Answers to 2024 JC2 Preliminary Examination H1 Paper 1

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

Suggested Solutions:

1 Assume that the diameter of the cross-section of the wire in a paper clip is 1 mm.

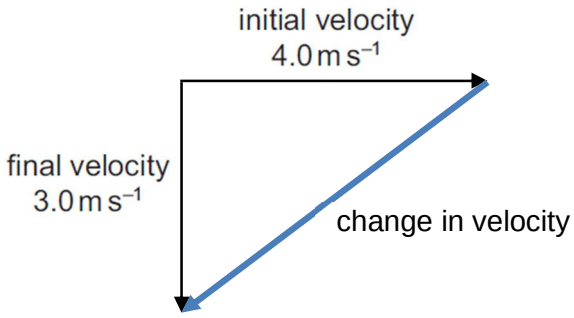
Cross-sectional area of the wire in a paper clip $= \pi\left(\frac{0.001}{2}\right)^2 = 7.85\times10^{-7}\ \text{m}^2 \approx 8\times10^{-7}\ \text{m}^2$

Answer: C

2 nano should be 10^{-9}

Answer: B

3



Answer: B

4 Using $v^2 = u^2 + 2as = 0 + 2(9.81)(2.5)$

$\rightarrow \quad v = 7.0\ \text{m s}^{-1}$

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

$\rightarrow\ 0.12 = 7.0t + \frac{1}{2}(9.81)t^2$

$\rightarrow \quad t = 0.0167\ \text{s}$

Answer: A

5 Horizontally, using $s = ut + \frac{1}{2}at^2$

$\rightarrow \quad 900 = (450\cos 31.6°)t + 0$

$\rightarrow \quad t = 2.35 \text{ s}$

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

$\rightarrow \quad s = (450\sin 31.6°)(2.35) + \frac{1}{2}(-9.81)(2.35)^2$

$= 527 \text{ m}$

Answer: A

6 In throwing vertically upward, the ball has the same horizontal velocity as the thrower. So the ball would be caught if the thrower maintain a constant velocity.

Answer: C

7 At equilibrium, force by air on four propellers = weight of drone

$4\left[(v_{\text{air}} - 0)\frac{dm}{dt}\right] = m_{\text{drone}}g$

$4\left[(v_{\text{air}} - 0)(0.40)\right] = (1.2)(9.81)$

$v_{\text{air}} = 7.4 \text{ m s}^{-1}$

Answer: C

8 Let T be the tension in the spring.

At equilibrium, $T = (0.30)(9.81)$

Immediately after the thread is cut,

$T - mg = ma$

$(0.30)(9.81) - (0.20)(9.81) = 0.20a$

$a = 4.9 \text{ m s}^{-2}$

Answer: A

9 Momentum has to be conserved since there is no external net force acting on the system (comprising the two asteroids).

As the collision is inelastic, some of the kinetic energy of the system could be converted to other forms of energy such as thermal energy which raises their temperature.

Answer: C

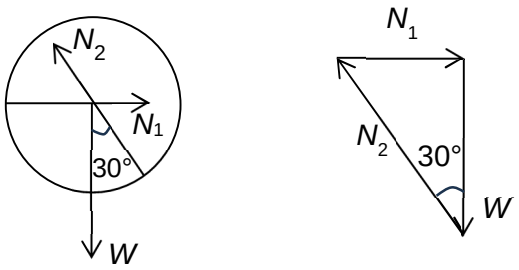
10 Torque of couple $= (5.0)(0.60\sin 40°) = 1.9 \text{ N m}$

Answer: A

11 Area under the *F*-*x* graph = $\frac{1}{2}(T_2 + T_1)(x_2 - x_1)$

Answer: B

12



Resolving the forces,
$N_2 \sin 30° = N_1$ (1)
$N_2 \cos 30° = W$ (2)
$\frac{(1)}{(2)}$: $\tan 30° = \frac{N_1}{W}$
$N_1 = W \tan 30° = 15 \tan 30° = 8.66 = 8.7$ N (2s.f.)

(Alternative: Using vector triangle)
$N_1 = W \tan 30° = 15 \tan 30° = 8.66 = 8.7$ N (2s.f.)

Answer: C

13 By conservation of energy, loss in K.E. = work done against frictional force.
$\frac{1}{2}mu^2 - 0 = fd$
$f = \frac{mu^2}{2d} = \frac{(800)(30)^2}{2(50)} = 7200$ N

Answer: C

14 $v = u + at = gt$

Kinetic energy $= \frac{1}{2}mv^2 = \frac{1}{2}m(gt)^2 = \left(\frac{mg^2}{2}\right)t^2$. This is given by Option A or C.

Based on conservation of energy,
Potential Energy = Total Energy – Kinetic energy

Answer: A

15 Using conservation of energy,

loss in G.P.E. = gain in K.E. + work done against frictional force

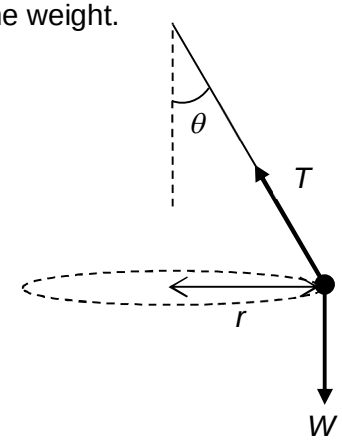
$$mgh = \frac{1}{2}mv^2 + f(200)$$

$$(60)g(50) = \frac{1}{2}(60)(20)^2 + f(200)$$

$$f = 87 \text{ N}$$

Answer: A

16 The horizontal component of *T* which is directed towards the centre of the circle provides the centripetal force. The vertical component of *T* is equal to the weight.



