Name:		Centre/Index Number:		Class:	

DUNMAN HIGH SCHOOL
Preliminary Examination
Year 6

H2 PHYSICS

9749/01

Paper 1 Multiple Choice

27 September 2021
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your centre number, index number, name and class at the top of this page.
Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D.**
Choose the one you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **17** printed pages and **1** blank page.

[Turn over

Data

speed of light in free space,	c =	3.00×10^{8} m s^{-1}
permeability of free space,	μ_o =	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	ε_o =	8.85×10^{-12} F m^{-1}
		$(1/(36\pi)) \times 10^{-9}$ F m^{-1}
elementary charge,	e =	1.60×10^{-19} C
the Planck constant,	h =	6.63×10^{-34} J s
unified atomic mass constant,	u =	1.66×10^{-27} kg
rest mass of electron,	m_e =	9.11×10^{-31} kg
rest mass of proton,	m_p =	1.67×10^{-27} kg
molar gas constant,	R =	8.31 J K^{-1} mol^{-1}
the Avogadro constant,	N_A =	6.02×10^{23} mol^{-1}
the Boltzmann constant,	k =	1.38×10^{-23} J K^{-1}
gravitational constant,	G =	6.67×10^{-11} N m^2 kg^{-2}
acceleration of free fall,	g =	9.81 m s^{-2}

Formulae

uniformly accelerated motion	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
work done on/by a gas	W	=	$p\Delta V$
hydrostatic pressure	p	=	ρgh
gravitational potential	ϕ	=	$-\frac{Gm}{r}$
temperature	T/K	=	T/°C + 273.15
pressure of an ideal gas	p	=	$\frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
mean translational kinetic energy of an ideal gas molecule	E	=	$\frac{3}{2}kT$
displacement of particle in s.h.m.	x	=	$x_0 \sin \omega t$
velocity of particle in s.h.m.	v	=	$v_0 \cos \omega t$
		=	$\pm \omega \sqrt{x_0^2 - x^2}$
electric current	I	=	$Anvq$
resistors in series	R	=	$R_1 + R_2 + \ldots$
resistors in parallel	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$
electric potential	V	=	$\frac{Q}{4\pi\varepsilon_0 r}$
alternating current / voltage	x	=	$x_0 \sin \omega t$
magnetic flux density due to a long straight wire	B	=	$\frac{\mu_0 I}{2\pi d}$
magnetic flux density due to a flat circular coil	B	=	$\frac{\mu_0 NI}{2r}$
magnetic flux density due to a long solenoid	B	=	$\mu_0 nI$
radioactive decay	x	=	$x_0 \exp(-\lambda t)$
decay constant	λ	=	$\frac{\ln 2}{t_{\frac{1}{2}}}$

1 Which estimate is realistic?

A The kinetic energy of a bus travelling on an expressway is 30 000 J.

B The power of a domestic light is 300 W.

C The temperature of a hot oven is 300 K.

D The volume of air in a car tyre is 0.03 m^3.

2 A radio aerial of length L, when the current is I, emits a signal of wavelength λ and power P. These qualities are related by

$$P = kI^2(\frac{L}{\lambda})^2$$

where k is a constant.

What unit, if any, should be used for the constant k?

A volt B ohm C watt D no unit

3 A skydiver falls from an aircraft that is moving horizontally.

The vertical component of the velocity of the skydiver is v.

The vertical component of the acceleration of the skydiver is a.

Which row describes v and a during the first few seconds after the skydiver leaves the aircraft?

	v	a
A	constant	constant
B	constant	decreasing
C	increasing	constant
D	increasing	decreasing

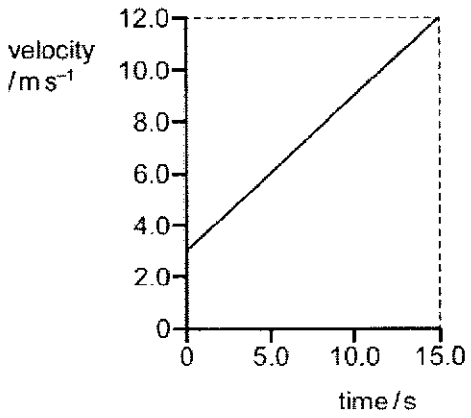
4 A ball is thrown vertically upwards from ground level and reaches a maximum height of 12.7 m before falling back to ground level.

