## Answers to 2014 JC2 Preliminary Examination Paper 1 (H1 Physics)

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

**1** Units of $c$ = J kg$^{-1}$K$^{-1}$ = (kg m$^2$ s$^{-2}$) kg$^{-1}$K$^{-1}$ = m$^2$ s$^{-2}$ K$^{-1}$
Units of $b$ = units of $c$ / K$^3$ = m$^2$ s$^{-2}$ K$^{-4}$

Answer: B

**2** Systematic error: All measurements are less than the true reading of $g$, which is 9.81 m s$^{-2}$.
All the measurements are very close to one another. Hence they were precise.

Answer: C

**3** Since $d = 2r$, $\Delta d = 2\Delta r$

Vol = $\frac{4}{3}\pi r^3 = \frac{4}{3}\pi(1.70)^3$ = 20.580 cm$^3$

$$\frac{\Delta \text{Vol}}{\text{Vol}} = 3\frac{\Delta r}{r}$$

$$\frac{\Delta \text{Vol}}{20.580} = 3\frac{0.005}{1.70}$$

$\Delta$Vol = 0.182 ≈ 0.2 (1 s.f.)

Vol $\pm$ $\Delta$Vol = (20.6 $\pm$ 0.2) cm$^3$

Answer: C

**4** At $t = 3$ s,

$$s_A - s_B = 27$$

$$(15\times 3) - \left(\frac{1}{2}\times a_B \times 3^2\right) = 27$$

$$a_B = 4.0 \text{ m s}^{-2}$$

Let the time for car B to catch up with car A be $t'$.

$$15\times t' = \frac{1}{2}\times 4.0\times t'^2$$

$$t' = 7.5 \text{ s}$$

Therefore, the additional time required is $7.5 - 3 = 4.5$ s.

Answer: B

**5** Let $v$ be the speed of the ball upon impact with the sand bed.
$v = u + at$
$v = 9.81 \times 1.0$
$v = 9.81 \text{ m s}^{-1}$

Let the acceleration of the ball be $a'$ as it moves into the sand bed.
$v'^2 = v^2 + 2a's$
$0 = 9.81^2 + (2 \times a' \times 0.0095)$
$a' \approx -5100 \text{ m s}^{-2}$

Therefore, the average deceleration of the ball is $5100 \text{ m s}^{-2}$.

Answer: C

**6** At maximum height, the bomb is moving horizontally with velocity 100 cos 40° m s$^{-1}$ = 76.6 m s$^{-1}$. At this instance when the bomb explodes, using conservation of momentum,
$m(76.6) = \frac{1}{3}mv \Rightarrow v = 230 \text{ m s}^{-1}$
Answer: B

**7** The kinetic energy of the ball at the highest point is non-zero, hence options B and D are wrong.

The vertical displacement of the ball is a parabolic equation of the form $s_y = -\left(\frac{g}{2u_x^{\,2}}\right)s_x^{\,2} + \left(\frac{u_y}{u_x}\right)s_x$. Since the gravitational potential energy is $mgs_y$, the graph should be a parabolic curve as well.

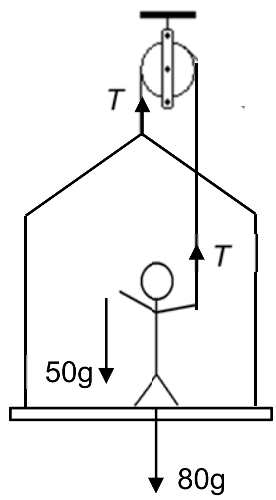
Answer: A

**8** Final velocity of the tennis ball is given by
$\frac{1}{2}mv^2 = \frac{1}{2}\left(\frac{1}{2}mu^2\right) = \frac{1}{2}\left(\frac{1}{2}m(30)^2\right) \Rightarrow v = 21.2 \text{ m s}^{-1}$
Taking vectors to the left as positive,
$\text{Impulse} = \Delta p = mv - mu = 0.30[21.2 - (-30)] = 15.4 \text{ N s}$

Answer: C

**9** Considering forces acting on the crate and man,
$2T - 80g - 50g = (80 + 50)a$
$T = \frac{130(g + a)}{2} = 770 \text{ N}$

