SAFE HANDS & IIT-ian's PACE

MONTHLY MAJOR TEST-07 (JEE) ANS KEY Dt. 05-05-2023

PHYSICS		CHEMISTRY		MATHS	
Q. NO.	[ANS]	Q. NO.	[ANS]	Q. NO.	[ANS]
1	C	31	C	61	C
2	B	32	C	62	C
3	B	33	B	63	B
4	D	34	D	64	A
5	A	35	D	65	C
6	B	36	A	66	D
7	A	37	C	67	B
8	B	38	C	68	A
9	A	39	B	69	D
10	B	40	D	70	C
11	D	41	B	71	B
12	C	42	B	72	D
13	C	43	B	73	D
14	A	44	A	74	C
15	B	45	C	75	C
16	D	46	C	76	C
17	B	47	D	77	D
18	A	48	B	78	B
19	C	49	C	79	C
20	B	50	D	80	A
21	5	51	14.3	81	4
22	8.9	52	5	82	206
23	150	53	-235.43	83	179
24	0.5	54	5	84	75
25	2	55	4	85	0
26	8	56	14.5	86	31
27	75	57	3.3	87	483
28	30	58	600	88	321
29	10	59	10	89	6
30	1.5	60	49	90	2

PHYSICS SOLUTIONS

01. C

02. B

03. B

04. Let s be the total distance . Let (s/3) distance be covered in time t_1 while the remaining distance (2s/3) in time t_2 second.

Now $\left(\frac{s}{3}\right) = v_0 t_1$ or $t_1 = \frac{s}{3v_0}$ ....(1)

and $\left(\frac{2s}{3}\right) = v_1\left(\frac{t_2}{2}\right) + v_2\left(\frac{t_2}{2}\right)$

or $t_2 = \frac{4s}{3(v_1+v_2)}$ ....(2)

Average velocity = $\frac{s}{t_1+t_2} = \frac{s}{\frac{s}{3v_0}+\frac{4s}{(v_1+v_2)}}$

$= \frac{3v_0(v_1+v_2)}{v_1+v_2+4v_0}$

05. Let 'u' and 'a' be the initial velocity and acceleration of the body respectively. For first two second (t = 2 sec), the distance covered is 200 cm.

Now using, $s = u\,t + \frac{1}{2}a\,t^2$

we have, $200 = u\,(2) + (1/2)\,a\,(2)^2$

.....(1)

After four seconds of this journey i.e., after a time t = 6 sec

the distance covered is

200 cm + 220 cm = 420 cm.

Hence $420 = u\,(6) + (1/2)\,a\,(6)^2$ .....(2)

Solving equations (1) and (2),

we get, u = 115 cm/sec and a = – 15 cm/sec^2

Now velocity after 7 seconds

= u + a t =115 + (–15) 7 = 10 cm/sec

Hence correct answer is (A)

06. Let x_1 and x_2 be the distance travelled by the car before they stop under deceleration. Using the formula $v^2 = u^2 + 2a\,s$,

we have, $0 = (10)^2 - 2 \times 2 \times x_1$

and $0 = (12)^2 - 2 \times 2 \times x_2$

Solving we get,

x_1 = 25 metre and x_2 = 36 metre,

Total distance covered by the two cars

$x_1 + x_2 = 25 + 36 = 61$ metre

Distance between the two cars when they stop

= 150 – 61 = 89 metre

Hence correct answer is (B)

07. The initial distance between the trains = 250 m. Before the application of brakes, the relative velocity of the passenger train with respect to goods train = (40 – 20) =20 m/sec. When the brakes were applied (after reaction time), the distance between the trains

= 250 – (20 × 0.5) = 240 metre.

The relative acceleration of passenger train = (–1 – 0) = – 1 m/sec^2. The crash can only be avoided provided that after applying the brakes the relative velocity of the passenger train with respect to goods train becomes zero before the relative distance becomes zero.

Now applying the formula $v^2 = u^2 + 2\,a\,s$, we have $0 = (20)^2 - 2 \times 1 \times s$

or $s = \frac{(20)^2}{2} = \frac{400}{2}$ = 200 metre

This is less than the distance between the trains before the application of brakes.

Hence the crash can be avoided.

Hence correct answer is (A).