Assume air resistance is negligible.

What is the total time for which the ball is in the air?

A 1.61 s B 3.22 s C 3.88 s D 5.18 s

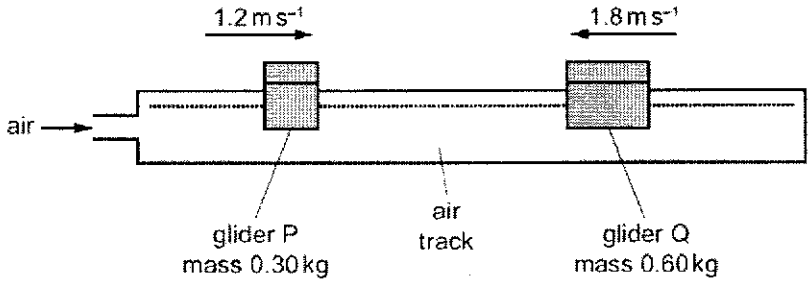
5 The velocity-time graph for an object of mass 2.5 kg is shown.



What is the resultant force acting on the object?

A 0.60 N **B** 0.80 N **C** 1.5 N **D** 2.0 N

6 Two gliders are travelling towards each other on a horizontal air track. Glider P has mass 0.30 kg and is moving with a constant speed of 1.2 m s^{-1}. Glider Q has mass 0.60 kg and is moving with a constant speed of 1.8 m s^{-1}.



The gliders have a perfectly elastic collision.

What are the speeds of the two gliders after the collision?

	speed of P / m s^{-1}	speed of Q / m s^{-1}
A	1.2	0.6
B	2.0	1.4
C	2.8	0.2
D	3.6	0.6

7 A space probe is due to be launched to one of the moons of Saturn. It is believed that the conditions on the moon are such that methane exists in liquid form and that lakes of methane may exist.

The probe is tested and it can be lowered to a depth of 64 m in a lake of water on Earth before the pressure is too high.

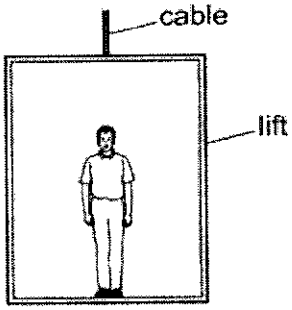
The following data regarding the Earth and the moon of Saturn are available:

atmospheric pressure on Earth = 100 kPa
density of water in lake on Earth = 1000 kg m^{-3}
atmospheric pressure on moon of Saturn = 35 kPa
density of liquid methane on moon of Saturn = 740 kg m^{-3}
gravitational field strength on moon of Saturn = 3.6 N kg^{-1}

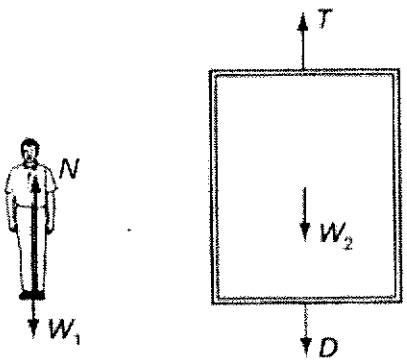
What is the maximum depth the probe may be lowered to, in a lake of methane on the moon of Saturn?

A 220 m
B 240 m
C 260 m
D 270 m

8 The diagram shows a man standing in a lift.



The forces acting on the man and the forces acting on the lift are shown below.



N is the force from the lift floor on the man.
W_1 is the weight of the man.
T is the tension in the lift cable.
W_2 is the weight of the lift.
D is the force from the man on the lift floor.

