IB-HL PHYSICS PAPER SOLUTION 1 MAY -2021

Diploma Programme
Programme du diplôme
Programa del Diploma

IB PHYSICS HL PAPER 1 MAY-2021 SOLUTION WITH EXPLANATION

Physics
Higher level
Paper 1

Monday 3 May 2021 (afternoon)

1 hour

Instructions to candidates

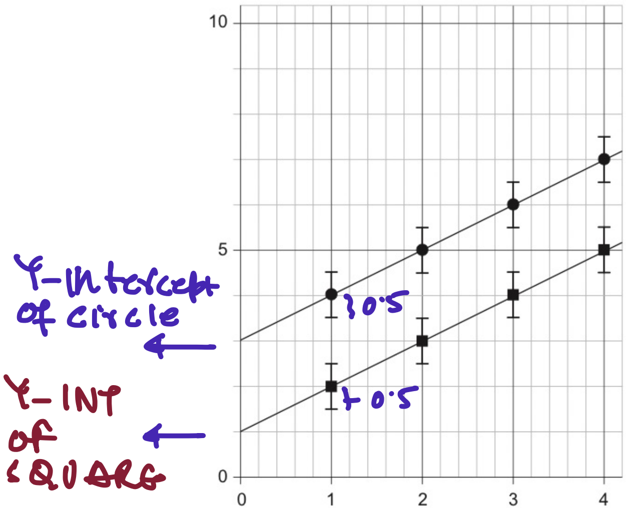
- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for this examination paper is **[40 marks]**.

2221 – 6507
19 pages

Go through the solution and understand the physics concepts

1 MAY - 2021
FREE SOLUTION

1. Two sets of data, shown below with circles and squares, are obtained in two experiments. The size of the error bars is the same for all points.



What is correct about the absolute uncertainty and the fractional uncertainty of the *y* intercept of the two lines of best fit?

	Absolute uncertainty	Fractional uncertainty
A.	larger for squares	same
B.	larger for squares	larger for squares
C.	same	same
D. ✓	same	larger for squares

(1) At $x=0$
$Y = Y_{\text{INTERCEPT}}$
SAME $(\Delta Y) \simeq \pm\Delta Y$
HENCE – SAME FOR BOTH

(2) FRACTIONAL UNCERTANITY
$= \dfrac{\Delta Y}{Y_{\text{INTERCEPT}}}$

FOR SQUARE
$= \dfrac{0.5}{1} = 0.5$

FOR CIRCLE
$= \dfrac{0.5}{3} = 0.17$

$FU_{\text{SQURE}} > FU_{\text{CIRCLE}}$

2. A large stone is dropped from a tall building. What is correct about the speed of the stone after 1 s?

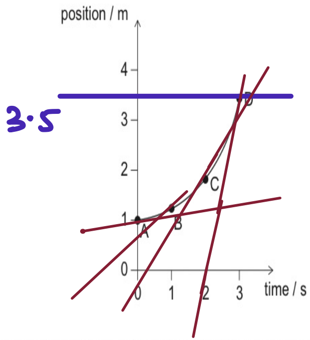
   A. It is decreasing at increasing rate.

   B. It is decreasing at decreasing rate.

   C. It is increasing at increasing rate.

   D. It is increasing at decreasing rate.

3. The graph shows how the position of an object varies with time in the interval from 0 to 3 s.



At which point does the instantaneous speed of the object equal its average speed over the interval from 0 to 3 s?

C

option is missing in the question paper

ANS – 2

$mg - F_{air} = ma$

$a = \frac{mg - F_{air}}{m}$

$F_{air} \propto v$

v increases then F_{air} ↑

Hence $a = \frac{mg - F_{air}}{m}$

acceleration is rate of speed change hence D

F_{air} ↑, ↓ mg

ANS – 3

Avg speed over (1 – 3 sec)

$v_{avg} = \frac{3.5}{3-0} = 1.17$ mt/sec

↓

This velocity is approx equal to slope of C

4. A car takes 20 minutes to climb a hill at constant speed. The mass of the car is 1200 kg and the car gains gravitational potential energy at a rate of 6.0 kW. Take the acceleration of gravity to be 10 m s^{-2}. What is the height of the hill?

A. 0.6 m

B. 10 m

C. 600 m ✓

D. 6000 m

ANS-4 →

$$\text{Power} = \frac{\text{Work}}{\text{time}}$$

$$\text{Work} = \text{Power} \times \text{time}$$

$$mgh = 6.0 \times 10^3 \times 20 \times 60$$

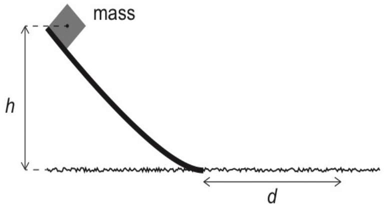
$$h = \frac{6.0 \times 10^3 \times 1200}{1200 \times 10}$$

$$= 600 \text{ mt}$$

NOTE

→ Remember gravitational force is conservative force

5. A mass is released from the top of a smooth ramp of height h. After leaving the ramp, the mass slides on a rough horizontal surface.



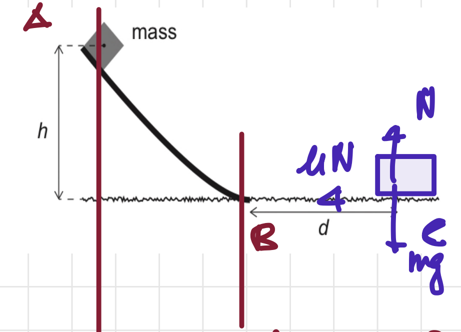
The mass comes to rest in a distance d. What is the coefficient of dynamic friction between the mass and the horizontal surface?

