Tampines Meridian Junior College

2023 JC2 H2 Physics Preliminary Examination Paper 1

Suggested Solution

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

1. Ans: A

$F = BIL$

$[B] = \dfrac{[F]}{[I][L]}$

$[B] = \dfrac{\text{kg m s}^{-2}}{\text{A m}} = \text{kg s}^{-2}\text{A}^{-1}$

2. Ans: C

$42.195 \text{ km} = 42195 \text{ m}$

$= 4.2195 \times 10^{6} \text{ cm}$

$= 4.2195 \times 10^{7} \text{ mm}$

$= 4.2195 \times 10^{10} \ \mu\text{m}$

$= 4.2195 \times 10^{13} \text{ nm}$

3. Ans: C

At time t :

$$s = ut + \frac{1}{2}at^2$$

$$x = \frac{1}{2}gt^2$$

At time $2t$:

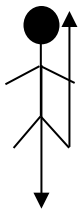
$$s = u(2t) + \frac{1}{2}g(2t)^2$$

$$= \frac{1}{2}g(2t)^2 = 4\left(\frac{1}{2}gt^2\right) = 4x$$

Hence distance fall in 2nd time interval $t = 4x - x = 3x$

4. Ans: B

force on boy by floor, N



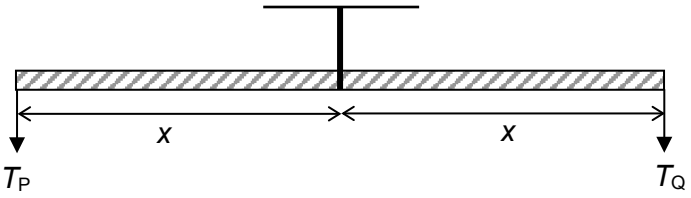
weight of boy, W

$$W - N = ma$$

$$N = W - ma \quad (< W)$$

By Newton's third law, the magnitude of the force on boy by floor is the same as the magnitude of the force on the floor by the boy.

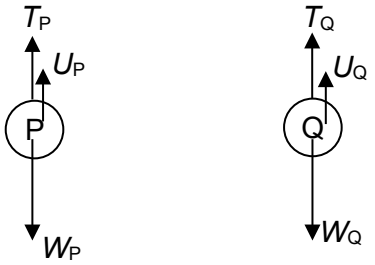
5. Ans: B



At equilibrium,
CW = ACW

$$T_P x = T_Q x$$

$$T_P = T_Q$$



$$T_P = T_Q$$

$$W_P - U_P = W_Q - U_Q$$

$$W_P - \rho_X gV = W_Q - \rho_Y gV$$

Since $\rho_X > \rho_Y$, $U_P > U_Q$ since both has the same volume.

Therefore, $W_P > W_Q$, $m_P > m_Q$.

6. Ans: D

Taking right as positive

Using conservation of momentum:

$mu_P + 0 = mv_P + mv_Q$

$u_P = v_P + v_Q$ ------ (1)

Using conservation of KE:

$\frac{1}{2}mu_P^2 + 0 = \frac{1}{2}mv_P^2 + \frac{1}{2}mv_Q^2$

$u_P^2 = v_P^2 + v_Q^2$ ------ (2)

$(1)^2 - (2)$:

$(v_P + v_Q)^2 - v_P^2 + v_Q^2 = 0$

$2v_Pv_Q = 0$

$\Rightarrow v_P = 0$

and

$\Rightarrow v_Q = u_P - v_P = u_P$

Hence, P becomes stationary and Q moves to the right with the same speed as P. When Q collides with R, the same occurs, Q becomes stationary while R moves to the right with the same speed.

7. Ans: D

Force exerted by the motor, F = 40 – 25 = 15 N

Output power of motor, $P = F\,v$, where v is speed of rotation (at circumference) of wheel.

Hence P = 15 [2π(0.080) x 10 / 1] = 75 W

8. Ans: B

Tension of cord provides for the centripetal force.