Which statement is correct?

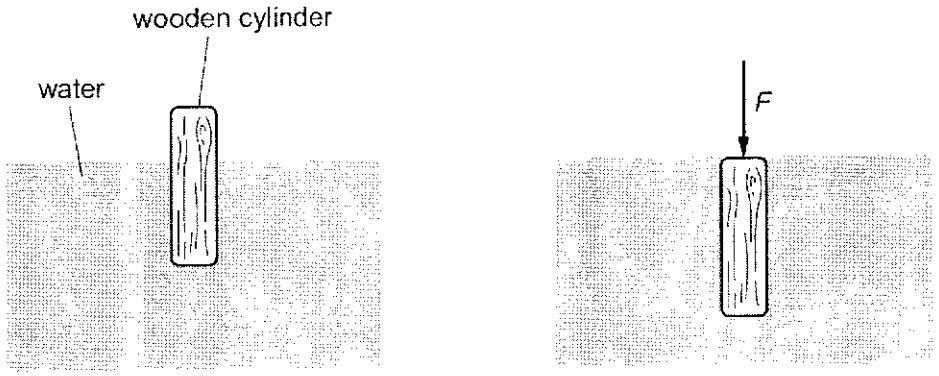
A $(W_1 + W_2)$ is always equal to T.

B If $N = W_1$, the lift must be at rest.

C N and W_1 are always equal and opposite.

D If $T = (D + W_2)$, the lift must have a constant velocity.

9 A wooden cylinder floats in a bath of water as shown. A force F is applied to the cylinder until it is just fully submerged.



Which statement is **not** correct?

A Some of the water gains gravitational potential energy.

B The cylinder loses gravitational potential energy.

C Positive work is done by force F on the cylinder.

D Positive work is done by the upthrust on the cylinder.

10 A pail containing 500 g of water is rotated in a vertical circle of radius 1.20 m.
What is the minimum speed of the pail such that no water spills out when it is upside down at the top of the circle?

A 3.43 m s^{-1} **B** 4.91 m s^{-1}

C 11.8 m s^{-1} **D** 24.1 m s^{-1}

11 An Earth satellite is moved from one stable circular orbit to another stable circular orbit at a greater distance from the Earth.

Which one of the following quantities increases for the satellite as a result of the change?

A gravitational force

B gravitational potential energy

C angular velocity

D centripetal acceleration

12 Two stationary particles of masses M_1 and M_2 are a distance d apart. A third particle, lying on the line joining the particles, experiences no resultant gravitational force.

What is the distance of this particle from M_1?

A $d\left(\frac{M_1}{M_2}\right)$ B $d\sqrt{\frac{M_1}{M_2}}$

C $d\sqrt{\frac{M_1}{M_1+M_2}}$ D $d\left(\frac{\sqrt{M_1}}{\sqrt{M_1}+\sqrt{M_2}}\right)$

13 A small ice cube of mass 20 g is heated and changes from the solid to the liquid state. During the change in state, the temperature of the substance does not change.

Which statement about this change in state is incorrect?

A The amount of energy the ice absorbs is equal to the specific latent heat of fusion.

B The average kinetic energy of the molecules remains unchanged.

C The average potential energy of the molecules increases.

D The total mass of ice and water remains constant throughout.

14 A gas cylinder is fitted with a safety valve which releases a gas when the pressure inside the cylinder reaches 2.0×10^6 Pa.

Given that the maximum mass of ideal gas the cylinder can contain at 300 K is 2.0 kg, what is the mass of gas that escapes from the cylinder if it is heated to 400 K?

A 0.50 kg B 0.75 kg C 1.2 kg D 1.5 kg

15 An ideal gas is heated very gradually. This causes it to expand slowly. During this entire process, the temperature of the gas remains constant.

Which statement is correct?