A. $\frac{gd}{h}$

B. $\sqrt{\frac{d}{2gh}}$

C. $\frac{d}{h}$

D. $\frac{h}{d}$ ✓



Apply conservation of energy between point A & point B.

$mgh = \frac{1}{2} m v^2 \Rightarrow v = \sqrt{2gh}$

Apply $K_f - K_i$ = Total energy (Between point B & C.)

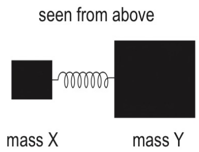
$0 - \frac{1}{2} m (v^2) = -\mu N (d)$

$\frac{1}{2} m (\sqrt{2gh})^2 = \mu (mg) d$

$mgh = \mu (mg) d$

$\mu = h/d$

6. Masses X and Y rest on a smooth horizontal surface and are connected by a massless spring. The mass of X is 3.0 kg and the mass of Y is 6.0 kg. The masses are pushed toward each other until the elastic potential energy stored in the spring is 1.0 J.



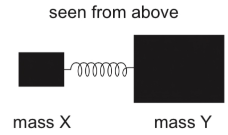
The masses are released. What is the maximum speed reached by mass Y?

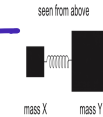
A. $0.11\,\mathrm{m\,s^{-1}}$

B. $0.33\,\mathrm{m\,s^{-1}}$ ✓

C. $0.45\,\mathrm{m\,s^{-1}}$

D. $0.66\,\mathrm{m\,s^{-1}}$





$v_x \leftarrow$ $\rightarrow v_y$

↳ when pushed

Apply conservation of linear momentum

$m_x v_x = m_y v_y$

$3 v_x = 6 v_y \Rightarrow$ $\boxed{v_x = 2 v_y}$

Apply conservation of energy.

$1.0 = \frac{1}{2} m v_x^2 + \frac{1}{2} m_y v_y^2$

$1.0 = \frac{1}{2}(3)(2v_y)^2 + \frac{1}{2}(6) v_y^2$

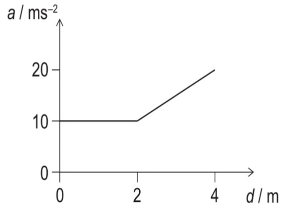
$1.0 = \frac{1}{2}\left[4 v_y^2 \times 3 + 6 v_y^2\right]$

$2 = \left[18 v_y^2\right]$

$v_y^2 = \frac{2}{18} \Rightarrow v_y = \frac{1}{3}$

$= 0.33\,\mathrm{ms^{-1}}$

7. A force acts on an object of mass 40 kg. The graph shows how the acceleration *a* of the object varies with its displacement *d*.



What is the work done by the force on the object?

A. 50 J

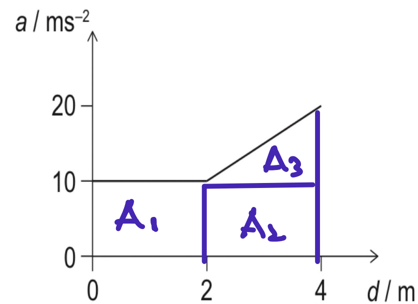
B. 2000 J ✓

C. 2400 J

D. 3200 J

Work done $= \vec{F}\cdot\vec{d}$

$= m[a\,d]$ → AREA OF THE GRAPH



$A_1 = 10 \times 2$

$A_2 = 10 \times 2$

$A_3 = \frac{1}{2} \times 10 \times 2$

$A_1 + A_2 + A_3 = 20 + 20 + 10 = 50$

Hence work done $= m[ad] = 40 \times 50$

$= 2000\,J$

8. Which aspect of thermal physics is best explained by the molecular kinetic model?

A. The equation of state of ideal gases ✓

B. The difference between Celsius and Kelvin temperature

C. The value of the Avogadro constant

D. The existence of gaseous isotopes

ANS-8

IDEAL GAS EQUATION CAN BE OBTAINED BY KINETIC THEORY (MOLECULAR)

9. When 40 kJ of energy is transferred to a quantity of a liquid substance, its temperature increases by 20 K. When 600 kJ of energy is transferred to the same quantity of the liquid at its boiling temperature, it vaporizes completely at constant temperature. What is

$$\frac{\text{specific latent heat of vaporization}}{\text{specific heat capacity of the liquid}}$$

for this substance?

A. $15\,K^{-1}$

B. $15\,K$

C. $300\,K^{-1}$

D. $300\,K$ ✓

ANS-9

CASE-I

$40 \times 10^3 = m(s)(20)$ — ①

CASE-2

$600 \times 10^3 = mL$ — ②

$\frac{\text{EQUATION ①}}{\text{EQUATION ②}} \Rightarrow \frac{40 \times 10^3}{600 \times 10^3} = \frac{m s 20}{m L}$

$\frac{1}{15} = \frac{s(20)}{L}$

$\frac{L}{s} = 300\,K$

10. Two ideal gases X and Y are at the same temperature. The mass of a particle of gas X is larger than the mass of a particle of gas Y. Which is correct about the average kinetic energy and the average speed of the particles in gases X and Y?

