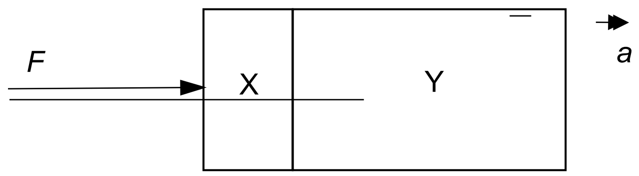
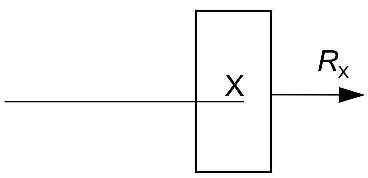
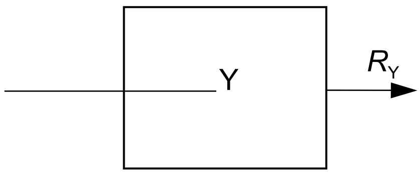
2021 YIJC JC2 H2 Preliminary Examination Physics Paper 1 Answer Key

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

2021 YIJC JC2 H2 Preliminary Examination Paper 1 Suggested Solutions

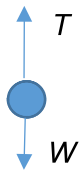
S/N	Answer	Explanation
1	**B**	$[\sigma]$ $=\dfrac{[\text{energy}]}{[\text{time}][\text{area}][T^4]}=\dfrac{\text{J}}{\text{s m}^2\text{ K}^4}=\dfrac{\text{kg m s}^{-2}\text{ m}}{\text{s m}^2\text{ K}^4}$ $=\text{kg s}^{-3}\text{ K}^{-4}$
2	**C**	**A** implies large random error. **B** implies non-ohmic conductor. **C** Graph should be a straight line passing through the origin if no systematic error. **D** implies a possible error in the experiment (one data point)
3	**B**	Estimation of values required: Mass of car = 1000 kg Speed limit on expressway = 90 km h^{-1} Δp =1000 ($\dfrac{90 \times 1000}{3600}$ - 0) = 25 000 = 2.5 × 10^4 kg m s^{-1}
4	**A**	The gas bubbles initially accelerate upwards before travelling at a terminal velocity. Hence, spacing between bubbles increases before becoming constant.
5	**D**	Take vertically upwards as positive direction, the acceleration (*g*) of the ball before and after the collision with the ceiling is negative (downwards). During collision with the ceiling, the ball experiences an downward force from the ceiling and together with its weight leads to a larger negative (downwards) acceleration.

6	**C**	For the bob, $T\cos 11^\circ = mg$ and $T\sin 11^\circ = ma$ $\Rightarrow \tan 11^\circ = a\,/\,g$ $\Rightarrow a = g\tan 11^\circ = 1.90687\text{ m s}^{-2}$ For the block and bob, $\Sigma F = (\Sigma m)\,a$ $250 - F_f = 100 \times 1.90687$ $F_f = 59.3\text{ N}$
7	**C**	Area under *F-t* graph gives the change in momentum of the body. From t = 75 ms to t = 150 ms, $\Delta p = mv - mu = ½\,(60 + 80)(100 - 75)(10^{-3}) + ½\,(80 + 40)(150 - 100)(10^{-3})$ $= 4.75$ $\therefore\ mv = 4.75 + mu = 4.75 + (0.200)(15) = 7.75$ $\therefore v = 7.75\,/\,0.200 = 38.8\text{ m s}^{-1}$
8	**A**	The resultant force acting on both blocks could be shown below.  Hence, $F = 3\,ma$ $a = F\,/\,3m$ For Block X, let resultant force = R_X  $R_X = ma = \frac{1}{3}F$ For Block Y, let resultant force = R_Y  $R_Y = 2\,ma = \frac{2}{3}F$

9	**B**	For an object to be in equilibrium with three coplanar forces acting on it, (a) The vector sum of the three forces must form a closed loop diagram. (Option C not possible) (b) Net moment about any point must be zero. (Option D not possible) (c) Line of action of the three forces must pass through a common point (Option A not possible)
10	**C**	Assume the sphere is dropped from a height *h*. Considering its downward motion to the plate, Gain in KE = Loss in GPE, $\frac{1}{2}mu^2 = mgh$ $u^2 = 2gh$ Upon rebound, considering its upward motion to its maximum height, Loss in KE = Gain in GPE, $\frac{1}{2}mv^2 = mg\left(\frac{1}{2}h\right)$ $v^2 = gh$ Hence, $\frac{v^2}{u^2} = \frac{gh}{2gh}$ $\left(\frac{v}{u}\right)^2 = \frac{1}{2}$ $\frac{v}{u} = \frac{1}{\sqrt{2}}$
11	**B**	Using conservation of energy, $KE_X + GPE_X$ + Energy input = $KE_Y + GPE_Y$ + Work Done by dissipative forces Taking Y as the reference point, $0 + mgh_X + 0 = ½\, mv_Y{}^2 + 0$ + Energy by frictional forces Energy by frictional forces = 500(9.81)(30) – ½(500)(11)^2 = 1.2×10^5 J

