2023 C2 H1 Physics Prelim Exams Paper 1 Suggested Solutions

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

1 **A**

unit of magnetic flux density, B = unit of (F/IL)

T = (kg m s^{-2}) A^{-1} m^{-1} = kg s^{-2} A^{-1}

2 **D**

intensity I = Power P / surface area A

$$I = \frac{P}{4\pi r^2}$$

$$P = 4\pi r^2 I = 4\pi (2.0)^2 (0.25) = 12.566 \text{ W}$$

$$\frac{\Delta P}{P} = \frac{\Delta I}{I} = +2\frac{\Delta r}{r}$$

$$\frac{\Delta P}{12.566} = \frac{0.05}{0.25} + 2\left(\frac{0.1}{2.0}\right) = 0.3$$

$$\Delta P = 4\text{W}$$

3 **B**

Student	electronic charge, e / x 10^{-19} C					mean value	spread
A	1.62	1.59	1.59	1.61	1.60	1.60	0.03
B	1.57	1.63	1.64	1.58	1.59	1.60	0.07
C	1.59	1.60	1.58	1.57	1.57	1.58	0.03
D	1.58	1.62	1.65	1.59	1.66	1.62	0.08

Student B's results have mean value = 1.60 x 10^{-19} C, which are accurate.
However, his results have the largest spread (random errors), thus are least precise.

4 **B**

Total displacement by car = [(10)(3.0)] + [-(5)(6.0)] = 0 m

Average velocity of toy car = $\frac{\text{total displacement}}{\text{total time taken}} = \frac{0}{15}$ = 0 m s^{-1}

5 **C**

Sketch the *v-t* graph for train. Let $t_{stations}$ be the time taken by the train to travel between the two stations.

Total distance travel by train between the two stations = 3000 m

[(0.5(20)(100))]+[(20)($t_{stations}$ – 150)]+[(0.5)(20)(50)] = 3000

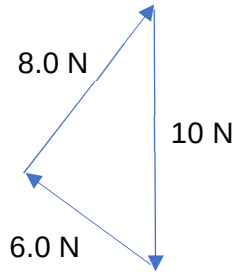
$t_{stations}$ = 225 s = 230 s (2 s.f.)

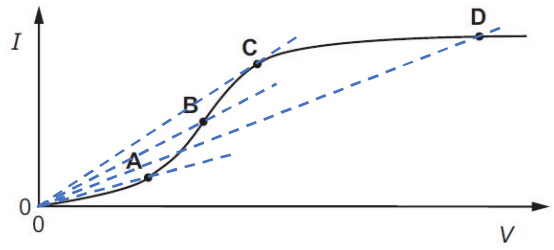
6 **C**

The speed of the projectile is the magnitude of the resultant velocity of the horizontal and vertical components velocities.

As the projectile rises to the highest point, its speed decreases. As the projectile falls from the highest point, its speed increases.

At the highest point, the speed is not zero as the projectile still has horizontal component velocity.

7	**B**	The acceleration is downwards as the lift is ascending (i.e. velocity vector is upwards). Thus resultant force is downwards. The magnitude of the force exerted on the block by the floor (upwards) is always less than the magnitude of his weight (downwards).
8	**D**	Constant force $F = ma$, thus acceleration is constant. Using equation of motion, $v^2 = u^2 + 2as$ Since it starts from rest, $u = 0$, $v = \sqrt{2ad}$ Momentum $p = mv = m\sqrt{2ad}$ Thus p is directly proportional to the square root of d.
9	**B**	Let cross-sectional area of the stream of water be A, Rate of mass of water hitting wall $= 1000 \times 8.0 \times A = 8000A$ kg $F = \frac{\Delta p}{\Delta t} = \frac{\Delta m(v_f - v_i)}{\Delta t} = 8000A(0 - 8.0) = -64000A$ N Pressure, $P = \frac{F}{A} = \frac{64000A}{A} = 64000$ Pa = 64 kPa
10	**C**	Redrawing the forces into a vector triangle  Recognize it is a 6-8-10 right-angled triangle. (similar to a 3-4-5). Analysing the horizontal components in equilibrium: $6.0 \cos \theta_1 = 8.0 \cos \theta_2 \Rightarrow \theta_1 < \theta_2$ Thus, $W_1 = 6.0$ N, $W_2 = 8.0$ N
11	**B**	Taking the pivot at the edge of table, Sum of clockwise moments = Sum of anti-clockwise moments $W(1.2) = 0.43(3.6)$ $W = 1.29$ $m = \frac{W}{9.81} = 0.13$ kg
12	**C**	For X: resultant force = 0 and net clockwise moments For Y: resultant force = 0 and net clockwise moments For Z: net resultant force and zero net moments.