	Average kinetic energy	Average speed
A.	larger for Y	larger for Y
✓ B.	same	larger for Y
C.	same	same
D.	larger for Y	same

X Y

Temp → T T → same

Hence **KE will remain same** for X & Y.

$$KE = \frac{3}{2}kT = \frac{3}{2}\left(\frac{R}{N}\right)T$$

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

$$v = \sqrt{\frac{2(KE)}{m}}$$

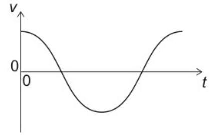
KE – constant

$$v \propto \frac{1}{\sqrt{m}}$$

$$m_X > m_Y$$

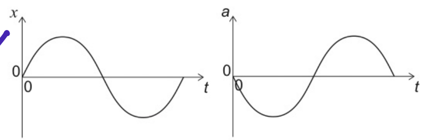
$$v_X < v_Y$$

11. An object performs simple harmonic motion (shm). The graph shows how the velocity *v* of the object varies with time *t*.

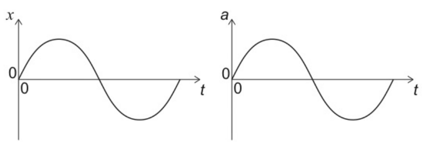


The displacement of the object is x and its acceleration is *a*. What is the variation of x with *t* and the variation of *a* with *t*?

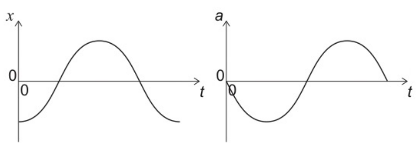
A.



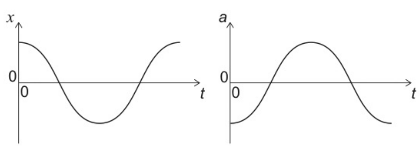
B.



C.



D.

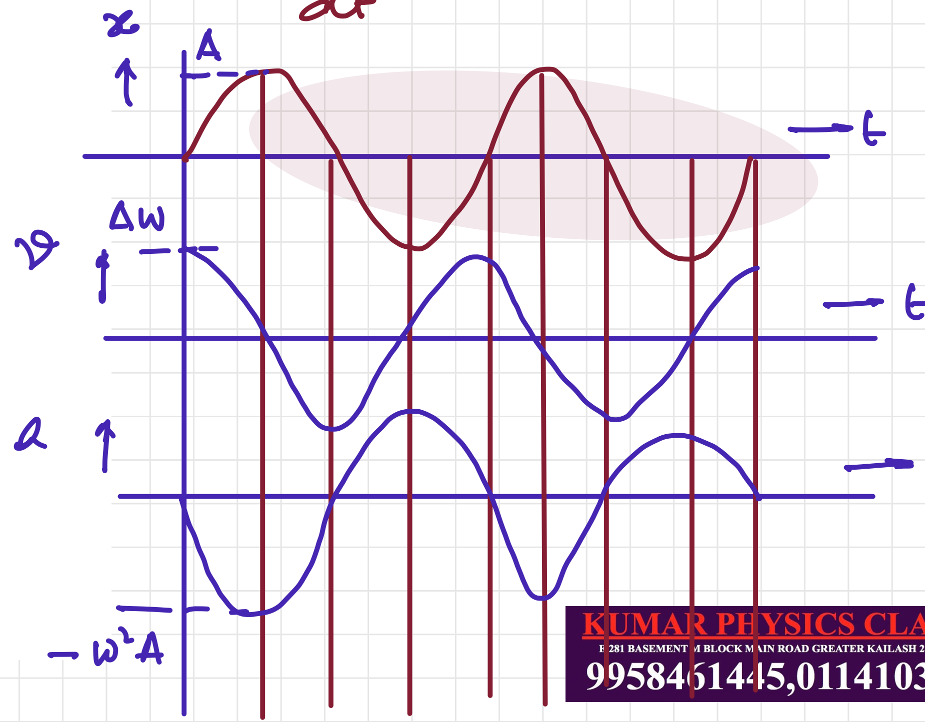


ANS -11

If $x = A \sin \omega t$

$v = \frac{dx}{dt} = A\omega \cos \omega t$

$A = \frac{dv}{dt} = -\omega^2 A \sin \omega t$



12. A sound wave has a frequency of 1.0 kHz and a wavelength of 0.33 m. What is the distance travelled by the wave in 2.0 ms and the nature of the wave?

	Distance travelled in 2.0 ms	Nature of the wave
A.	0.17 m	longitudinal
B.	0.17 m	transverse
C. ✓	0.66 m	longitudinal
D.	0.66 m	transverse

Sound WAVE → Always longitudanal

$f = 1 \times 10^3\ Hz$

$\lambda = 0.33\ mt$

$t = 2.0 \times 10^{-3}\ sec$

$v = f\lambda$

$v = 1 \times 10^3 \times 0.33$

$= 1000 \times \frac{33}{100} = 330\ \frac{mt}{sec}$

$v = \frac{d}{t}$

$d = (v)(t)$

$= (330)(2 \times 10^{-3})$

$= 660 \times 10^{-3} = 0.66\ mt$

13. Monochromatic light of wavelength λ is incident on a double slit. The resulting interference pattern is observed on a screen a distance y from the slits. The distance between consecutive fringes in the pattern is 55 mm when the slit separation is a.

λ, y and a are all doubled. What is the new distance between consecutive fringes?

A. 55 mm

B. 110 mm ✓

C. 220 mm

D. 440 mm

CASE-I

$\lambda_1 = \lambda$

$D_1 = y$

$\beta_1 = \frac{D_1 \lambda_1}{a}$ —(1)

CASE-2

$\lambda_2 = 2\lambda$

$D_2 = 2y$

$\beta_2 = \frac{D_2 \lambda_2}{2a}$ —(2)

EQUATION (1) / EQUATION (2)

$\frac{\beta_1}{\beta_2} = \frac{D_1 \lambda_1 2a}{a D_2 \lambda_2} = \frac{y \lambda (2)}{(2y)(2\lambda)}$

$\beta_2 = 2\beta_1$

$= 2(55\text{ mm}) = 110\text{ mm}$

14. A metal rod of length 45 cm is clamped at its mid point. The speed of sound in the metal rod is 1500 m s^{-1} and the speed of sound in air is 300 m s^{-1}. The metal rod vibrates at its first harmonic. What is the wavelength in air of the sound wave produced by the metal rod?

