NJC Preliminary Examination 2024
H2 Physics Paper 1

Solutions

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

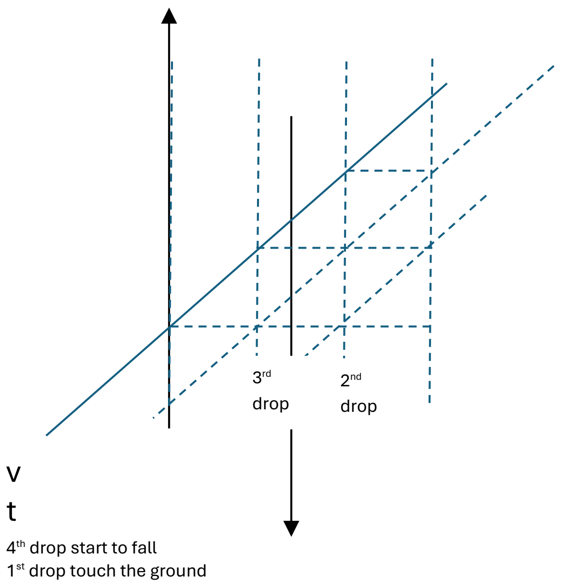
<table>
<tr><td>1</td><td>C</td><td>1 per second, 3600 per hour</td></tr>
<tr><td>2</td><td>C</td><td>by definition</td></tr>
<tr><td>3</td><td>A</td><td>Slope has constant gradient. $v^2 = u^2 + 2as$. So KE is proportional to the displacement with a being negative.</td></tr>
<tr><td>4</td><td>B</td><td>Let time interval between each drop be t.

First drop took 3t to reach the ground and travelled 9 m
$9 = 0\,(4t) + \frac{1}{2}(g)(3t)^2$
$t^2 = \frac{2}{g}$

distance travelled by 2nd drop = $0(2t) + \frac{1}{2} g\,(t)^2$
distance travelled by 3rd drop = $0\,(3t) + \frac{1}{2} g\,(2t)^2$

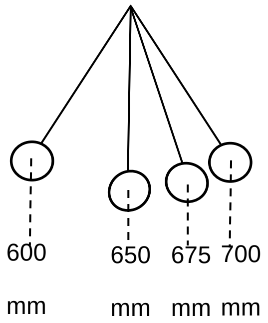
distance between 2nd and 3rd drop = $\frac{1}{2} g\,(2t)^2 - \frac{1}{2} g\,(t)^2 = 3.0$ m

alternative solution:



distance between 1st drop and 4th drop = 9 triangles = 9m
distance between 2nd and 3rd drop = 3 triangles = 3m</td></tr>
<tr><td>5</td><td>A</td><td>F = 70 = (20+6) a
a = 2.692 ms^{-2}
f on B = 6 a = 16.15 N (to right)
N3L, f on A = f on B = 16.15 N = 16 N (2sf) (to left)</td></tr>
<tr><td>6</td><td>A</td><td>Taking moments. A has the greatest moments.</td></tr>
<tr><td>7</td><td>C</td><td>Kinetic energy is conserved only for elastic collision, momentum is conserved for both elastic and inelastic</td></tr>
</table>

8	A	GPE = KE $0.3\ (9.81)\ (2) = 5.886 = ½\ (0.3)\ v^2$ $v = 6.2641$ m s^{-1} $P_i = P_f$ $0.3\ (6.2641) = (0.3 + 0.5)\ V$ $V = 2.3491$ m s^{-1} KE after collision = ½ (0.8) 2.3491^2 = 2.20725 J therefore EPE = 5.886 – 2.20725 = ½ k $(0.20)^2$ k = 184 N m^{-1} (3 s.f.)
9	B	At B, resultant force towards centre of dome $F_{net} = mg \cos 48.2^o$ Centripetal acceleration = F_{net} / m = $g \cos 48.2^o$ = 6.54 m s^{-2}
10	B	Geostationary orbit is always at the same radius, have the same period and mass does not affect the orbit
11	B	Uniform g field has the same g field strength at all points
12	A	Mean speed $= \frac{(2+10+11)u}{3} = 7.67u$ Mean square speed $= \frac{(4+100+121)u^2}{3} = 75u^2$ Root mean square speed $= u\sqrt{75} = 8.66u$
13	B	$pV = nRT = \frac{m}{M}RT$ At constant pressure and volume, mT = constant. $m_2T_2 = m_1T_1$ ® $m_2 = \frac{m_1T_1}{T_2} = \frac{(273+10)}{(273+30)} \times 15 = 14$ kg
14	B	Q = Pt = mcΔ(P = mc(Δ(/t) P and m is constant, Δ(/t is bigger for liquid than solid, therefore specific heat capacity c is smaller for liquid than solid. (A is wrong) Q = mL 2000 x 3 = 1 x L L = 6000 J kg^{-1} (B is correct) The substance melts after an increase in temperature of 3K from room temperature. The melting temperature is not 3K. (C is wrong) Unless the graph becomes horizontal again, we are unable to determine when the substance starts to become gaseous. And only after it stops being horizontal again will it be completely gaseous. (D is wrong)