Answer: B

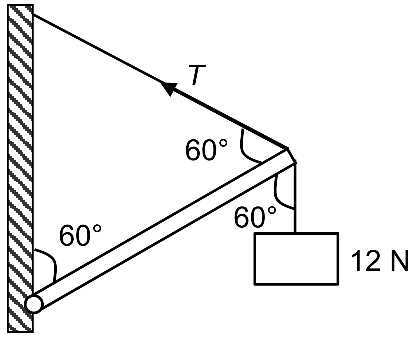


**10** Taking moments about the hinge,

$$T\sin 60°(L) = 20\sin 60°\left(\frac{L}{2}\right) + 12\sin 60°(L)$$

$T = 22$ N

Answer: A




**11** An object moving with constant velocity has no net force acting on it and as such, is in equilibrium.

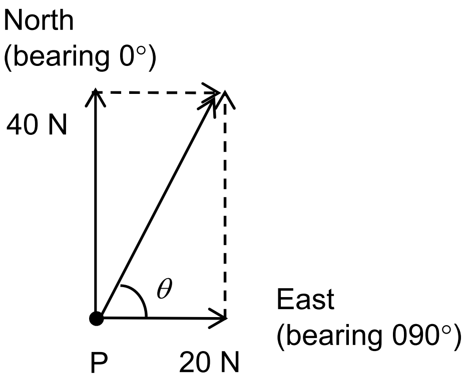
Answer: C

**12** $\tan\theta = \dfrac{40}{20} \Rightarrow \theta = 63.4^o$

To maintain equilibrium, the additional force must be applied in a direction that is directly opposite to the resultant force.

Thus it is at a bearing of $270° - 63.4° = 207°$

Answer: C




**13** At the bottom of the ramp,
Gain in KE of a block is equal to loss in GPE of block
$\frac{1}{2} mv^2 = mgh$
$v^2 = 2gh$
$v = \sqrt{2gh}$
$v \propto \sqrt{h}$

$$\frac{v_1}{v_2} = \sqrt{\frac{h_1}{h_2}} = \sqrt{\frac{X\sin 60°}{Y\sin 30°}} = \sqrt{\frac{2\sin 60°}{\sin 30°}} = 1.9$$

Answer: B

**14** At constant speed,
Driving force on boat = Total frictional drag $F$

$P = Fv$

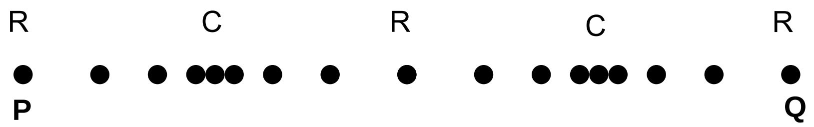
Answer: B

**15** For elastic potential energy of spring, $U = \frac{1}{2}kx^2$ where $x$ is the extension of the spring.

Graph C shows a $U \propto x^2$ relationship.

Answer: C

**16**




region of rarefaction – R
region of compression – C

Wavelength of sound wave = 0.250 m
Speed of sound = $f\lambda$
= (1500) (0.25)
= 375 m $s^{-1}$

Answer: C

**17** Using $x = \dfrac{\lambda D}{a}$,

$$0.40 \times 10^{-3} = \frac{600 \times 10^{-9} \times D}{a} \text{ ---------- (1)}$$

$$0.33 \times 10^{-3} = \frac{\lambda D}{a} \text{ ---------- (2)}$$

Solving,

$$\lambda = \frac{0.33 \times 10^{-3}}{0.40 \times 10^{-3}} \times 600 \times 10^{-9}$$

$$\lambda = 495 \text{ nm}$$

Answer: B

**18** $I \propto A^2$
For maximum intensity, $I_o \propto (3A)^2$
For minimum intensity, $I \propto (A)^2$

$$\frac{I}{I_o} = \left(\frac{A}{3A}\right)^2$$

$$I = \frac{I_o}{9}$$

Answer: D

**19** Particles in adjacent segments of a stationary wave are in antiphase.
Point B has a larger amplitude of vibration than point A. Thus the maximum kinetic energy that point B can have during the vibration is greater than A.