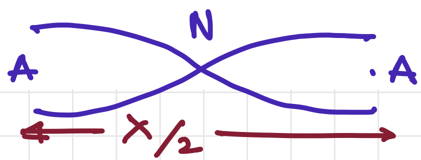
A. 4.5 cm

B. 9.0 cm

C. 18 cm ✓

D. 90 cm

METAL



$l = \lambda/2 \Rightarrow \lambda = 2l$

$v = 1500$ m/sec

$v = f\lambda$

$f = \frac{v}{\lambda} = \frac{1500}{2 \times 45 \times 10^{-2}}$

$= \frac{1500 \times 100}{90} = \frac{5000}{3}$

AIR

$v = f\lambda$

$\lambda = \frac{v}{f} = \frac{300 \times 3}{5000}$

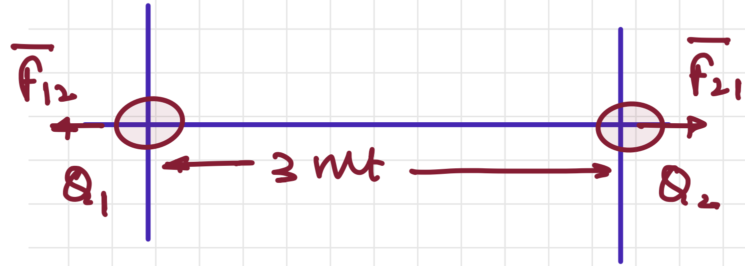
$= \frac{900}{5000}$

$= \frac{1.8}{10} = 0.18$ mt

$= 18$ cm

15. Two charges Q_1 and Q_2, each equal to 2 nC, are separated by a distance 3 m in a vacuum. What is the electric force on Q_2 and the electric field due to Q_1 at the position of Q_2?

	Electric force on Q_2	Electric field due to Q_1 at the position of Q_2
A.	4×10^{-9} N	2 N C^{-1}
B.	4 N	2 N C^{-1}
C.	4×10^{-9} N	2 x 10^{-9} N C^{-1}
D.	4 N	2 x 10^{-9} N C^{-1}



$$|F_{12}| = |F_{21}| = \frac{1}{4\pi\epsilon_0}\frac{Q_1 Q_2}{r^2}$$

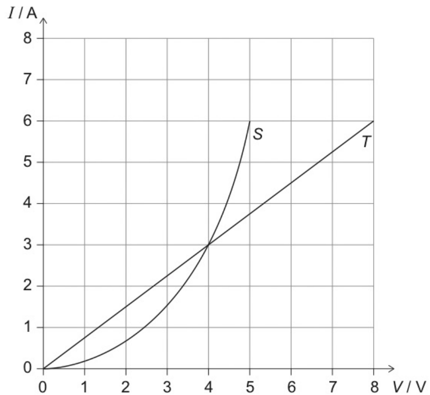
$$= \frac{9\times10^9 (Q)^2}{(3)^2} = \frac{9\times10^9 \times 4\times10^{-18}}{9}$$

$$= 4\times10^{-9} \text{ N/C}$$

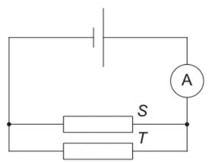
Electric field to Q_1 due to Q_2

$$E_{21} = \frac{\vec{F}_{21}}{Q_2} = \frac{4\times10^{-9}}{2\times10^{-9}} = 2 \text{ N/C}$$

16. Two conductors *S* and *T* have the *V*/*I* characteristic graphs shown below.



When the conductors are placed in the circuit below, the reading of the ammeter is 6.0 A.



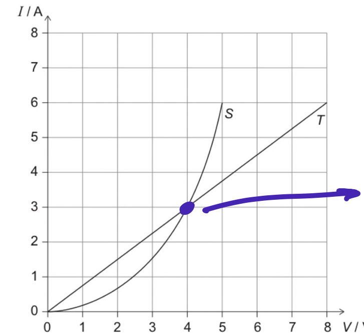
What is the emf of the cell?

A. 4.0 V

B. 5.0 V

C. 8.0 V

D. 13 V



potential is 4 Volt and summation of current at this point (both the conductors) = 3 + 3 = 6 Amp

17. For a real cell in a circuit, the terminal potential difference is at its closest to the emf when

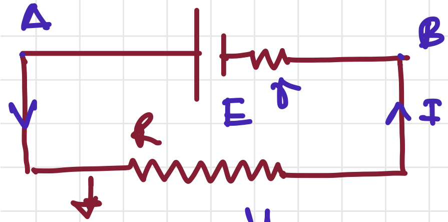
A. the internal resistance is much smaller than the load resistance. ✓

B. a large current flows in the circuit.

C. the cell is not completely discharged.

D. the cell is being recharged.

ANS-17



LOAD (R) RESISTANCE

$V_{AB} = E - Ir$

$I = E/(r+R)$

$V_{AB} = E - \left(\frac{E}{r+R}\right) r$

$V_{AB} = E\left[\frac{r+R-r}{r+R}\right] = E\left(\frac{R}{r+R}\right)$

$= E\left(\frac{1}{r/R+1}\right)$

if $R >> r$

$V_{AB} = E$

18. An electron enters the space inside a current-carrying solenoid. The velocity of the electron is parallel to the solenoid's axis. The electron is