08. b

09. Acceleration $= \frac{\vec{F}}{m} = \frac{6\hat{i} + 8\hat{j}}{10}$ in the direction of force and displacement

$\vec{S} = \vec{u}t + \frac{1}{2}\vec{a}t^2 = 0 + \frac{1}{2}\left(\frac{6\hat{i} + 8\hat{j}}{10}\right) 100$

$= 30\hat{i} + 40\hat{j}$

So the displacement is 50 m along $\tan^{-1}\frac{4}{3}$ with x-axis

Hence correct answer is (A)

10. W = Δ(KE)

11. d disp. of first particle after 2 sec $d_1 = v_1 t$

$= 2(4\hat{i} + 3\hat{j}) = 8\hat{i} + 6\hat{j}$

Position after 2 sec $= r_1 + d_1 = (3\hat{i} + 5\hat{j}) + (8\hat{i} + 6\hat{j})$

$= 11\hat{i} + 11\hat{j}$

disp of sec particle after 2 sec $d_2 = u_2 t = 2a\hat{i} + 14\hat{j}$

Position after 2 sec $= r_2 + d_2 = (2a - 5)\hat{i} + (14 - 3)\hat{j}$

for collision $2a - 5 = 1$

$a = 8$

12. Two types of acceleration are experienced by the car

(i) Radial acceleration due to circular path,

$a_r = \frac{v^2}{r} = \frac{(30)^2}{500} = 1.8 \text{ m/s}^2$

(ii) A tangential acceleration due to increase of tangential speed given by

$a_t = \Delta v/\Delta t = 2 \text{ m/s}^2$

Radial and tangential acceleration are perpendicular to each other.

Net acceleration of car a

$= \sqrt{a_r^2 + a_t^2} = \sqrt{(1.8)^2 + (2)^2} = 2.7 \text{ m/s}^2$

Hence correct answer is (C)

13. (C)

Consider the case of a body of mass m placed on the earth's surface (mass of the earth M and radius R). If g is acceleration due to gravity, then

$mg = G\frac{M_e m}{R^2}$ or $g = \frac{GM_e}{R^2}$

where G is universal constant of gravitation.

Now when the radius is reduced by 1%, i.e., radius becomes 0.99 R, let acceleration due to gravity be g', then

$g' = \frac{GM_e}{(0.99R)^2}$

From equation (A) and (B), we get

$\frac{g'}{g} = \frac{R^2}{(0.99R)^2} = \frac{1}{(0.99)^2}$

$g' = g \times \left(\frac{1}{0.99}\right)^2$ or $g' > g$ Thus , the value of g is increased.

14. a

15. Equation of S.H.M. $y = A \sin(\omega t + \phi)$

when displacement is half of amplitude

$\Rightarrow y = \frac{A}{2}$

$\frac{A}{2} = A \sin(\omega t + \phi)$

$\sin(\omega t + \phi) = 1/2$

$\omega t + \phi = 30^0$ or 150^0

When particles are in opposite direction at that moment, phase of both particle will be 30^0 & 120^0 respectively.

Hence correct answer is (B)

16. At y displacement , velocity of particle is

$v = \omega\sqrt{a^2 - y^2}$

where ω is constant & a is amplitude

if T is time period, then $\omega = 2\pi/T$

$\therefore \quad v = \frac{2\pi}{T}\sqrt{a^2 - y^2}$

$v = \frac{2 \times 22/7}{11/7}\sqrt{(10)^2 - (0.6)^2}$

$v = 3.2$ m/sec.

kinetic energy of particle at displacement

$k = \frac{1}{2} mv^2$

$k = \frac{1}{2} \times 0.8 \times (3.2)^2$

$k = 4.1J$

Hence correct answer is (D)

17. Since temperature is varying linearly so

$$T = \frac{60}{10\times60} t^\circ C/\text{sec}. = \frac{t}{10} ^\circ C/\text{sec}$$

Now,

$$\frac{dH}{dt} = \frac{KA(T_1 - T_2)}{\ell}$$

$$\frac{dH}{dt} = \frac{KAT}{\ell}$$

$$\frac{dH}{dt} = \frac{KAt}{10\ell}$$

$$H = \frac{KAt^2}{20\ell}$$

$$= \frac{200\times1\times10^{-4}\times(600)^2}{20\times20\times10^{-2}}$$

= 1800 Joule

18. $Q = \frac{KA(Q_1 - Q_2)t}{x}$

$\Rightarrow$ 4800 x 80 = $\frac{K\times3600\times100\times3600}{10}$

$\Rightarrow$ K = 0.003 cal/cm/ºC

19. $E_m \propto T^5$ and $\lambda_m \propto \frac{1}{T}$ i.e. on increasing temperature λ_m decrease and E_m increases

Hence the correct answer is (C).

20. b

21. The velocity v acquired by the parachutist after 10 s:

$$v = u + gt = 0 + 10 \times 10 = 100 \text{ ms}^{-1}$$

Then, $s_1 = ut + \frac{1}{2}gt^2 = 0 + \frac{1}{2} \times 10 \times 10^2 =$ 500m

The distance travelled by the parachutist under retardation is

$$s_2 = 2495 - 500 = 1995 \text{ m}$$

Let v_g be the velocity on reaching the ground. Then

$$v_g^2 - v^2 = 2as_2$$

or $v_g^2 - (100)^2 = 2 \times (-2.5) \times 1995$ or

$v_g = 5 \text{ ms}^{-1}$

22. $u_x = 16 \cos 60° = 8 \text{ ms}^{-1}$

Time taken to reach the wall = 8/8 = 1 s

Now $u_y = 16 \sin 60° = 8\sqrt{3} \text{ ms}^{-1}$

$$h = 8\sqrt{3}\times1 - \frac{1}{2} \times 10 \times 1 = 13.86 - 5 = 8.9\text{m}$$