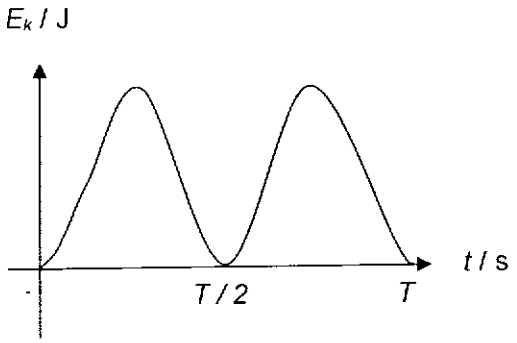
A As the heat is applied, the internal energy of the gas increases.

B The gas does no work in expanding.

C The rate of heating and the rate of gas doing work are equal at all times.

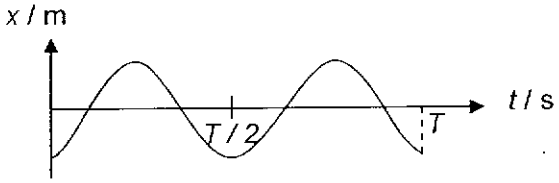
D The root-mean-square speed of the gas molecules increases as the heat is applied.

16 The following graph shows the variation of kinetic energy, E_k with time, t of a particle undergoing simple harmonic motion about a point Q. The period of the motion is T.

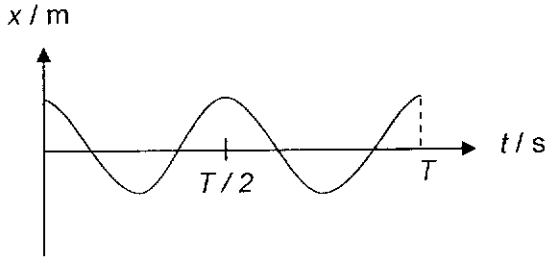


Which of the following graphs best shows the variation with time of its displacement, x from point Q?

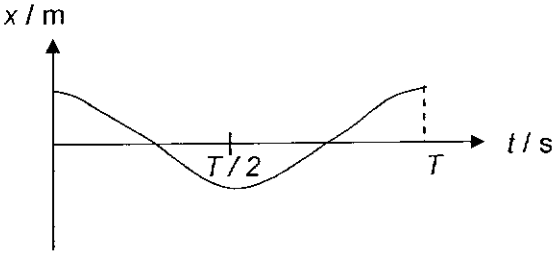
A



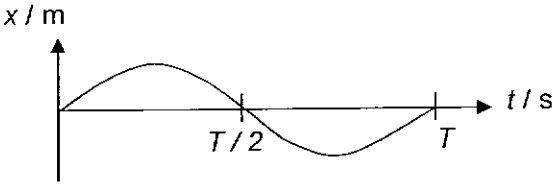
B



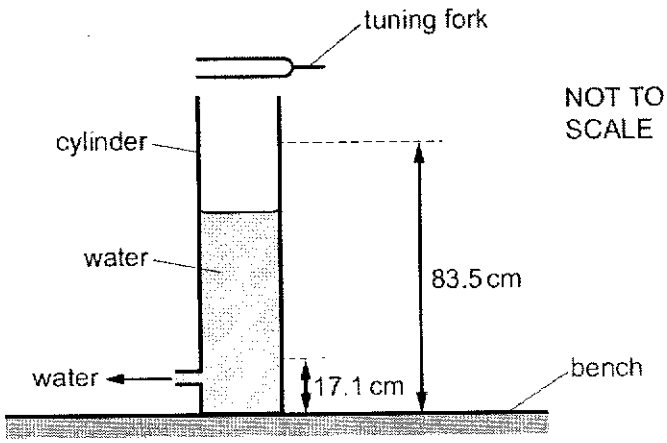
C



D



17 A vibrating tuning fork is held above a glass cylinder filled to the top with water. The water level is steadily lowered. A loud sound is first heard when the water level is 83.5 cm above the bench. The next loud sound is heard when the water level is 17.1 cm above the bench.



