PHYSICS

9749

SUGGESTED MARK SCHEME
Maximum Mark: 190

October/November 2020

Paper 1
Multiple Choice

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

Notes:

Candidates found Questions 8, 16, 19, 22 and 24 more challenging.

Question 8
distractor **B** – did not account for two ropes
distractor **C** – confused the air densities
distractor **D** – did not account for the weight of air inside the balloon

Question 11
Takes 1 hour (3600 s) for a minute hand to complete one revolution.

Question 14
Note that line MN is NOT an isothermal change. Using PV = nRT, temperature is decreasing.

Question 16
Note that the energy of the oscillations reduced **by** E / 4 rather than **to** E / 4.

Question 19
Single slit equation accounts for only one side of the central maximum. The width of the central maximum is double of this.

Question 24
Note that the question asks for potential difference, not potential.

1 let radius be r

volume of sphere $V = \frac{4}{3}\pi r^3$

$\frac{\Delta V}{V} = 3\left(\frac{\Delta r}{r}\right)$

so y quantity is directly proportional to x quantity

2 for N3L, the forces involved should

- be of same type
- be of same magnitude
- be of different directions
- act on different interacting bodies

Option D fails first bullet point

3 let wire be a cylinder length L and cross-sectional radius r

$$\text{stress} = \frac{F}{\pi r^2}$$

$$\text{strain} = \frac{\Delta L}{L}$$

$$\text{units of area under curve} = \left(\frac{\text{N}}{\text{m}^2}\right)\left(\frac{\text{m}}{\text{m}}\right) = \text{J m}^{-3}$$

4 at t = 0, both car are at same position
at t = T, both cars same position again
so equal displacement from 0 to T
since area under v-t graph is displacement
P + (Q + R) = (Q + R) + S

5 relative velocity taking car as reference
$\overline{v_r} = \overline{v_b} - \overline{v_c}$
so $\overline{v_r}$ has a rightwards component and a downwards component

6 equilibrium so
no resultant force in any direction
no resultant torque about any point

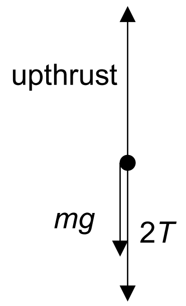
C is wrong because while the torque have same magnitude, one must act clockwise and the other anti-clockwise (so **not** "equal")

7 moment of a couple can be calculated by either of the following:

- (magnitude of one of the pair of equal and opposite forces)(perpendicular distance between forces)
- 2(magnitude of one of the pair of equal and opposite forces)((perpendicular distance between 1 force and the pivot)

[useful tip for angles] check what it means by $\theta = 0°$ and $\theta = 90°$. in this case when $\theta = 90°$ we should get max force so the function should be $\sin\theta$

8 there are **two ropes.** consider free body diagram of balloon+basket:



upthrust
U = weight of displaced air
$= \rho_{\text{cool}} V g$

total weight
$W = (m_{\text{deflated}} + m_{\text{hot air}})g$

equilibrium so
$U = W + 2T$

$$T = \frac{1}{2}\left((\rho_{\text{cool}} - \rho_{\text{hot}})V - m_{\text{deflated}}\right)g$$
$$= \frac{1}{2}\left((1.204 - 0.898)(2800) - 700\right)(9.81)$$
$$= 769 \text{ N}$$

9 some thermal energy is not converted into useful work

$$P_{useful} = F_{useful}v$$
$$= (1600)(22)$$

$$P_{produced} = \frac{3.3\times10^6}{60}$$

$$\text{efficiency} = \frac{P_{useful}}{P_{produced}} \times 100\%$$
$$= \frac{(1600)(22)}{\frac{3.3\times10^6}{60}} \times 100\%$$
$$= 64\%$$

10 given period,

$$a_c = r\omega^2$$
$$= r\left(\frac{2\pi}{T}\right)^2$$
$$= (3.85\times10^8)\left(\frac{2\pi}{27.3\times24\times60^2}\right)^2$$
$$= 0.00273 \text{ m s}^{-2}$$