Applying Newton's second law of motion,

$$T\sin\theta = \frac{mv^2}{r} \qquad \text{- - - - (1)}$$

$$T\cos\theta = mg \qquad \text{- - - - (2)}$$

$$\frac{(1)}{(2)} : \tan\theta = \frac{v^2}{rg} = \frac{r\omega^2}{g}$$

Answer: D

17 When the passengers feel weightless, the centripetal acceleration is equal to the gravitational acceleration at that point.

$$\frac{v^2}{r} = g$$

$$v = \sqrt{rg} = \sqrt{(1000)(9.81)} = 99 \text{ m s}^{-1}$$

Answer: A

18 For circular motion at the highest point,

$$mg - N = \frac{mv^2}{r}$$
$$W - \frac{W}{3} = \frac{mv^2}{r}$$
$$mg - \frac{mg}{3} = \frac{mv^2}{r}$$
$$\frac{2mg}{3} = \frac{mv^2}{r}$$
$$v = \sqrt{\frac{2gr}{3}}$$

Answer: B

19 $R = \frac{\rho L}{A} = \frac{\rho b}{ac}$

Answer: B

20 From Fig. 20.1, when the current is 5 mA, the p.d. across the diode is 0.8 V
The p.d. across the 50 Ω resistor is given by V = (5 mA)(50 Ω) = 0.25 V
So the p.d. across the supply = 0.8 + 0.25 = 1.05 V

Answer: C

21 Using the equation $P = IV$,

$$\text{Current in circuit} = \frac{\text{total power dissipated in circuit}}{\text{e.m.f.}} = \frac{P + p}{E}$$

Answer: B

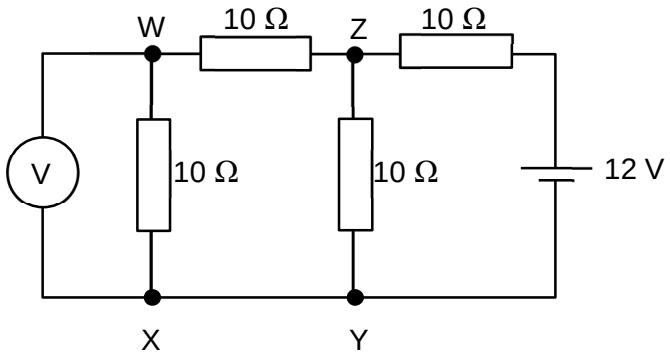
22 The variable resistor is set such that current can pass through the whole resistor (i.e. resistance = R), or that current can totally bypass the resistor (resistance = 0).

Hence, the maximum p.d. happens when the resistance of variable resistor is zero → maximum p.d. = 6 V

Minimum p.d happens when the resistance of the variable resistor is maximum →
minimum p.d. $\frac{R}{R+R}(6) = 3$ V

Answer: D

23



Effective resistance across YZ $= \dfrac{R_{YZ}R_{XZ}}{R_{YZ}+R_{XZ}} = \dfrac{10\times(10+10)}{10+(10+10)} = 6.667\ \Omega$

P.d. across YZ = p.d across XZ $= \dfrac{R_{eff}}{10+R_{eff}}\times E = \dfrac{6.667}{10+6.667}\times 12 = 4.80$ V

Voltmeter reading = pd across WX = half of pd across XZ = 2.4 V

Answer: A

24 By Fleming's left-hand rule, *F* is perpendicular to *B*.

Answer: D

25 $F_B = Bqv\sin 30° = B(2e)(0.5v) = Bev$

$a = \dfrac{F_B}{m} = \dfrac{Bev}{m}$

Answer: A

26 At equilibrium,

$F_E = \dfrac{qV}{d} = mg$

When d is twice, F_E is reduced by half,

$F'_E = \dfrac{1}{2}mg$

$F_{resultant} = mg - \dfrac{1}{2}mg = 0.5mg = ma$

$a = 0.5g$

Oil drop accelerates downwards as weight is now greater than upward electric force.

Answer: D

27 Using Right Hand Grip rule, the direction of flux density at O due to the currents in each option are:
A: leftwards (XO)
B: rightwards (OX)
C: upwards (OY)
D: downwards (YO)

Answer: D

28 Majority of the α-particles pass through the gold foil without being deflected since the atom consists of mostly empty space. Some are deflected by small angles. Very few are detected on the same side as the alpha beam.

Answer: D

29 An α-particle is a helium nucleus ${}^{4}_{2}\text{He}$. Hence the answer can only be either option A or B.

The symbol of a neutron is ${}^{1}_{0}\text{n}$ and not ${}^{1}_{1}\text{n}$ as depicted in option A.

Answer: B

30 Total mass of nuclides after 12 days $= 200\left(\frac{1}{2}\right)^{6} + 100\left(\frac{1}{2}\right)^{3} = 15.6$ g

Answer: C