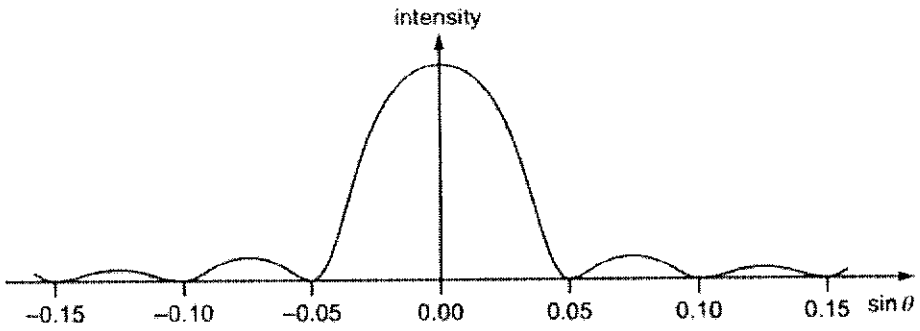
Given that the speed of sound in air is 340 m s^{-1}, what is the frequency of the tuning fork?

A 128 Hz **B** 256 Hz

C 384 Hz **D** 512 Hz

18 A parallel, monochromatic beam of electromagnetic radiation is incident at right angles onto a single slit of width 0.010 mm.

The graph shows the variation of the intensity of the radiation with the sine of the angle θ through which the light is diffracted.



What is the wavelength of the radiation?

A 500 nm **B** 750 nm

C 500 μm **D** 750 μm

19 Light produced by a calcium discharge lamp strikes a diffraction grating at right angles to the surface. The grating has 800 lines per mm. The second order spectrum includes a line at an angle of 41.0° to the normal of the grating.

What is the wavelength of the light producing this line?

A 1.6×10^{-6} m

B 4.1×10^{-7} m

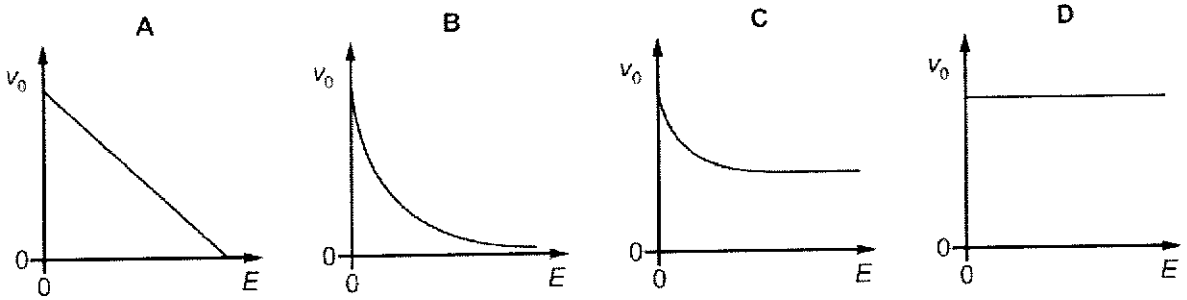
C 4.6×10^{-7} m

D 8.2×10^{-7} m

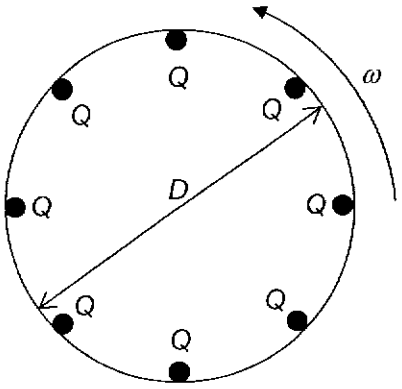
20 A positively charged oil droplet falls in air that has a uniform electric field pointing vertically upwards. The droplet has a terminal speed v_0 and the electric field strength is E.

The magnitude of the force due to air resistance acting on the droplet is proportional to the speed of the droplet.

Which graph shows the variation with E of v_0?



21 Eight small conductors of charge Q are placed at the edge of an insulating disc of diameter D. The angular frequency of rotation of the disc is ω.



What is the electric current at the edge of the disc?

