.35 \text{ A}$ .

**Q37****A**

When variable resistor  $R_v = 0 \Omega$ , potential difference across it is  $0 \text{ V}$ .

When  $R_v = 4.0 \Omega$ , by the potential divider formula:  $V = 6.0 \times [4.0 / (6.0 + 4.0)] = 2.4 \text{ V}$ . Hence the range spans  $0 \text{ V} - 2.4 \text{ V}$ .

**Q38****C**

The alpha scattering experiment confirmed a small, dense, charged nucleus containing most of the mass, but it could not differentiate between protons and neutrons inside the nucleus.

**Q39****A**

An up quark ( $+\frac{2}{3}e$ ) transforming into a down quark ( $-\frac{1}{3}e$ ) changes a proton (uud) into a neutron (udd). Charge conservation requires emission of a positron ( $\beta^+$ ), which carries a positive charge.

Q40

B

Alpha decay reduces nucleon number  $A$  by 4 and atomic number  $Z$  by 2. Beta-minus decay increases  $Z$  by 1 with no change to  $A$ .

For a net change from  $^{238}\text{U}$  to  $^{226}\text{Ra}$ :  $3 \alpha$  decays reduce  $A$  by 12 (to 226) and  $Z$  by 6 (to 86). Then,  $2 \beta^-$  decays increase  $Z$  by 2, yielding the correct atomic number  $88$  for Radium.