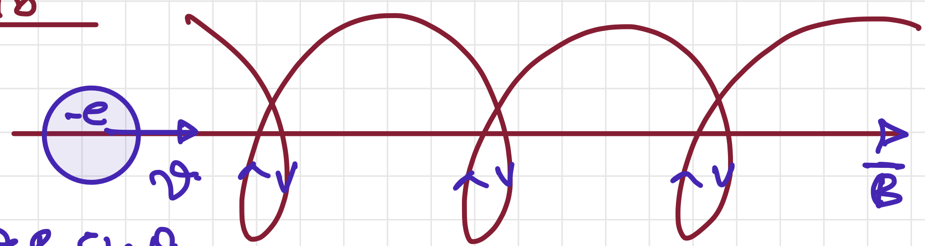
A. slowed down.

B. speeded up.

C. undeflected. ✓

D. deflected outwards.

ANS-18



$F = qvB\sin\theta$

Here angle between velocity and magnetic field is equal to zero

$F = qvB\sin 0 = 0$

19. A child stands on a horizontal rotating platform that is moving at constant angular speed. The centripetal force on the child is provided by

A. the gravitational force on the child.

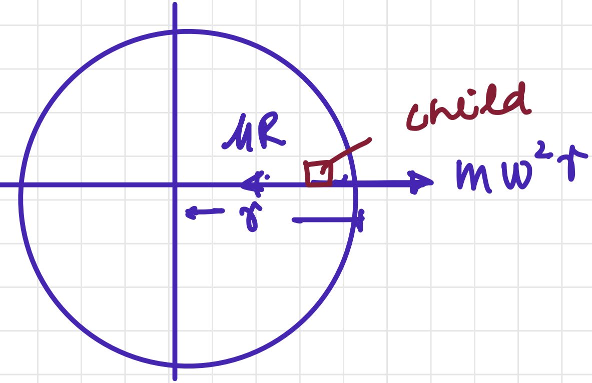
B. the friction on the child's feet. ✓

C. the tension in the child's muscles.

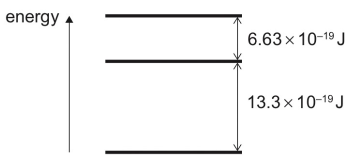
D. the normal reaction of the platform on the child.

$$\mu R = m\omega^2 r$$

FRICTIONAL FORCE ON CHILD FEET



20. A simple model of an atom has three energy levels. The differences between adjacent energy levels are shown below.



What are the two smallest frequencies in the emission spectrum of this atom?

A. 0.5×10^{15} Hz and 1.0×10^{15} Hz

B. 0.5×10^{15} Hz and 1.5×10^{15} Hz

C. 1.0×10^{15} Hz and 2.0×10^{15} Hz ✓

D. 1.0×10^{15} Hz and 3.0×10^{15} Hz

ANS-20

$$E = hf$$

$$f_1 = \frac{E_1}{h} = \frac{6.63 \times 10^{-19}}{6.6 \times 10^{-34}} = 1 \times 10^{15}\ \text{Hz}$$

$$f_2 = \frac{E_2}{h} = \frac{13.3 \times 10^{-19}}{6.6 \times 10^{-34}} = 2.0 \times 10^{15}\ \text{Hz}$$

21. What is the relation between the value of the unified atomic mass unit in grams and the value of Avogadro's constant in mol^{-1}?

A. Their ratio is 1.

B. Their product is 1. ✓

C. Their sum is 1.

D. Their difference is 0.

ANS 21

$N_A (amu)$

$6.02 \times 10^{23}\ mol^{-1} \times 1.661 \times 10^{-24}\ grm$

$= 1$

22. In a hydrogen atom, the sum of the masses of a proton and of an electron is larger than the mass of the atom. Which interaction is mainly responsible for this difference?

A. Electromagnetic

B. Strong nuclear

C. Weak nuclear

D. Gravitational ✓

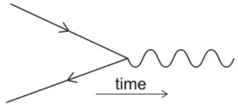
ELECTROMAGNETIC
WEAK NUCLEAR → DOES NOT AFFECT MASS

STRONG NUCLEAR → only between proton and neutron.

GRAVITATIONAL → This interaction is mainly possible.

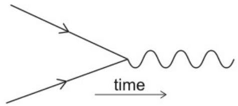
23. Which Feynman diagram describes the annihilation of an electron and its antiparticle?

A.

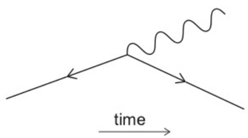


ARROW IN OPPOSITE DIRECTION

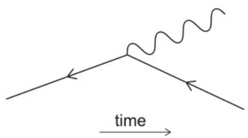
B.



C.



D.



24. Burning one litre of gasoline produces more energy than burning one kilogram of coal, and the density of gasoline is smaller than 1 g cm^{-3}. What can be deduced from this information?