A $\frac{4Q\omega}{\pi}$ **B** $\frac{8Q\omega}{\pi D}$

C $8Q\omega$ **D** $\frac{16Q\pi}{\omega}$

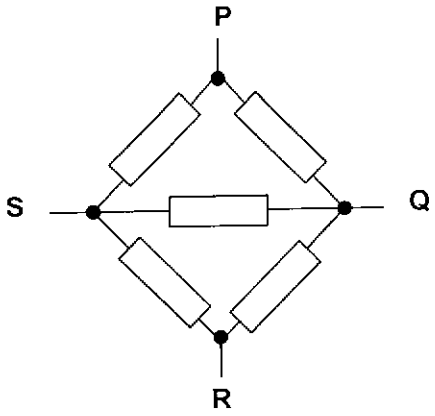
22 A strain gauge consists of a length of wire with uniform cross-sectional area. Its resistance is 2.000 kΩ. It is attached to a gas container. When the container expands, the strain gauge changes its dimensions. Its length increases by 0.40% and diameter reduces by 1.0 %.

What is the new resistance of the strain gauge?

A 1.968 kΩ **B** 2.028 kΩ

C 2.049 kΩ **D** 2.122 kΩ

23 Five resistors of equal resistance are connected as shown.



Which two points would give the maximum resistance?

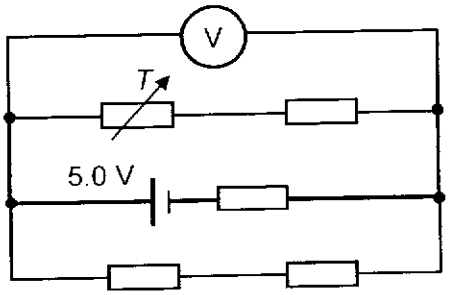
A PQ

B PR

C PS

D QS

24 A cell of e.m.f. 5.0 V and negligible internal resistance is connected to four similar resistors and a variable resistor T, as shown.



The resistance of each resistor is 1.0 kΩ and the resistance of T is 5.0 kΩ.

What is the reading of the ideal voltmeter?

A 0 V

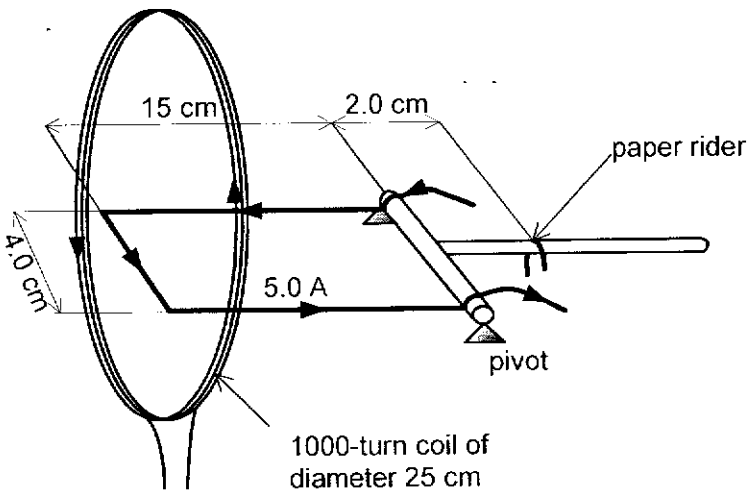
B 2.0 V

C 3.0 V

D 5.0 V

25 One end of a flat rectangular coil of negligible mass is placed at the centre of a 1000-turn circular coil of diameter 25 cm as shown.

A current of 5.0 A is passed through the rectangular coil.
When a 5.0 g paper rider is placed 2.0 cm to the right of the pivot, the rectangular coil is balanced horizontally.



What is the magnitude of the current in the 1000-turn circular coil in order for the rectangular coil to remain horizontal?

