2021 DHS H2 Physics Prelim Paper 1 Suggested Solutions

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
D	**B**	**D**	**B**	**C**	**C**	**C**	**D**	**D**	**A**
Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
B	**D**	**A**	**A**	**C**	**C**	**B**	**A**	**B**	**A**
Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
A	**C**	**B**	**C**	**C**	**D**	**D**	**B**	**A**	**A**

1 **D** Average car tyre radius, R = 0.20 m
Cross sectional radius r = 0.10 m
Volume = $(2\pi R)(\pi r^2)$ = 0.039 m^3

2 **B** Units on right side = (unit of k)(A^2)(m/m)^2 = (unit of k)(A^2)
Units on left side = W
unit of k =W/ A^2= (W/A)(A) = V/A = Ω

3 **D** v increases as the skydiver accelerates vertically downwards.
Resultant force decreases (force due to air resistance) causes acceleration to decrease.

4 **B** $v^2 = u^2 + 2as$, $0 = u^2 + 2(-9.81)(12.7)$
$v = u + at$, $0 = \sqrt{2(9.81)(12.7)} + (-9.81)t$
t = 1.61s, total time = $2t$ = 2(1.61) = 3.22 s

5 **C** Gradient = acceleration = (12.0 – 3.0)/15.0 = 9.0/15.0
Resultant force = ma = (2.5)(9.0/15.0) = 1.5 N

6 **C** perfectly elastic collision :
$v_Q - v_p = u_P - u_Q$ = 1.2 – (-1.8) = 3.0 -- Eqn 1

COM :

$(0.30)(1.2) – (0.60)(1.8) = 0.30\ v_P + 0.60\ v_Q$ -- Eqn 2

Solve Eqn 1 and 2, $v_P = 2.8$ m s^{-1}, $v_Q = 0.20$ m s^{-1}

7 **C** Max pressure the probe can take = atmospheric pressure + pressure due to the liquid

On Earth:

Max pressure = $100 \times 10^3 + (64)(1000)(9.81) = 727840$ Pa

On Moon of Saturn:

$727840 = 35 \times 10^3 + h\ (740)\ (3.6)$

h = **260 m**

8 **D** When $T = (D + W_2)$, the net force on the lift is 0.

Hence by Newton's first law, the lift must have a constant velocity. If it was originally at rest, it will be at rest (constant velocity of 0).

9 **D** *Negative* work is done by the upthrust on the cylinder.

10 **A** At the top of circle, $mg + N = mv^2/r$

At minimum speed, $N = 0$

$mg = mv^2/r$

$v^2 = rg = (1.20)\ (9.81)$

$v = \underline{3.43 \text{ m s}^{-1}}$

11 **B** **A** is wrong because magnitude of gravitational force GMm/r^2 decreases with increasing distance.

In an orbit, gravitational force provides centripetal force, and since centripetal force decreases, so is the centripetal acceleration (Thus **D** is wrong).

From Kepler's Third Law,

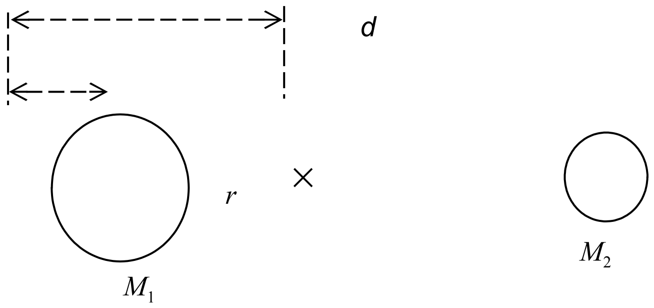
$T^2 \propto r^3$

T increases as r increases.

Hence angular velocity $\omega = 2\pi / T$ decreases with increasing distance (Thus **C** is wrong).

B is correct, as gravitational potential energy $-GMm/r$ is a scalar and it becomes less negative (hence increases) with increasing distance.

12 **D**



Let the distance from M_1 be r from where it experiences no resultant gravitational force.

At r,

$$\frac{GM_1}{r^2} = \frac{GM_2}{(d - r)^2}$$

Simplifying,

$$r = d\left(\frac{\sqrt{M_1}}{\sqrt{M_1} + \sqrt{M_2}}\right)$$

13 **A** **A** is incorrect as the amount of energy absorbs is equal to the latent heat rather than the specific latent heat.

14 **A** $\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2} \Rightarrow \frac{P_1V_1}{m_1T_1} = \frac{P_2V_2}{m_2T_2}$ since $n = \frac{mass}{molar\ \text{mass}}$

As pressure and volume remains constant,

$m_1T_1 = m_2T_2$

$(2.0)(300) = m_2(400)$

$m_2 = 1.5$

Hence mass of gas escaping = 2.0 - 1.5 = 0.50 kg

15 **C** As temperature is constant, the internal energy of the gas is unchanged. Hence A is wrong.

Work is done by the gas during expansion, hence B is wrong.