Answer: C

**20** In 1 second, the area of belt that passes by the point = *wv*
The amount of charge on this area is $wv\varepsilon$
Current = charge collected in 1 second = $wv\varepsilon$

Answer: A

**21** Efficiency of the lamp = $\dfrac{\text{useful power output}}{\text{total power input}}$

$$= \frac{I^2R}{I^2(R+r)}$$

$$= \frac{R}{(R+r)}$$

Answer: B

**22** Since $R = \dfrac{\rho L}{\pi r^2}$, $\dfrac{R_X}{R_Y} = \dfrac{{r_Y}^2}{{r_X}^2}$

$$\frac{I_X}{I_Y} = \frac{R_Y}{R_X}$$

$$= \left(\frac{r_X}{r_Y}\right)^2$$

$$= 4$$

$I_X = 4\ I_Y$

Total current = 5 $I_Y$

$$\frac{I_X}{I_X + I_Y} = \frac{4}{5} = 0.8$$

Answer: D

**23** Between P and Q, combined resistance = $\dfrac{(3)(4)}{(3+4)}$ = 1.71

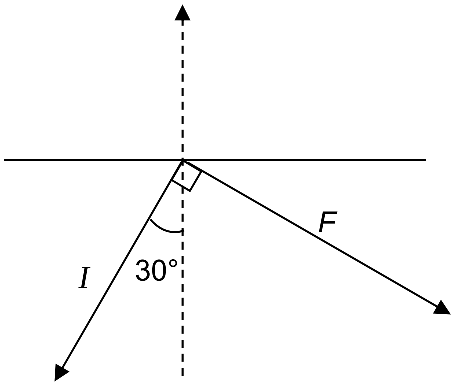
Between P and R, combined resistance = $\dfrac{(2)(5)}{(2+5)}$ = 1.43

Between P and S, combined resistance = $\dfrac{(3)(4)}{(3+4)}$ = 1.71

Between R and S, combined resistance = $\dfrac{(1)(6)}{(1+6)}$ = 0.86

Answer: D

**24** A negative charge produces a current in the opposite direction. By Fleming's Left Hand Rule, the force is directed perpendicular to both the current and the *B*-field, as shown.




Hence, the force is directed at 30° South of East.

Answer: B

**25** The forces acting on Q and R are an action-reaction pair. By Newton's third law, the arrows must be oppositely directed. This eliminates options A and D.

Wires carrying currents flowing in the same direction will cause mutually attractive forces. Hence, the answer must be C.

Answer: C

**26** Options A and D decrease the magnetic field strength at X. C does nothing. Hence, the answer must be B.

Answer: B

**27** Since electrons pass through undeflected,

$$F_E = F_B$$

$$qE = Bqv$$

$$v = \frac{E}{B} = \frac{1400}{2.0 \times 10^{-3}} = 700000 \text{ m s}^{-1}$$

By Einstein's Photoelectric Equation,

$$\frac{hc}{\lambda} = \phi + KE_{Max}$$

$$\phi = \frac{(6.63 \times 10^{-34})(3.0 \times 10^{8})}{(450 \times 10^{-9})} - [\frac{1}{2} \times (9.11 \times 10^{-31}) \times (700000)^2]$$

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

Answer: A

**28** $\dfrac{hc}{\lambda_3} = \dfrac{hc}{\lambda_1} - \dfrac{hc}{\lambda_2}$

$\dfrac{1}{\lambda_3} = \dfrac{1}{\lambda_1} - \dfrac{1}{\lambda_2}$

$\dfrac{1}{\lambda_3} = \dfrac{\lambda_2 - \lambda_1}{\lambda_1 \lambda_2}$

$\lambda_3 = \dfrac{\lambda_1 \lambda_2}{\lambda_2 - \lambda_1}$

Answer: D

**29** $p = \dfrac{h}{\lambda}$

$p_{initial} = \dfrac{h}{\lambda}$

$p_{final} = -\dfrac{h}{\lambda}$

For a photon,

$\Delta p = p_f - p_i$

$\Delta p = -\dfrac{h}{\lambda} - \dfrac{h}{\lambda}$

$\Delta p = -\dfrac{2h}{\lambda}$

$F = \dfrac{dp}{dt}$

$F = \dfrac{2nh}{\lambda}$

Answer: B

**30** By Einstein's Photoelectric Equation,

$K = hf - \Phi$

$\therefore hf = K + \Phi$

$K' = 2(K + \Phi) - \Phi$

$\therefore K' = 2K + \Phi$

Intensity does not affect the maximum kinetic energy of the electrons.

Answer: C