A. Energy density is greater for gasoline.

B. Specific energy is greater for gasoline. ✓

C. Energy density is greater for coal.

D. Specific energy is greater for coal.

$Q = m\,s\,\Delta t$

$s = \frac{Q}{m\Delta t}$, $s \propto Q$

$s_g > s_c$

gasoline — coal

$10^{-3}\ mt^3$ $m_c = 1\ kg$

$d_g < 10^3\ kg/mt^3$

$m_g = (d_g)(V_g)$

$m_g < m_c$

25. Which change produces the largest percentage increase in the maximum theoretical power output of a wind turbine?

A. Doubling the area of the blades

B. Doubling the density of the fluid

C. Doubling the radius of the blades

✓ D. Doubling the speed of the fluid

ANS-25

$E = \frac{1}{2} m v^2 = \frac{1}{2} A l (\rho) v^2$

$\text{Power} = \frac{\text{Energy}}{\text{time}} = \frac{1}{2} A \left(\frac{l}{t}\right) \rho v^2$

$= \frac{1}{2} A \rho v^3$ $\quad \frac{l}{t} = v$

$P \propto A \rho v^3$

If $v \rightarrow$ double then power becomes 8 times

26. Which is correct for the tangential acceleration of a simple pendulum at small amplitudes?

A. It is inversely proportional to displacement.

B. It is proportional to displacement.

C. It is opposite to displacement.

✓ D. It is proportional and opposite to displacement.

$y = a \sin \omega t$

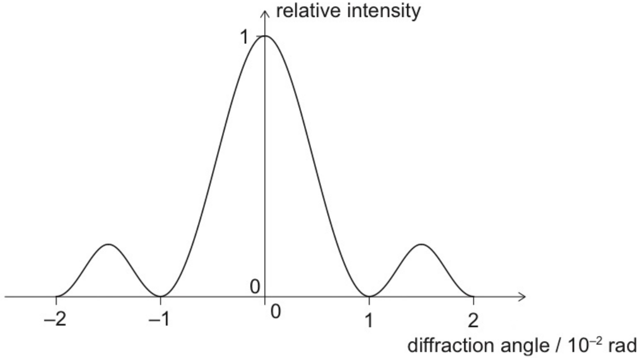
$v = \frac{dy}{dt} = a \omega \cos \omega t$

$A = \frac{dv}{dt} = -\omega^2 a \sin \omega t$

$= -\omega^2 y \rightarrow$ opposite to the displacement

$A \propto -y$

27. The diagram shows the diffraction pattern for light passing through a single slit.



What is

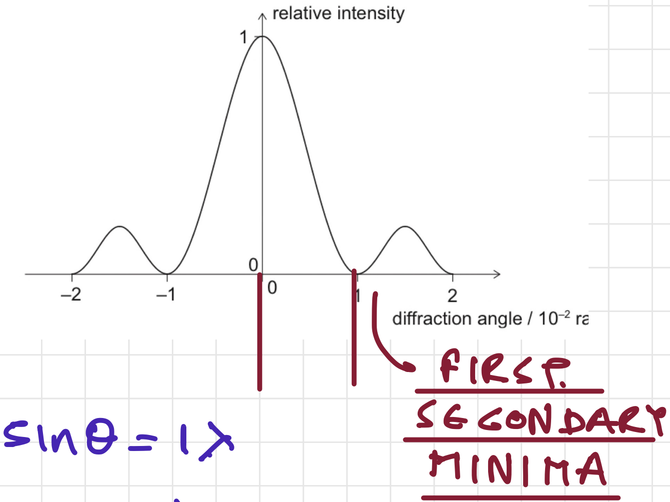
$$\frac{\text{wavelength of light}}{\text{width of slit}}$$

A. 0.01 ✓

B. 0.02

C. 1

D. 2



$a \sin\theta = 1\lambda$

$\sin\theta = \frac{\lambda}{a} \simeq \theta$

$\frac{\lambda}{a} \simeq 1 \times 10^{-2}$

$\simeq .01$

28. Light is incident on a diffraction grating. The wavelength lines 600.0 nm and 601.5 nm are just resolved in the second order spectrum. How many slits of the diffraction grating are illuminated?

A. 20

B. 40

C. 200 ✓

D. 400

Resolution $= \frac{\lambda}{\Delta\lambda} = mN$

m: ORDER OF THE DIFFRACTION

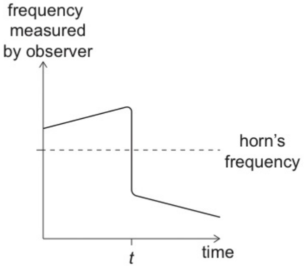
N: Total number of slit illumanated by the incident beam

$\frac{600}{1.5} = 2N$

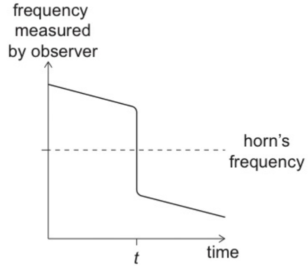
$N = \frac{2000}{1.5} = 200$

29. On approaching a stationary observer, a train sounds its horn and decelerates at a constant rate. At time *t* the train passes by the observer and continues to decelerate at the same rate. Which diagram shows the variation with time of the frequency of the sound measured by the observer?

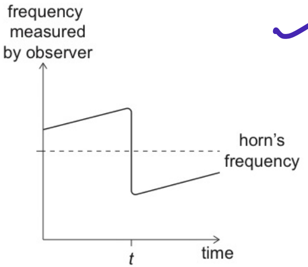
A.



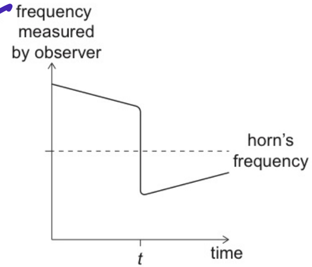
B.

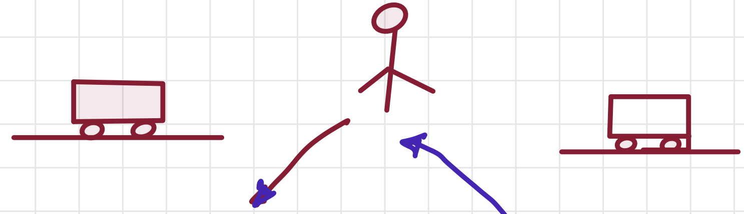


C.