C is correct as $\Delta U = Q + W \Rightarrow Q = -W$ when $\Delta U = 0$

D is wrong as temperature is unchanged thus root-mean-square speed is unchanged.

16 **C** Positions of the KE = 0 (*at t = 0, T/2 and T*) corresponds to *x* = amplitude positions.

Positions of max KE corresponds to *x* = 0 positions. Hence **C** is correct.

17 **B** Let the height of the cylinder be *h*.

$h - 0.835 = \lambda / 4$ ------(1)

$h - 0.171 = 3\lambda / 4$ ------(2)

(2) – (1):

$0.664 = 0.5\lambda$

$\lambda = 1.328$ m

$f = v/\lambda = (340)/(1.328)$

$f = 256$ Hz

18 **A**

$$\sin\theta = \frac{\lambda}{b}$$

$$\lambda = (0.05)(0.010 \times 10^{-3}) = 500 \times 10^{-9} \text{ m} = 500 \text{ nm}$$

19 **B**

$$d \sin\theta = n\lambda$$

$$\frac{10^{-3}}{800} \sin 41.0^\circ = 2\lambda$$

$$\lambda = 4.1 \times 10^{-7} \text{ m}$$

20 **A** Weight of oil drop = Electric force (vertically upwards) + Force due to air resistance

$Mg = QE + kv$,

Rearranging, $v = \frac{Mg}{k} - \frac{QE}{k}$

A graph of v against E will give a straight line of gradient, $\frac{-Q}{k}$ and y-intercept, $\frac{Mg}{k}$

21 **A** From the definition of current,

$$I = \frac{Q_{Total}}{T} = \frac{8Q}{2\pi/\omega} = \frac{4Q\omega}{\pi}$$

22 **C**

$$R_{old} = \frac{\rho L}{A} = \frac{4\rho L_{old}}{\pi d_{old}^{\ 2}} = 2.000\ \text{k}\Omega$$

$$R_{new} = \frac{4\rho L_{new}}{\pi d_{new}^{\ 2}} = \frac{4\rho(1.004L_{old})}{\pi(0.99d_{old})^2} = 2.049\ \text{k}\Omega$$

23 **B** Due to symmetry, **A** and **C** will have the same effective resistance, so they cannot be correct answers.

D has one identical resistor, say R, in parallel with the rest, so the effective resistance will be $<R$.

24 **C**

Effective resistance of circuit = $\left(\frac{1}{1+1} + \frac{1}{1+5}\right)^{-1} + 1 = 2.5\ \text{k}\Omega$

Current drawn from cell = $5/2.5 = 2.0\ \text{mA}$

Voltmeter reading = $5 - 2(1) = 3.0\ \text{V}$

25 **C** By conservation of moments,

magnitude of moment due to force acting on current carrying conductor =

magnitude of moment due to paper rider

➔ $B_{coil}IL(15) = W_{rider}(2)$

➔ $\left(\dfrac{\mu_0 N I_{coil}}{2r}\right) IL(15) = W_{rider}(2)$

➔ $\left(\dfrac{(4\pi \times 10^{-7})1000 I_{coil}}{2(12.5/100)}\right)(5)(4/100)(15/100) = \left(\dfrac{5}{1000}9.81\right)(2/100)$

➔ $I_{coil} = 6.5$ A

26 **D** Component of weight parallel to slope = $mg\sin\theta$

Component of magnetic force acting of rod in the opposite direction

$= BIL\cos\theta = B\left(\dfrac{E_{induced}}{R}\right)L\cos\theta = B\left(\dfrac{BLv\cos\theta}{R}\right)L\cos\theta$

Thus, $mg\sin\theta = \dfrac{B^2L^2v\cos^2\theta}{R}$

➔ $v = \dfrac{mgR\tan\theta}{B^2L^2\cos\theta}$

27 **D** The equation is $I = I_0\sin(\frac{2\pi t}{T}) = I_0\sin(\frac{2\pi t}{0.0025}) = I_0\sin(800\pi t)$

28 **B** $\langle P\rangle = I_{rms}^2R = (I_0/\sqrt{2})^2R = (2.0/\sqrt{2})^2(200) = 400$ W

29 **A** Since the target is unchanged, the wavelengths of the peaks will remain the same.

However, with an increase in the p.d. between the target and cathode, the target will be bombarded with electrons of higher energy. These electrons will have a higher chance to remove an inner shell electron from the target, resulting in more de-excitations between energy levels and hence higher intensity of the peaks.

30 **A** $Bqv = qE$

$v = E / B = 1400 / (2.0 \times 10^{-3}) = 7.0 \times 10^{5}\ \text{m s}^{-1}$

$hf = \phi + \frac{1}{2}mv^{2}$

$\phi = \frac{hc}{\lambda} - \frac{1}{2}mv^{2} = \frac{(6.63 \times 10^{-34})(3 \times 10^{8})}{450 \times 10^{-9}} - \frac{1}{2}(9.1 \times 10^{-31})(7.0 \times 10^{5})^{2}$

$\phi = 2.2 \times 10^{-19}\ \text{J}$

~ THE END ~