11 minute hand takes 1 hour to go around

$$\omega = \frac{2\pi}{T}$$
$$= \frac{2\pi}{60^2}$$
$$= 0.00175 \text{ rad s}^{-1}$$

12 let increase in GPE be U

$$U = m(\phi_{final} - \phi_{initial})$$
$$= m_2\left(\frac{-Gm_1}{2r} - \frac{-Gm_1}{r}\right)$$
$$= \frac{Gm_1m_2}{2r}$$

13 gravitational field strength

$$g = \frac{GM}{r^2}$$
$$= \frac{(6.67\times10^{-11})(2.0\times10^{31})}{(150\times10^6\times10^3)^2}$$
$$= 0.0593 \text{ N kg}^{-1}$$

14 $pV = (nR)T$

for L → M, process is constant pressure
V is directly proportional to T,
eliminate A and D

for M → N,

$$p_MV_M = (2.0\times10^6)(0.003)$$
$$= 6000 \text{ Pa m}^3$$
$$p_NV_N = (0.8\times10^6)(0.005)$$
$$= 4000 \text{ Pa m}^3$$

temperature drops so eliminate C
(as a second layer of confirmation, direct proportionality above should suffice)

15 by first law of thermodynamics,

$\Delta U = Q + W$

for expt 1, $\Delta U = Q + 0$

for expt 2, $\Delta U = Q + (-W)$ due to expansion (negative work done <u>on</u> gas)

so $\Delta U_1 > \Delta U_2$

16 energy is transferred to and fro between max ke and max pe every quarter cycle

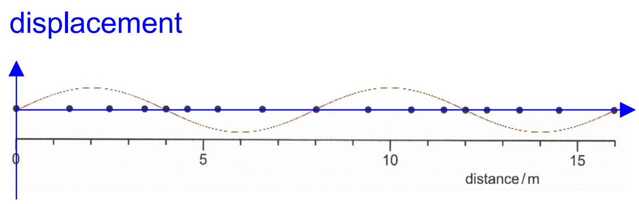
$$E_{max} = KE_{max} = \frac{1}{2}mv_0^2$$
$$= \frac{1}{2}m\left(\pm\omega\sqrt{x_0^2 - x^2}\right)^2 \propto x_0^2$$
$$\frac{x_{new}}{x_0} = \sqrt{\frac{E - E/4}{E}} = 0.867$$

Change in amplitude = (1– 0.867)x
= 0.134x

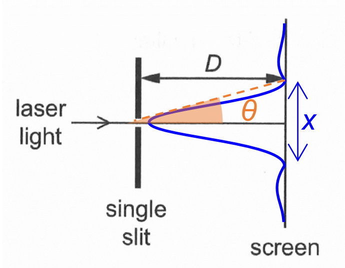
17 phase difference between a sine and negative cosine wave is 90°

18 wavelength is 8 m

$$f = \frac{v}{\lambda} = \frac{12}{8} = 1.5 \text{ Hz}$$



19 angle of first minima involves half of x:



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

$$\simeq \frac{x/2}{D} \text{ for small angles}$$

$$b = \frac{\lambda D}{x/2} = \frac{2D}{x}\left(\frac{c}{f}\right)$$

20 taking ratios:

$$\frac{V_{\text{new}}}{V_{\text{old}}} = \frac{\dfrac{Q}{4\pi\varepsilon_0 d}}{\dfrac{Q}{4\pi\varepsilon_0 \dfrac{d}{2}}} = 2$$