12 **D**

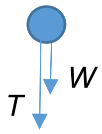
At the bottom of the circle,



$T - W = mv^2 / r$

$T = W + mv^2 / r$

At the top of the circle,



$T + W = mv^2 / r$

$T = mv^2 / r - W$

Hence, the tension is greatest when the stone is at the bottom of the circle.

13 **B**

GPE = Scalar sum of the GPE between masses at X and P and between masses at Y and P

$$= -\frac{GM_X m_P}{XP} + \left(-\frac{GM_Y m_P}{YP} \right)$$

$$= -2\frac{(6.67\times10^{-11})(8000)(5)}{0.25}$$

$$= -2.1\times10^{-5}\,\text{J}$$

14 **A**

Thermal equilibrium ⇒ same temperature ⇒ no net transfer of thermal energy

15 **A**

Option A: The increase in internal energy for process Z is $6/2P_0V_0$, while the work done on the gas is less than $5/2P_0V_0$ (This will be the area under the graph if process C is a straight line process). So there is non-zero heat flow into the gas.

16 **B**

Solid	Melting point/ °C	Specific heat capacity/ J kg^{-1} K^{-1}	ΔT from 20 °C to melting pt	Energy required for 1 kg to reach melting point / kJ
A	80	1200	60	72
B	100	800	80	64
C	150	600	130	78
D	300	250	280	70

Based on the energy required for each solid to reach their melting point, solid

		B which requires the least amount of energy to reach its melting point will melt first since they are all heated at same rate ($E = Pt$)
17	**C**	With partial vacuum, the max amplitude would be larger and natural frequency would be larger, as the damping effect is less.
18	**C**	*Intensity* $\propto$ *energy* and *Intensity* $\propto$ (*amplitude*)^2 $\therefore$ *energy* $\propto$ (*amplitude*)^2 $E = k(A)^2$ --- (1), where E is the energy of the incident light, and A is the amplitude of the incident light. $0.70\,E = k(A_1)^2$ --- (2), where the unknown amplitude is A_1. (2) / (1) $\Rightarrow 0.70 = (A_1 / A)^2$ $\Rightarrow A_1 = 0.84\,A$
19	**B**	$\lambda / 4$ – end correction = 18.8 cm $3\lambda / 4$ – end correction = 56.4 cm λ = 75.2 cm => frequency = 440 Hz
20	**D**	The electric field pattern shows the direction that a small positive test charge would follow. At X, a small positive test charge will be in the direction of the (tangential) electric field (i.e. in A's direction). However, since the test charge is negative, the force on the electron is in the opposite direction (i.e. D)
21	**A**	The hollow metal sphere is a good electrical conductor and as such, excess charges on it will move until there is no potential difference across its surface nor within the sphere. The sphere is said to have an equipotential volume.
22	**C**	Based on the field pattern given, the smaller charge is on the left. Let x = distance between the neutral point and the smaller charge. At the neutral point (which is somewhere between the two charges), $E_1 = E_4$ $\frac{1}{4\pi\varepsilon_o}\frac{(1.0\mu C)}{x^2} = \frac{1}{4\pi\varepsilon_o}\frac{(4.0\mu C)}{(6.0\text{ cm} - x)^2}$ $\frac{1}{x^2} = \frac{4}{(6.0 - x)^2} \Rightarrow \frac{6.0 - x}{x} = 2.0$ x = 2.0 cm The location is 2.0 cm to the right of the smaller charge.
23	**C**	From t = 0 to t = 2.0 min, the current in the cell = $\frac{6.0}{4.0 + (\frac{1}{3} + \frac{1}{6})^{-1} + 1.0} = \frac{6}{7}$ A