$T = \frac{mv^2}{r}$

$kx = \frac{mv^2}{r}$

$(42)x = \frac{(0.80)(3.2)^2}{0.72}$

$x = 0.27$ m

Unstretched length = 0.72 – 0.27 = 0.45 m

9. Ans: D

Net forces acting on satellite,

$Fnet = ma$

$$G\frac{M_S m}{R^2} - G\frac{M_E m}{r^2} = ma$$

$$a = G\frac{M_S}{R^2} - G\frac{M_E}{r^2}$$

10. Ans: C

Escape speed, v

$$v = \sqrt{\frac{2GM}{r}}$$

$$v \propto \sqrt{\frac{M}{r}}$$

$$\frac{v_m}{v_E} = \sqrt{\frac{M_m}{M_E} \times \frac{r_E}{r_m}} = \sqrt{\frac{1}{81} \times \frac{4}{1}} = \frac{2}{9} = 0.22$$

11. Ans: A

$$E_P = \frac{1}{2} m\omega^2 x^2$$

12. Ans: C

From Graph 1, $\lambda = 0.45 - 0.15 = 0.30$ m

From Graph 2, $T = 1.6 - 1.2 = 0.4$ ms $= 0.4 \times 10^{-3}$ s

$$v = f\lambda = \frac{\lambda}{T} = \frac{0.30}{0.4 \times 10^{-3}} = 750 \text{ m s}^{-1}$$

13. Ans: C

Average wavelength of light = 550 nm.

Using Rayleigh criterion, limiting angle $= \frac{550 \times 10^{-9}}{2.8 \times 10^{-3}} = 1.964 \times 10^{-4}$ rad

Using small angle approximation, taking the distance between pixels as the “arc length”,

$s = r\theta$

$$r = \frac{s}{\theta} = \frac{3.0 \times 10^{-4}}{1.964 \times 10^{-4}} = 1.5 \text{ m}$$

Note if wavelength of light is not given:

Using wavelength as 400 nm, distance = 2.1 m

Using wavelength as 700 nm, distance = 1.2 m

Hence answer must lie between 1.2 m to 2.1 m.

14. Ans: A

For the maxima to coincide, the angle of diffraction are the same for both the red and blue light.

Since $d\sin\theta = n\lambda$, and θ is the same,

$$n_{red}\lambda_{red} = n_{blue}\lambda_{blue}$$

$$\frac{n_{red}}{n_{blue}} = \frac{\lambda_{blue}}{\lambda_{red}} = \frac{411}{685} = \frac{3}{5}$$

Hence 3rd order of red will coincide with 5th order of blue.

15. Ans: D

The gas molecules are very far apart hence no intermolecular forces and the potential energy between molecules is zero.

16. Ans: C

$$\frac{1}{2}m(c_{\text{rms}})^2 = \frac{3}{2}kT$$

$$m(c_{\text{rms}})^2 \propto T$$

$$\frac{m_{He}(c_{\text{rms}})^2_{He}}{m_{Ne}(c_{\text{rms}})^2_{Ne}} = 1 \quad \text{(thermal equilibrium)}$$

$$\frac{(c_{\text{rms}})^2_{He}}{(c_{\text{rms}})^2_{Ne}} = \frac{m_{Ne}}{m_{He}}$$

$$\frac{c_{\text{rms}He}}{c_{\text{rms}Ne}} = \sqrt{\frac{m_{Ne}}{m_{He}}}$$

$$= \sqrt{2.5}$$

$$= 1.6$$

17. Ans: A

From Z to X,

$$pV \propto T$$

$$p_Z V_Z < p_X V_X$$

$$T_Z < T_X$$

$$U \propto T$$

$$U_Z < U_X$$

18. Ans: A

$$V = \frac{Q}{4\pi\varepsilon_o r}$$

$V \propto \frac{1}{r}$ (since Q is constant)

$$\frac{V_P}{V_{surface}} = \frac{r_{surface}}{r_P}$$

$$V_P = \frac{0.10}{0.20} \times (-180)$$

$$= -90 \text{ kV}$$

19. Ans: A

Explanation: Initially effective resistance is zero. As resistance of variable resistor is increased, the effective resistance increases until it is R/2. By potential divider rule, terminal p.d will increase.

