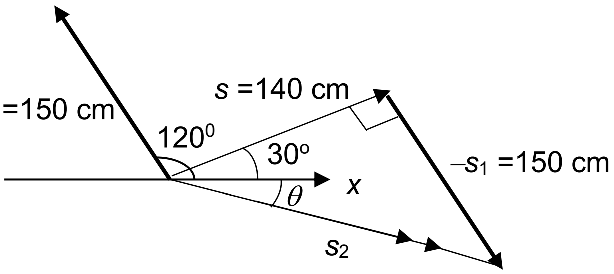
2024 DHS H2 Physics Prelim Paper 1 Suggested Solutions

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
A	**A**	**B**	**D**	**B**	**A**	**C**	**B**	**C**	**D**
Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
C	**C**	**C**	**D**	**C**	**D**	**A**	**C**	**A**	**C**
Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
A	**D**	**A**	**B**	**C**	**D**	**D**	**B**	**B**	**A**

1 **A** By dimensional analysis,

Units of $\sqrt{g\lambda} = \sqrt{\text{m}^2\ \text{s}^{-2}} = \text{m s}^{-1}$

2 **A**



$s_2 = s - s_1$

By Pythagoras theorem, $s_2 = \sqrt{140^2 + 150^2} = 205$ cm

$\tan\theta = \frac{150}{140}$ or $\theta = 47^o$

Hence $\theta = -17^o$ anti-clockwise with respect to positive x-axis

3 **B** $a = (v - u)/t = (0 - 15)/1.2 = -12.5$ m s^{-2}

$v^2 = u^2 + 2as$
$0^2 = 15^2 + 2(-12.5)s$
$s = 9.0$ m

Closest distance = 9.0 + 15(0.10) = 10.5 m

4 **D** For a (perfectly) elastic collision between two bodies, the relative speed of approach is equal to the relative speed of separation.

relative speed of P approaching Q	Option	relative speed of Q separating from P	equal ?
$(1.30)-(-0.50)$ $=1.80$ m s^{-1}	**A**	$(0.58)-(0.22)=0.36$ m s^{-1}	×
	B	$(0.40)-(0.40)=0.00$ m s^{-1}	×
	C	$(0.99)-(-0.19)=1.18$ m s^{-1}	×
	D	$(1.30)-(-0.50)=1.80$ m s^{-1}	✓

5 **B** By Newton's Third Law of Motion,
the magnitude of the force exerted on m_1 by m_2 is equal to the magnitude of the force exerted on m_2 by m_1.

6 **A** Air resistance increases proportionately with speed.
Resultant force = Weight – Air resistance

7 **C** Work done by a constant force on an object is defined as the product of the force and its displacement in the direction of the force.

8 **B** (0.5 x power output/power input) = 0.80

(0.5 x 200 000 x 250/power input) = 0.80

Power input = 31.3 MW

9 **C** Period, $T = 60\ x\ 60$ s

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{60 \times 60} = 1.75 \times 10^{-3} \text{ rad s}^{-1}$$

10 **D** At the Earth's surface: $W = \dfrac{GMm}{R^2}$

At orbit: $F = \dfrac{GMm}{(R+6R)^2} = \dfrac{1}{49}\left(\dfrac{GMm}{R^2}\right) = \dfrac{W}{49}$

11 **C** For geostationary satellites, all satellites orbit the Earth at a fixed distance from the Earth, *r*, and the orbital period *T* is the same as Earth's rotation of 24 hours. Hence, all geostationary satellites also have the same angular velocity by $\omega = \frac{2\pi}{T}$ **(options A and D are eliminated)**

For a satellite, the gravitational force F_G provides the centripetal force. Therefore,

$$\frac{GMm}{r^2} = mr\omega^2$$
$$\frac{GM}{r^2} = r\omega^2 = g$$

Therefore, the centripetal acceleration which is dependent on the radius and orbital period is the same for geostationary satellites. **(Option B is eliminated)**

Even though the speed of the satellites are the same, as given by the equation $v = r\omega$, the mass of the satellites may be different. So by $KE = \frac{1}{2}mv^2$, the kinetic energy of the satellites may be different. **(Option C is the answer)**

12 **C** Since the mixture is in thermal equilibrium, gases X and Y have the same temperature. Since $T \propto KE_{avg}$, the average kinetic energy of gases X and Y are the same.
Therefore, the average kinetic energy of molecules of X is 6.0×10^{-21} J.

13 **C** Let Q be the heat supplied to the liquid per minute,

Considering the heat capacity of the liquid: $Q = mc\Delta T = mc(4)$

Considering the latent heat of the liquid: $Q(40) = mL$

Therefore, $$\frac{c}{L} = \frac{\left(\frac{Q}{4m}\right)}{\left(\frac{40Q}{m}\right)} = \frac{1}{160}\ \text{K}^{-1}$$

14 **D** The time required for the object to move from P to Q, half a complete oscillation, is half a period, $\frac{T}{2}$. Thus, **A** and **B** are eliminated since the options are more than $\frac{T}{2}$.