23. If the plane makes an angle 6 with horizontal, then $\tan\theta = 8/15$. If R is the normal reaction,

$$R = 170g \cos\theta = 170 \times 10 \times \left(\frac{15}{17}\right) = 1500 \text{ N}$$

Force of friction on A = 1500 × 0.2 = 300 N

Force of friction on B = 1500 × 0.4 = 600 N

Considering the two blocks as a system, the net force parallel to the plane is

= 2 × 170 g sin θ - 300 - 600 = 1600 - 900 = 700 N

$\therefore$ Acceleration = $\frac{700}{340} = \frac{35}{17} \text{ms}^{-2}$

Consider the motion of A alone.

$$170 \text{ g} \sin\theta - 300 - P = P170 \times \frac{35}{17}$$

(where P is pull on the bar)

P = 500 -350= 150 N

24. Retardation of train = 20/4 = 5 ms^{-2}

It acts in the backward direction. Fictious force on suitcase = 5m Newton, where m is the mass of suitcase.

In acts in the forward direction. Due to this force, the suitcase has a tendency to slide forward. If suitcase is not to slide, then 5m = force f of friction

or 5m = m mg or $m = \frac{5}{10} = 0.5$

25. From work-energy theorem,

$$\Delta KE = W_{net} \text{ or } K_f - K_i = \int Pdt$$

Or $\quad \frac{1}{2}mv^2 - 0 = \int_0^2 \left(\frac{3}{2}t^2\right)dt$

Or $\quad v^2 = \left|\frac{t^3}{2}\right|_0^2 \quad$ or $\quad v = 2\ ms^{-1}$

26. From work-energy theorem, for upward motion

$\frac{1}{2}m(16)^2 = mgh + W$ (work done by air resistance)

for downward motion,

$\frac{1}{2}m(8)^2 = mgh - W$

$\Rightarrow \quad \frac{1}{2}[(16)^2 + (8)^2] = 2gh$

or $h = 8$ m

27. The bullet and block will meet after time

$$t = \frac{h}{u_{rel}} = \frac{100}{100} = 1$$

During this time, distance travelled by the block,

$$s_1 = \frac{1}{2}gt^2 = \frac{1}{2}\times 10\times 1^2 = 5\,m$$

Distance travelled by the bullet,

$s_2 = 100 - s_1 = 95$ m

Velocity of the bullet before collision,

$u_2 = u - gt = 100 - 10 \times 1 = 90$ m/s

Velocity of the block before collision,

$u_1 = gt = 10$ m/s

Let V be the combined velocity after collision.

According to the law of conservation of momentum,

$m_1u_1 + m_2u_2 = (m_1 + m_2)V$

or $\quad 0.01 \times (-10) + 0.01 \times 90 = 0.02V$

(Velocity in upward direction is considered positive.)

Solving, we get V = 40 m/s.

Maximum height risen by the block = $\frac{V^2}{2g}$ = 80 m

Height reached above the top of the tower is $80 - s_1 = 80 - 5 = 75$ m

28. From conservation of momentum along incident direction

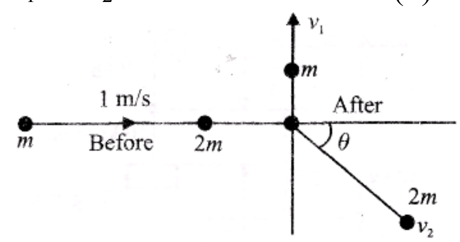
$m \times 1 = 2\,mv_2 \cos\theta$

(i)

From conservation of momentum along perpendicular direction,

$m \times 0 + 2\,m \times 0 = mv_1 - 2\,mv_2 \sin\theta$

$\Rightarrow \quad v_1 = 2v_2 \sin\theta \qquad$ (ii)



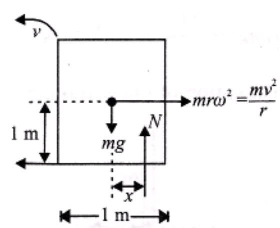
From energy conservation,

$\frac{1}{2}m \times (1)^2 = \frac{1}{2}mv_1^2 + \frac{1}{2}2mv_2^2$

(iii)

From Eqs. (i), (ii) and (iii), we get θ = 30°.

29. The free-body diagram of the box w.r.t. the truck is as shown in Fig..



For vertical equilibrium, mg = N

For horizontal equilibrium, f = (mv)/r

For rotational equilibrium, f × 1 = N × x

For no tipping to take place, x < (1/2) m

So, $mg \times x = \frac{mv^2}{r} \Rightarrow \quad x = \frac{v^2}{rg} < \frac{1}{2}$

$\Rightarrow \quad v < \sqrt{\frac{rg}{2}} = 10$ m/s

30. 1.5