D.





$f' = f\left(\frac{v}{v - v_s}\right)$

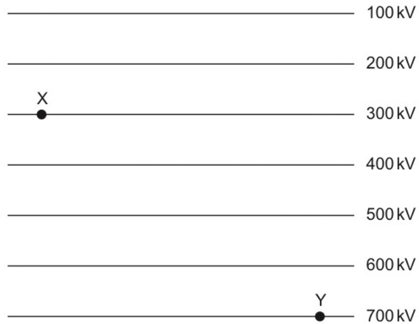
when $v_s \downarrow$, $f' \downarrow$

$f'' = f\left(\frac{v}{v + v_s}\right)$

$v_s \downarrow$, $f'' \uparrow$

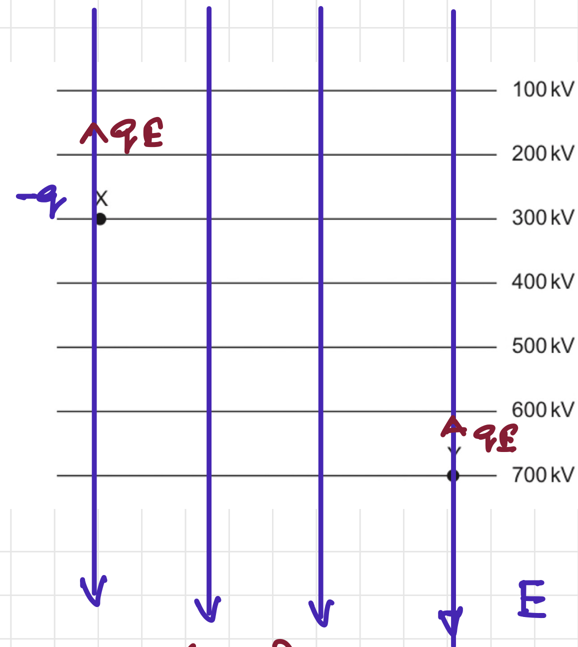
(D)

30. A particle with charge -2.5×10^{-6} C moves from point X to point Y due to a uniform electrostatic field. The diagram shows some equipotential lines of the field.



What is correct about the motion of the particle from X to Y and the magnitude of the work done by the field on the particle?

	Motion of the particle from X to Y	Magnitude of the work done by the field on the particle
A.	uniform linear	0 J
B.	uniform linear	1 J
C.	uniformly accelerated	0 J
D. ✓	uniformly accelerated	1 J



$$= q(\Delta V)$$
$$W = -2.5 \times 10^{-6} (V_f - V_i)$$
$$= -2.5 \times 10^{-6} (700 - 300) \times 10^{3}$$
$$= -2.5 \times 400 \times 10^{-3}$$
$$= -2.5 \times 0.4$$
$$= -1\text{ J}$$

As potential energy decreases then KE increases.

31. Which is a correct unit for gravitational potential?

A. $m^2 s^{-2}$ ✓

B. J kg

C. $m s^{-2}$

D. $N m^{-1} kg^{-1}$

ANS-31

$V_g = \frac{W}{m}$ = Work done per unit mass

$= J/kg = \frac{kg\, m^2}{sec^2\, kg} = m^2 sec^{-2} = m^2 s^{-2}$

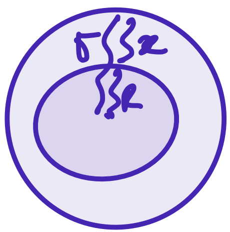
32. A planet has radius *R*. The escape speed from the surface of the planet is *v*. At what distance from the surface of the planet is the orbital speed 0.5*v*?

A. 0.5*R*

B. *R* ✓

C. 2*R*

D. 4*R*



ANS-32

$v = \sqrt{\frac{2GM}{R}}$ —(1) $\quad v_0 = \sqrt{\frac{GM}{r}}$

$v_0 = 0.5v = \sqrt{\frac{GM}{r}}$ —(2)

$\frac{v}{0.5v} = \sqrt{\frac{2GM\, r}{R\, GM}}$

$\frac{1}{(0.5)} = \sqrt{\frac{2r}{R}}$

$4 = \frac{2r}{R} \Rightarrow r = 2R$

$2R = x + R$

FROM SURFACE $x = R$

33. A conducting ring encloses an area of $2.0\,cm^2$ and is perpendicular to a magnetic field of strength $5.0\,mT$. The direction of the magnetic field is reversed in a time $4.0\,s$. What is the average emf induced in the ring?

A. 0

B. $0.25\,\mu V$

C. $0.40\,\mu V$

D. $0.50\,\mu V$ ✓

34. The conservation of which quantity explains Lenz's law?

A. Charge

B. Energy ✓

C. Magnetic field

D. Mass

ANS-33

$N = 1$

$$e = -N\frac{d\phi}{dt}$$

$$e = -\frac{(\phi_f - \phi_i)}{(t_2 - t_1)}$$

$\phi_i = BA\cos 0^\circ = BA$

$\phi_f = BA\cos 180^\circ = -BA$

$$e = -\frac{(-BA - BA)}{(4-0)}$$

$$e = \frac{2BA}{4} = \frac{2 \times 5\times10^{-3} \times 2\times10^{-4}}{4}$$

$= 5\times10^{-7}$ volt

$= 0.5\times10^{-6}$ volt

$= 0.5\,\mu V$

ANS-34

ONLY - ENERGY

35. A resistor designed for use in a direct current (dc) circuit is labelled "50 W, 2 Ω". The resistor is connected in series with an alternating current (ac) power supply of peak potential difference 10 V. What is the average power dissipated by the resistor in the ac circuit?