Consider the time taken *t* required for the object in Simple Harmonic Motion (SHM) with amplitude *A* to move from P to X, thus

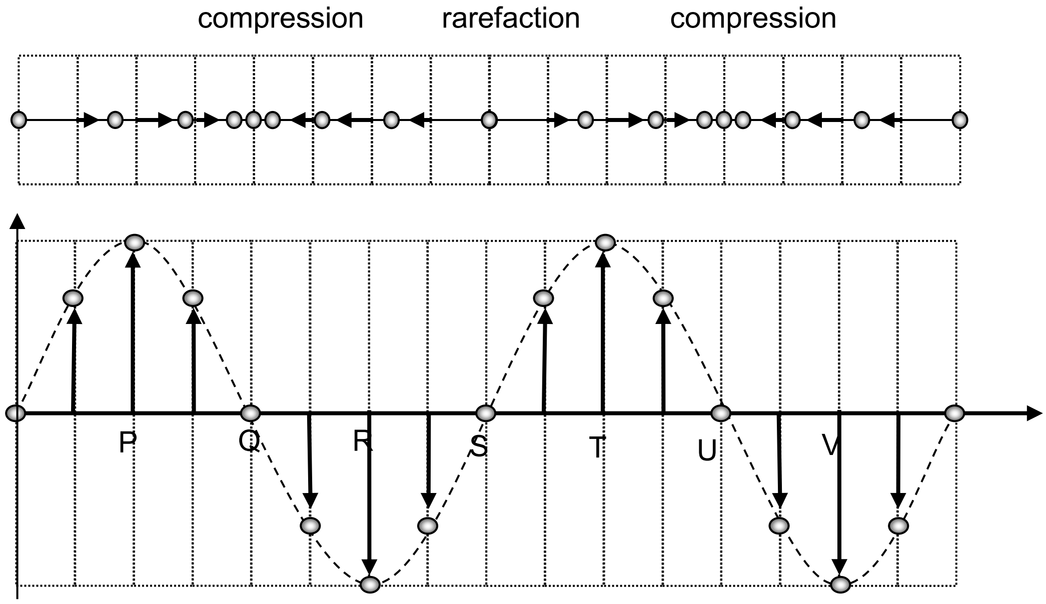
$$\frac{A}{2} = A\cos\left(\frac{2\pi}{T}t\right) \rightarrow t = \frac{T}{6}$$

and the required answer is given by

$$\frac{T}{2} - \frac{T}{6} = \frac{T}{3}$$

15 **C** Object Q experiences more damping. Hence amplitude of Q is smaller. The graphs do not pass through the origin, so B is wrong, leaving C as correct answer.

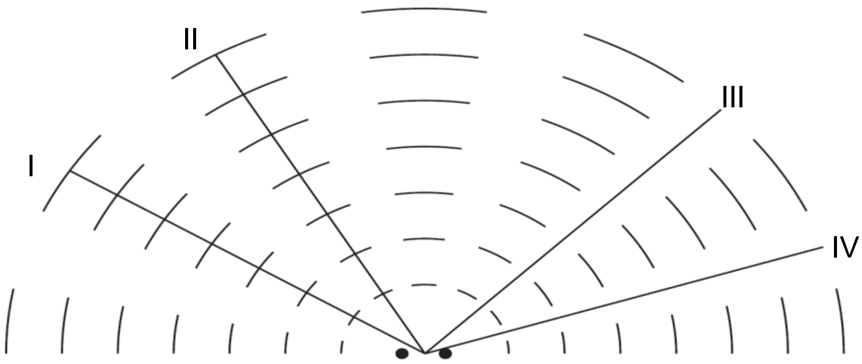
16 **D**



17 **A** Using $\frac{x}{\lambda} = \frac{\theta}{2\pi}$,

$$\frac{1}{8} = \frac{\theta}{2\pi} \rightarrow \theta = \frac{\pi}{4}$$

18 **C**



Constructive interference occurs at I, II while destructive interference occurs at III, IV.
Since sources are in phase,
path difference = λ and 2λ at II and I respectively,
path difference = 1.5λ and 2.5λ at III and IV respectively.