15	B	 Taking the initial position at 650 mm mark, $x = x_0 \, sin \, sin \, \omega \, t = x_0 \, sin \, sin \, \left[\left(\frac{2\pi}{T}\right)t\right] \; 25 = 50 \, sin \, sin \, \left[\left(\frac{2\pi}{2}\right)t\right] \; t = 0.167 \, s$ $x = x_0 \, sin \, sin \, \omega \, t = x_0 \, sin \, sin \, \left[\left(\frac{2\pi}{T}\right)t\right] \; 10 = 50 \, sin \, sin \, \left[\left(\frac{2\pi}{2}\right)t\right] \; t = 0.064 \, s$ t_{Total} = 0.167 + 0.064 = 0.231 = 0.23 s
16	D	$y = A \, cos \, cos \, \theta$ $y_P = \pm A = A \, cos \, cos \, \theta_P \; \Rightarrow \theta_P = 0°, 180°$ $y_Q = \pm \frac{1}{3} A = A \, cos \, cos \, \theta_Q \; \Rightarrow \theta_Q = 70.5°, 109°$
17	C	Intensity proportional to (amplitude)^2 × (frequency)^2. $\frac{I'}{I} = \left(\frac{1.2}{2.4}\right)^2 \left(\frac{15}{5}\right)^2 = \frac{9}{4}$
18	B	$d \sin\theta = n\lambda$ $4\lambda \sin\theta = 2\lambda$ $\sin\theta_1 = 0.5, \longrightarrow \theta_1 = 30^{\circ}$ $\sin\theta_2 = \frac{3\lambda}{4\lambda} \longrightarrow \theta_2 = 48.59^0$ $48.59^0 - 30^0 = 18.59^0 \approx 18.6^0$

19	C	Option A: Depending on the charge of the object, the force could either be left (positive charge) or right (negative charge). Option B: The magnitude of the field strength can be found using E = – dV/dr. The gradient at P is larger than Q, so the field strength is larger at P Option C: The potential at P is lower than R, and thus Δ*V* is a negative number. The work done is W = q Δ*V* and this is a positive number since *q* is also negative. So, the work done is positive□□ Option D: The potential energy is given by U = qV, and so, since *V* is more negative at P than at R, the potential energy is lower at P than at R.
20	D	Using F = ma, thus eE = m a a = e(V/d) / m_e = 5.3 X 10^{17} m s^{-2}
21	C	There is no difference between the connections in diagram 1 and diagram 2. Since the lamps are of the same resistance, putting a wire across the points parallel to the lamps P and Q does nothing to change the circuit itself
22	D	Total energy provided by battery is 60J Emf is W/Q = 60/20 = 3.00 V Pd across r = 10/20 = 0.50 V Pd across R = 50/20 = 2.50 V
23	A	The forces acting on XY and ZW have the same magnitude in opposite directions. These two forces form a couple with a torque as follow: $\tau = NBIL \times d = (20)(0.80)(I)(0.17) \times (0.11) = 1.35$ *I* = 4.5 A
24	A	Negative charges gain KE as it loses EPE from Source S to the hollow metal container. qV = ½ mv^2 □ 2V (q/m) = v^2 --- (1) Inside the hollow metal container, in order for the ions to pass through un-deviated, $F_B = F_E$ Bqv = qE = q(V/d) Bv = (V/d) v = (V/Bd) --- (2) Sub (2) in (1) $(V/Bd)^2$ = 2V (q/m) q/m = V / (2 B^2 d^2)

25	C	Emf of a rotating disc of radius L $= \dfrac{\text{Change in flux}}{\text{Time}}$ $= \dfrac{B.\pi L^2}{T}$ $= \dfrac{B.\pi L^2}{\frac{2\pi}{\omega}}$ $= \dfrac{1}{2} BL^2 \omega$ $\lvert e \rvert = \dfrac{1}{2} BL^2\ \omega.$ Emf between R and S = ½ BL^2 ω - ½ B(L/2)^2 ω = ¾ (1/2 BL^2 ω) According to the question E = ½ BL^2 ω, therefore, emf between R and S is ¾ E
26	A	Since inner loop experiences decreasing flux linkage, current in the inner wire will flow in the same direction as that in the outer wire to oppose this deceasing flux linkage (Lenz's law). Since the rate of decrease of current with time is constant, the rate of decrease of B and hence flux linkage is constant, hence e.m.f. induced in inner loop is constant and the current in the inner loop is constant.
27	B	Clockwise: current pass through 200 $\wedge$ only. anticlockwise: current pass through both resistors.
28	C	Photocurrent is proportional to intensity. Intensity is proportional to (amplitude)^2. $\dfrac{amplitude\ of\ wave\ P}{amplitude\ of\ wave\ Q} = \sqrt{\dfrac{intensity\ of\ wave\ P}{intensity\ of\ wave\ Q}} = \sqrt{\dfrac{photocurrent\ of\ wave\ P}{photocurrent\ \ of\ wave\ Q}}$ $= \sqrt{\dfrac{4}{1}} = 2$
29	B	Energy of red wavelength photon $= \dfrac{hc}{\lambda} \approx \dfrac{(6.63 \times 10^{-34}) \times (3 \times 10^{8})}{600 \times 10^{-9}} \times \dfrac{1}{1.6 \times 10^{-19}} = 2.1\ eV$ Only option B's energy difference is the closest to red wavelength
30	D	Nucleon number = 232 – 4 + 0 + 0 + 0 – 4 = 224 Proton number = 90 – 2 + 1 + 1 + 0 – 2 = 88