A. 25 W ✓

B. 35 W

C. 50 W

D. 100 W

ANS-35

$P = 50\ W$

$R = 2\ \Omega$

maximum current with stand by resistor ⇒ $P = I^2 R$

$50 = I^2 (2) \Rightarrow I = 5\ Amp = I_0$

FOR AC

$V_0 = 10$ Volt

$V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{10}{\sqrt{2}}$, $I_{rms} = \frac{I_0}{\sqrt{2}} = 5/\sqrt{2}$

$P_{avg} = (V_{rms})(I_{rms}) \cos\phi$

for resistor $\cos\phi = 1$

$= \frac{10}{\sqrt{2}} \times \frac{(5)}{\sqrt{2}}$

$= 25$ watt

36. A capacitor of capacitance X is connected to a power supply of voltage V. At time $t = 0$, the capacitor is disconnected from the supply and discharged through a resistor of resistance R. What is the variation with time of the charge on the capacitor?

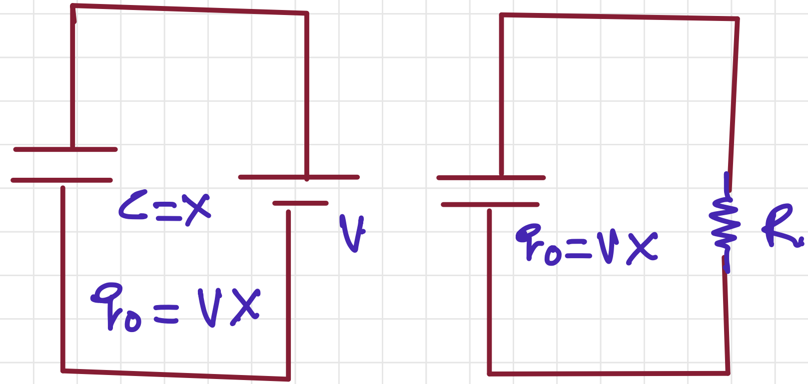
A. $\frac{X}{V}e^{-RXt}$

B. $\frac{X}{V}e^{-\frac{t}{RX}}$

C. XVe^{-RXt}

D. $XVe^{-\frac{t}{RX}}$ ✓

ANS-36



$q = q_0 e^{-t/\tau}$

$= (VX) e^{-t/RX}$

37. What is a consequence of the uncertainty principle?

A. The absorption spectrum of hydrogen atoms is discrete.

B. Electrons in low energy states have short lifetimes.

C. Electrons cannot exist within nuclei. ✓

D. Photons do not have momentum.

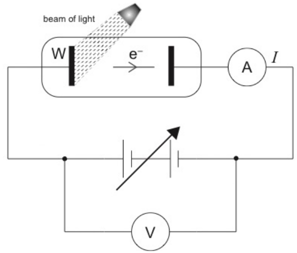
ANS-37

$$(\Delta x)(\Delta p) \geq \frac{h}{4\pi}$$

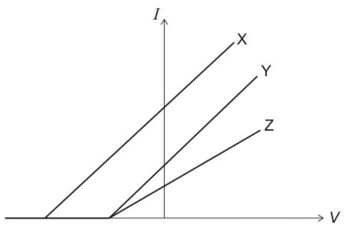
→ about position of particle

↑ INTERACTION OF MATTER WITH RADIATION

38. In a photoelectric effect experiment, a beam of light is incident on a metallic surface W in a vacuum.



The graph shows how the current I varies with the potential difference V when three different beams X, Y, and Z are incident on W at different times.



I. X and Y have the same frequency.

II. Y and Z have different intensity.

III. Y and Z have the same frequency.

Which statements are correct?

A. I and II only

B. I and III only

C. II and III only ✓

D. I, II and III

$h\nu = W_0 + eV_0$

$KE = eV_0$

FOR-X FOR-Y

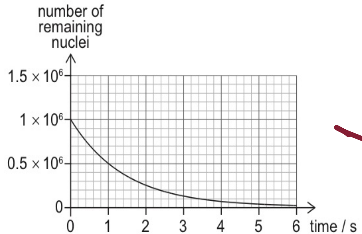
$f_X > f_Y = f_Z$

BECAUSE THEIR KE ARE SAME

Intensity $\propto$ current

Indenbendent of incident frequency

39. The graphs show the variation with time of the activity and the number of remaining nuclei for a sample of a radioactive nuclide.



What is the decay constant of the nuclide?

✓ A. $0.7\,s^{-1}$

B. $1\,s^{-1}$

C. $\frac{1}{0.7}\,s^{-1}$

D. $1.5\,s^{-1}$

$$N = N_0 e^{-\lambda t}$$

$$0.5 \times 10^6 = 1 \times 10^6 e^{-\lambda t}$$

$$0.5 \times 10^6 = 1 \times 10^6 e^{-\lambda}$$

$$\frac{1}{2} = e^{-\lambda} \Rightarrow 2 = e^{\lambda}$$

$$\log_e 2 = \lambda \log_e e$$

$$\lambda = 0.693\,s^{-1}$$

$$= 0.7\,s^{-1}$$

40. What was a reason to postulate the existence of neutrinos?

A. Nuclear energy levels had a continuous spectrum.

B. The photon emission spectrum only contained specific wavelengths.

C. Some particles were indistinguishable from their antiparticle.

D. The energy of emitted beta particles had a continuous spectrum.

other particle involved
In energy distribution

IB PHYSICS HL PAPER 1 MAY-2021 SOLUTION

WITH EXPLANATION

ROUGH WORK

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