13	**C**	The increase in gravitational potential energy is ΔGPE = (2.0 N) (0.80 m) = 1.6 J. The power output is P_{out} = (1.6 J) / (4.0 s) = 0.40 W. The electrical power supplied to the motor is thus P_{in} = (0.40) / (0.20) = 2.0 W
14	**A**	The loss in gravitational potential energy is mgh = (50) (9.81) (5.00) = 2450 J. The final kinetic energy is $\frac{1}{2}mv^2$ = 0.5 (50) $(4.90)^2$ = 600 J. The loss in energy is 2450 – 600 = 1850 J. Hence, the resistive force is (1850) / (10.0) = 185 N
15	**A**	$\text{power} = \frac{\text{work done}}{\text{time}} = \frac{\text{force} \times \text{displacement in the direction of the force}}{\text{time}}$ Hence, power = force × $\frac{\text{displacement in the direction of the force}}{\text{time}}$ = force × velocity. Thus, the equation force = mass × acceleration is not used
16	**D**	$\text{angular speed} = \frac{\text{angular displacement}}{\text{time taken}} = \frac{2\pi}{T} = \frac{2\pi \text{ rad}}{(24 \times 3600 \text{ s})} = 7.3 \times 10^{-5} \text{ rad s}^{-1}$
17	**D**	$v = r\omega$, so $r = v/\omega$. $\omega = 2\pi/T$, so $T = 2\pi/\omega$. $a = v^2/r = \omega^2 r = (\omega^2)(v/\omega) = v\omega$
18	**B**	The gravitational force between Io and Jupiter provides the required centripetal force on Io. $F_g = F_c$ $G\frac{Mm}{r^2} = m\omega^2 r = m\left(\frac{2\pi}{T}\right)^2 r$ $M = \frac{4\pi^2}{T^2}\frac{r^3}{G} = \frac{4\pi^2}{(1.77 \times 24 \times 3600)^2}\frac{(4.22 \times 10^8)^3}{(6.67 \times 10^{-11})} = 1.9 \times 10^{27}$ kg
19	**C**	 Smallest resistance, R → largest I/V (as $R = V/I$, definition of resistance) The reciprocal of the gradient of the straight line that joins the origin to the point on the I-V graph is equal to the resistance of the liquid.

20	**C**	Resistance X = 10^2 / 100 = 1.0 Ω Resistance Y = 10^2 / 50 = 2.0 Ω When in series, current through them = 20.0 / 3.0 A Power dissipated in X = $(20/3)^2$ (1.0) = 44.4 W Power dissipated in Y = $(20/3)^2$ (2.0) = 89 W
21	**C**	Initially, when distance x (less than mid-way of OZ from O) increases, with a small change in distance x, the cross-sectional area increases, resulting in smaller increases in R. Later, when distance x (more than mid-way of OZ from O) increases, with a small change in distance x, the cross-sectional area decreases, resulting in larger increases in R.
22	**B**	The resistor across CD can be ignored as no current will flow across CD when a voltage source is connected across AB. Thus the effective resistance across AB is (two 6.0Ω resistors in series) parallel to (two 6.0Ω resistors in series) parallel to (one 6.0Ω resistor), i.e. equivalent resistance of 3.0 Ω.
23	**B**	When temperature of the thermistor increases, its resistance drops and the current through it increases. Thus, the p.d. across J and K increases. The p.d. across L and M increases, implying that the p.d across J and L decreases.
24	**C**	For a full-scale deflection, the current through A is 10 mA and p.d. is 100 mV. Thus, if a circuit has a current of 100 mA, the current through R is (100 - 10) = 90 mA. Since p.d. across 10 Ω, and R are the same $0.100 = (0.090)R$ $R_{\square}$ = 1.1 Ω
25	**B**	Moment $\tau = r \times F = (r)(BIL)$ $7.2 \times 10^{-3} = (0.250)(B \times 1.60 \times 0.091)$ $B = 0.1978 \approx 0.198\,T$ Direction – along x direction
26	**D**	Electric force on P, $F = qE = (2)(1.6 \times 10^{-19})(1.5 \times 10^{5}) = 4.8 \times 10^{-14}\ N$ Toque $\tau = r \times F = (4.0 \times 10^{-12})(\sin 55^{o})(4.8 \times 10^{-14}) = 1.6 \times 10^{-25}\ Nm$ The direction of torque is anti-clockwise.

27	**B**	Magnetic force provides required centripetal force $Bev = \frac{mv^2}{r}$ $r = \frac{mv}{Be}$
28	**D**	Back scattering and large angle scattering is due to the positive charge in the gold nucleus. Since the charge of the nucleus is constant, the scattering will not change. Thus A, B & C is incorrect.
29	**D**	Fusion or fission will only result in products with higher binding energy per nucleon so that energy can be released in the process.
30	**C**	$\frac{1}{2^n} = \frac{2}{64} = \frac{1}{32} = \frac{1}{2^5}$ ⇨ The radioactive isotopes have undergone 5 half-lives in 60 min. ⇨ Half-life = 60/5 = 12 min.