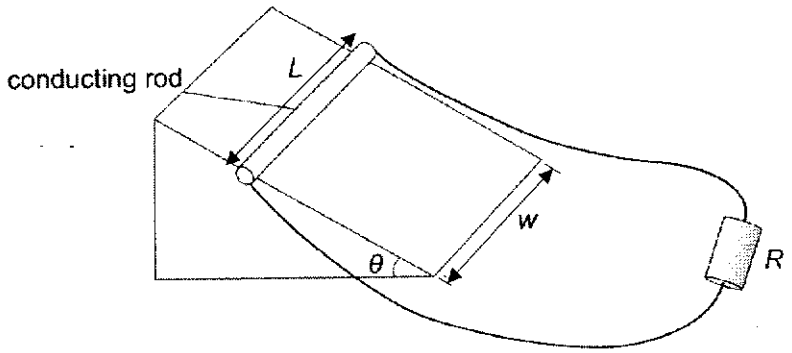
A 3.3 A

B 5.0 A

C 6.5 A

D 9.0 A

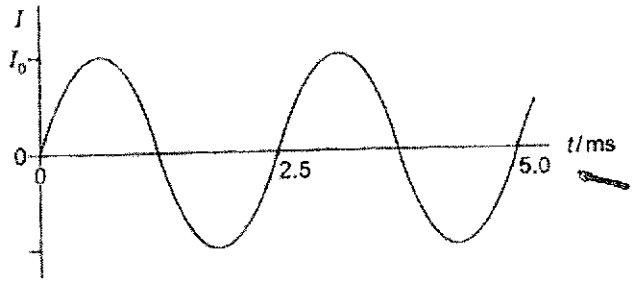
26 A conducting rod of length L and mass m is placed on a very long and smooth plane of width w. The plane makes an angle of θ to the horizontal. The rod is connected to a resistor of resistance R through light and flexible wires. The rod is released from rest at the top of the plane and moves in a uniform magnetic flux density B that is vertically downwards everywhere.



After time t, what is the magnitude of its terminal velocity?

A $\dfrac{mgR\tan\theta}{B^2w^2}$ B $\dfrac{mgR\tan\theta}{B^2L^2}$ C $\dfrac{mgR\tan\theta}{B^2w^2\cos\theta}$ D $\dfrac{mgR\tan\theta}{B^2L^2\cos\theta}$

27 The graph shows the variation with time t of an alternating current I.
The peak current is I_0.



Which expression gives the alternating current I?

A $I = I_0\sin(5\pi t)$

B $I = I_0\sin\left(\dfrac{2\pi t}{2.5}\right)$

C $I = I_0\sin\left(\dfrac{\pi t}{0.0025}\right)$

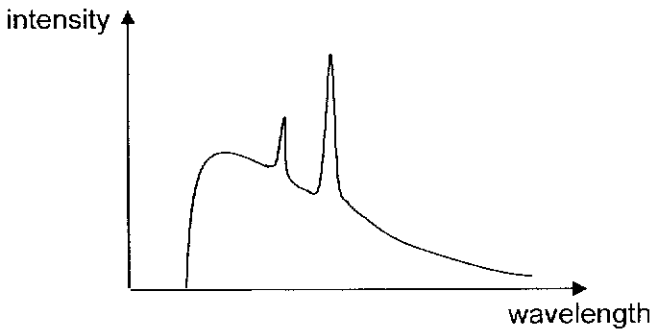
D $I = I_0\sin(800\pi t)$

28 A sinusoidal voltage supply at 50 Hz connected across a resistor of 200 Ω delivers a peak current of 2.0 A. The frequency of the supply is doubled to 100 Hz.

What is the mean power dissipated in the resistor at the higher frequency?

A 200 W **B** 400 W **C** 800 W **D** 1600 W

29 The following graph shows the spectrum of X-rays emitted from an X-ray tube.



If the potential difference between the target and cathode is increased, which one of the following combinations represents a possible change in wavelength and intensity of the peaks?

	wavelength	intensity
A	remain the same	increase
B	decrease	remain the same
C	remain the same	remain the same
D	decrease	increase

30 Light of wavelength 450 nm is incident on a metal surface. The most energetic electrons ejected from the metal surface are undeflected as they pass through a region of mutually perpendicular magnetic and electric fields of strength 2.0×10^{-3} T and 1400 V m^{-1}, respectively.