19 **A** An electric field strength upwards means that the lower plate is at a higher potential than the upper plate **(Options C and D are eliminated)**

$$E = \frac{|\Delta V|}{d}$$

$$\left(V_{lower} - V_{upper}\right) = Ed$$

$$-6 - V_{upper} = 4000(4 \times 10^{-3}) = 16$$

$$V_{upper} = -22 \text{ V}$$

20 **C**

For X, $R_X = \frac{\rho L}{A} = \frac{\rho l}{l^2}$

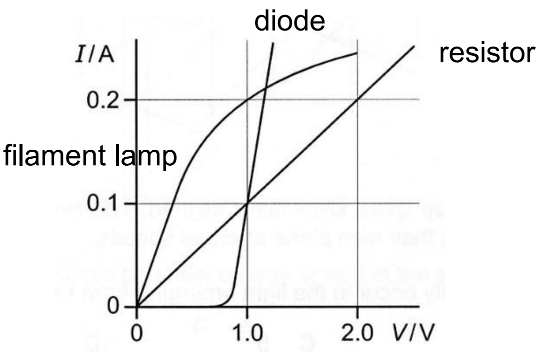
For Y, $R_Y = \frac{\rho L}{A} = \frac{2\rho l}{2l^2} = R_X$

21 **A** $I = nAve$

$$v = \frac{I}{nAe} = \frac{I}{ne\pi\frac{d^2}{4}} = \frac{4I}{ne\pi d^2}$$

Since I, n and e are constants, as x increases, d decreases and v increases.
The graph is non-linear as v is not linearly related to d.

22 **D**



$R = \dfrac{V}{I}$

for resistor, resistance = 10 Ω (constant)

for filament lamp, resistance = 5.0 Ω at 1.0 V

At about 1.2 V, the graphs for diode and filament lamp intersects and they both have the same I, V values and hence same resistance.

23 **A** Before the negative ions of mass m and charge q enter the metal container, its velocity v is found from the following:

$qV = \frac{1}{2}mv^2$ or $v = \sqrt{\dfrac{2qV}{m}}$

For the ions to travel undeflected,

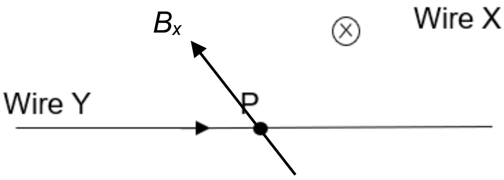
electric force qE = magnetic force Bqv

$$q\left(\frac{V}{d}\right) = Bq\left(\sqrt{\frac{2qV}{m}}\right)$$

$$\frac{V}{Bd} = \sqrt{\frac{2qV}{m}}$$

$$\frac{q}{m} = \frac{V}{2B^2d^2}$$

24 **B**



Direction of magnetic field produced by wire X at point P is as shown.

Using Fleming left hand rule to determine force on wire Y, where the vertical component of B_x is upwards in the plane of the paper.

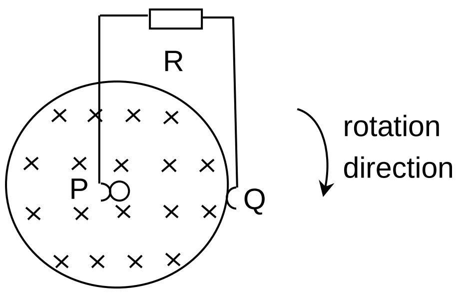
25 **C**

rate of heat dissipation $P = I_{rms}^2 R = \frac{I_o^{\ 2}}{2} R$

for half-rectified wave, $I_{rms} = \frac{I_o}{2}$

so rate of heat dissipation $P_{new} = I_{rms}^2 R = \frac{I_o^{\ 2}}{4} R = \frac{P}{2}$

26 **D**



From Fleming left hand rule, electrons at Q will experience a force towards O. Hence Q is at higher potential than P or an induced current will flow from Q to P.

27 **D** Using the de Broglie's relation, the magnitude of the momentum of a photon of wavelength λ is $p = \frac{h}{\lambda}$.

From Newton's 2nd law, the force exerted by 1 photon upon reflection off the mirror is

$$F = \frac{dp}{dt} = \frac{\Delta p}{t} = \frac{2h}{\lambda}$$

For n photons: $F = \frac{2nh}{\lambda}$

28 **B**

$$E_{photon} = \phi + eV_s$$
$$3.5 \times 10^{-19} = \phi + 1.6 \times 10^{-19}(0.25)$$
$$\phi = 3.1 \times 10^{-19} \text{ J}$$

29 **B** From $\frac{hc}{\lambda} = \phi + KE_{max}$:

As the intensity of light affects the number of photons incident on the metal rather than the energy carried by each photon, $\frac{hc}{\lambda}$, the maximum KE of an electron is independent of the intensity.

30 **A** The diagram shows that most of the alpha particles passed through the gold foil undeflected or deflected by small angles.

This indicates that the size of the nucleus relative to the size of the atom is small, as most alpha particles interacting with the gold atoms were not close enough to the nucleus to experience significant electrical repulson and hence, were only deflected by small angles or remain undeflected.

~ THE END ~