20. Ans: B

Explanation: using potential divider, potential at top left corner will be 6 V while potential at bottom right corner will be 4 V. Thus potential difference as read by voltmeter will be 2 V.

21. Ans: B

Explanation: By using RHGR, wires at the top left and bottom right corner of square will produce a B-field that cancels off one another since they have same current and at a same distance apart from center. Using RHGR, wire with $2I$ will produce a B field diagonally to top left of square.

22. Ans: D

Explanation: Recall like currents attract, unlike current repel. Both X and Z will cause a leftward force on Y. Adding up, total magnitude will be 3 F

23. Ans: A

Explanation: The soft iron core increases the flux linkage through coil Q. Hence the rate of change of flux linkage is larger, resulting in a larger induced e.m.f. in coil Q. However, the frequency of the signal remains unchanged as the frequency of the alternating voltage in P remains unchanged.

24. Ans: A

$\varepsilon = BLv = (0.54)(0.10)(2.2) = 0.12$ V

With reference to an electron in the rod, using Fleming's LHR, the force on the electron is downwards. Hence end B will be at a lower potential.

25. Ans: C

$$V_s = \frac{N_s}{N_p} V_p$$

$$\text{Power} = \frac{V_s^2}{R} = \frac{\left(\frac{N_s}{N_p} V_p\right)^2}{R} = \frac{N_s^2 V_p^2}{N_P^2 R}$$

26. Ans: B

Consider a one-period time frame,

1. Square the graph. $V^2 = 46^2 = 2116$
2. Determine the mean over one period. $\langle V^2 \rangle = \frac{area}{period} = \frac{(2116)(0.25 \times 10^{-3})}{1.0 \times 10^{-3}} = 529$
3. Take square root. $V_{r.m.s.} = \sqrt{\langle V^2 \rangle} = \sqrt{529} = 23 \text{ V}$

27. Ans: B

$$hf = \phi + E_{\max}$$

$$E_{\max} = hf - hf_0$$

The x-intercept is the threshold frequency. A large work function will result in a larger threshold frequency. The gradient of the graph is Planck's constant and hence should not change.

28. Ans: D

$$\Delta p = m\Delta v$$

$$= (9.11 \times 10^{-31})(5.8 \times 10^6)\frac{0.2}{100}$$

$$= 1.0568 \times 10^{-26} \text{ kg m s}^{-1}$$

$$\Delta p \Delta x \geq h$$

$$Min\Delta x = \frac{6.63 \times 10^{-34}}{1.0568 \times 10^{-26}}$$

$$= 6.3 \times 10^{-8} \text{ m}$$

29. Ans: A

A range of (kinetic) energies indicates a range of speeds for the β particles.
Since beta particles are emitted with a range of speeds, the products of a beta decay process cannot just consist of the daughter nuclide (product nuclide) and the beta particle as this would imply definite speeds for both products, in order for linear momentum to be conserved.

Option B is wrong. There is no such observation. Neutrino is chargeless. The total charge of the decay products is equal to the charge of the parent nuclide.

Option C is wrong. It is a true observation, but the loss in mass during β decay is due to conversion to energy released, and not the existence of the neutrino.

Option D is wrong. There is no such observation. Neutrino is chargeless so has no ionising power, and therefore cannot be observed in a cloud chamber.

30. Ans: C

Since the count rate drops significantly when there is a piece of paper, the radiation is stopped by the paper. Therefore it must be α radiation, which has low penetrative power.

The background count rate is 24 min^{-1}.
Hence initial count rate due to source is 532 – 24 = 508 min^{-1}

After two half-lives, count rate due to source = ¼ (508) = 127 min^{-1}
Hence reading = 127 + 24 = 151 min^{-1}