21 electric field strength of point charge:

$$E = \left(\frac{Q}{4\pi\varepsilon_0}\right)\left(\frac{1}{r^2}\right)$$

$$\text{gradient } = \frac{Q}{4\pi\varepsilon_0}$$

$$Q = (4\pi\varepsilon_0)(\text{gradient})$$

22 same p.d. across both elements:

$$\frac{P_X}{P_Y} = \frac{\dfrac{V^2}{R_X}}{\dfrac{V^2}{R_Y}} = \frac{R_Y}{R_X} = \frac{\rho\dfrac{L}{A_Y}}{\rho\dfrac{L}{A_X}} = \frac{A_X}{A_Y}$$

$$= \frac{\pi\left(\dfrac{d_X}{2}\right)^2}{\pi\left(\dfrac{d_Y}{2}\right)^2} = \left(\frac{d_X}{d_Y}\right)^2$$

$$\frac{d_X}{d_Y} = \sqrt{\frac{P_X}{P_Y}} = \sqrt{\frac{1}{1.5}} = 0.816$$

23 effective external resistance of circuit 2 is $R/2$

$$I = \frac{E}{2R + r}$$

$$3I = \frac{E}{\dfrac{R}{2} + r}$$

$$\frac{E}{2R + r} = \frac{E}{3\left(\dfrac{R}{2} + r\right)}$$

$$= \frac{E}{\left(\dfrac{3R}{2} + 2r\right) + r}$$

$$2R = \frac{3R}{2} + 2r$$

$$r = \frac{R}{4}$$

24 to have zero p.d., R_{XY} has to have ability to be zero, eliminate A, C and D

25 let time of flight within plates be t

$$t = \frac{s_x}{v_x} = \frac{5 \times 10^{-2}}{1.97 \times 10^7}$$

$$F = ma = qE = q\left(\frac{\Delta V}{d}\right)$$

$$a_y = \frac{q\Delta V}{m_e d}$$

$$\Delta h = ut + \frac{1}{2}a_y t^2$$

$$= 0 + \frac{1}{2}\left(\frac{q\Delta V}{m_e d}\right)t^2$$

$$= \frac{1}{2}\left(\frac{q\Delta V}{m_e d}\right)\left(\frac{s_x}{v_x}\right)^2$$

$$= \frac{1}{2}\left(\frac{(1.6 \times 10^{-19})(3000)}{(9.11 \times 10^{-31})(10 \times 10^{-2})}\right)\left(\frac{5 \times 10^{-2}}{1.97 \times 10^7}\right)^2$$

$$= 0.017 \text{ m}$$

26 let vertical component of Earth's flux density be B

$$NBA = (10)\left(2.1\times10^{-5}\right)\left(20^2\right)$$
$$= 0.084 \text{ T m}^2$$

27

$$P = I_{\text{rms}}^2 R$$
$$I_{\text{rms}} = \sqrt{\frac{P}{R}}$$

28

$$E_1 - E_2 = hf = \frac{hc}{\lambda}$$
$$\lambda = \frac{hc}{E_1 - E_2}$$

29

$$m_{\text{rxt}}$$
$$= (235.04 + 1.01)u$$

$$m_{\text{pdt}}$$
$$= \left(140.91 + 91.91 + 3(1.01)\right)u$$

$$E$$
$$= \left(m_{\text{rxt}} - m_{\text{pdt}}\right)c^2$$
$$= 0.2uc^2$$
$$= 0.2\left(1.66\times10^{-27}\right)\left(3\times10^{8}\right)^2$$
$$= 2.99\times10^{-11} \text{ J}$$

30

$$N_0 - N = 3.00\times10^{12}$$
$$5.00\times10^{12} - N = 3.00\times10^{12}$$
$$N = 2.00\times10^{12}$$

$$N = N_0 e^{-\lambda t}$$
$$\frac{N}{N_0} = e^{-\lambda t}$$
$$\ln\left(\frac{N}{N_0}\right) = -\lambda t$$
$$\ln\left(\frac{N_0}{N}\right) = \lambda t$$
$$t = \left(\frac{1}{1.15\times10^{-8}}\right)\left(\ln\left(\frac{5}{2}\right)\right)$$
$$= 7.97\times10^{7} \text{ s}$$