<table>
<tr><td></td><td></td><td>From t = 2.0 min to t = 4.5 min, the current in the cell = $\frac{6.0}{4.0+6.0+1.0}=\frac{6}{11}$ A
Using $Q = It$,
total charge = ($\frac{6}{7}$)(2.0 × 60) + ($\frac{6}{11}$)(2.5 × 60) = 184.7 C = 180 C (to 2 s.f.)</td></tr>
<tr><td>24</td><td>C</td><td>The 2.0 Ω and 4.0 Ω resistors are in series. So effective resistance is 6.0 Ω
This 6.0 Ω resistor is parallel to the given 6.0 Ω, which results in an effective resistance of 3.0 Ω
This 3.0 Ω resistor is in series with the given 3.0 Ω
Hence, 15 V is shared equally across both 3.0 Ω resistors.
Hence 7.5 V appears across the effective resistance of 3.0 Ω which means 7.5 V appears across the given 6.0 Ω resistor.</td></tr>
<tr><td>25</td><td>B</td><td>
<table>
<tr><th>Option</th><th>p.d. across both resistors</th><th>p.d. across top resistor</th><th>Potential of point J</th></tr>
<tr><td>A</td><td>8 - (-8) = 16 V</td><td>$\frac{2}{2+2}\times 16 = 8$ V</td><td>8 – V_J = 8
V_J = 0 V</td></tr>
<tr><td>B</td><td>16 V</td><td>$\frac{6}{6+2}\times 16 = 12$ V</td><td>8 – V_J = 12
V_J = –4 V
(as required)</td></tr>
<tr><td>C</td><td>16 V</td><td>$\frac{2}{2+6}\times 16 = 4$ V</td><td>8 – V_J = 4
V_J = 4 V</td></tr>
<tr><td>D</td><td>16 V</td><td>$\frac{6}{6+8}\times 16 = 6.86$ V</td><td>8 – V_J = 6.86
V_J = 1.14 V</td></tr>
</table>
</td></tr>
<tr><td>26</td><td>C</td><td>The force is directly proportional to the product of the currents.
Since both currents are doubled, the force is 4 times larger.</td></tr>
</table>

27	**B**	The magnetic force provides the centripetal force on the moving charge. $Bqv = \frac{mv^2}{r} \Rightarrow B = \frac{mv}{qr}$ The proton and the electron carry the same charge *q* but of opposite sign. For the proton to retrace the path of the electron with the same speed, the radius must be the same. Thus, the magnetic flux density is now $B_p = \frac{m_p v}{-qr}$ $\frac{B_p}{B_e} = -\frac{m_p}{m_e}$ $\frac{B_p}{1.0\text{ mT}} = -\frac{1.67 \times 10^{-27}}{9.11 \times 10^{-31}}$ $B_p = -1800\text{ mT}$ The field is in the opposite direction to the initial.
28	**C**	A: True. As $\omega = \frac{\theta}{t}$, from graph it is clear that angular velocity is a constant. B: True. At 0.4 s, the angle rotated is 360°, the rate of cutting of magnetic flux linkage is the largest possible. C: False. At 0.4 s, the angle rotated is 360°, the flux linkage is zero at that instant. D: True. The flux linkage follows the equation $NBA\sin(\omega t)$. So, induced e.m.f. will follow the equation of $-NBA\omega\cos(\omega t)$
29	**B**	When the potential at X is higher than the potential at Y, the total resistance in the circuit is R_1. Current flows from X to Y. Similarly, when the potential at Y is higher than the potential at X, the total resistance in the circuit increased to $R_1 + R_2$. Current flows from Y to X (opposite direction) and has a lower peak value compared to when it flows from X to Y.

30	**C**	The energy of the photon emitted corresponds to the transitions between the energy levels in the hydrogen atom. $\Delta E = \frac{hc}{\lambda} = \frac{(6.63\times10^{-34})(3.0\times10^{8})}{656.28\times10^{-9}} = 3.03\times10^{-19}\text{ J} = 1.9\text{ eV (2sf)}$ Option A : ΔE = (-3.4)-(-13.6) = 10.2 eV Option B : ΔE = (-1.5)-(-13.6) = 12.1 eV Option C : ΔE = (-1.5)-(-3.4) = 1.9 eV (Answer) Option D : ΔE = (-0.5)-(-3.4) = 2.9 eV Alternative method (without calculation) It should be noted that visible light range occurs for the Balmer series where the transition involves n = 2. So the answer is narrowed to C or D. Red light has the longest wavelength and so the energy transition must be the smallest. Likely n = 3 to n = 2.