What is the work function energy of the metal?

A 2.2×10^{-19} J **B** 4.4×10^{-19} J **C** 6.6×10^{-19} J **D** 8.8×10^{-19} J

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2021 DHS H2 Physics Prelim Paper 1 Suggested Solutions

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

1 **D**

Average car tyre radius, R = 0.20 m
Cross sectional radius r = 0.10 m
Volume = $(2\pi R)(\pi r^2)$ = 0.039 m^3

2 **B**

Units on right side = (unit of k)$(A^2)(m/m)^2$ = (unit of k)(A^2)
Units on left side = W
unit of k = W/ A^2= (W/A)(A) = V/A = Ω

3 **D**

v increases as the skydiver accelerates vertically downwards.
Resultant force decreases (force due to air resistance) causes acceleration to decrease.

4 **B**

$v^2 = u^2 + 2as$, $0 = u^2 + 2(-9.81)(12.7)$

$v = u + at$, $0 = \sqrt{2(9.81)(12.7)} + (-9.81)t$

t = 1.61s, total time = $2t$ = 2(1.61) = 3.22 s

5 **C**

Gradient = acceleration = (12.0 – 3.0)/15.0 = 9.0/15.0
Resultant force = ma = (2.5)(9.0/15.0) = 1.5 N

6 **C**

perfectly elastic collision :
$v_Q - v_P = u_P - u_Q$ = 1.2 – (-1.8) = 3.0 -- Eqn 1

COM :
(0.30)(1.2) – (0.60)(1.8) = 0.30 v_P + 0.60 v_Q -- Eqn 2

Solve Eqn 1 and 2, v_P = 2.8 m s^{-1}, v_Q = 0.20 m s^{-1}

7 **C** Max pressure the probe can take = atmospheric pressure + pressure due to the liquid

On Earth:

Max pressure = $100 \times 10^3 + (64)(1000)(9.81) = 727840$ Pa

On Moon of Saturn:

$727840 = 35 \times 10^3 + h\,(740)\,(3.6)$

h = **260 m**

8 **D** When $T = (D + W_2)$, the net force on the lift is 0.

Hence by Newton's first law, the lift must have a constant velocity. If it was originally at rest, it will be at rest (constant velocity of 0).

9 **D** *Negative* work is done by the upthrust on the cylinder.

10 **A** At the top of circle, $mg + N = mv^2/r$

At minimum speed, $N = 0$

$mg = mv^2/r$

$v^2 = rg = (1.20)\,(9.81)$

$v = \underline{3.43 \text{ m s}^{-1}}$

11 **B** **A** is wrong because magnitude of gravitational force GMm/r^2 decreases with increasing distance.

In an orbit, gravitational force provides centripetal force, and since centripetal force decreases, so is the centripetal acceleration (Thus **D** is wrong).

From Kepler's Third Law,

$T^2 \propto r^3$

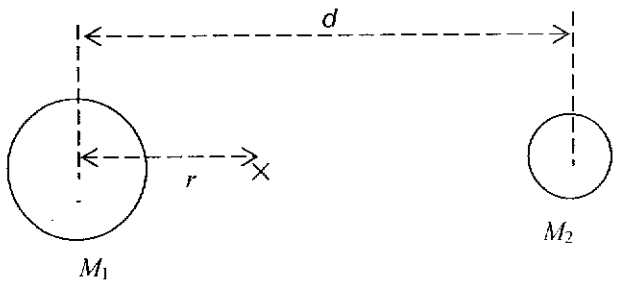
T increases as r increases.

Hence angular velocity $\omega = 2\pi / T$ decreases with increasing distance (Thus **C** is wrong).

B is correct, as gravitational potential energy $-GMm/r$ is a scalar and it

becomes less negative (hence increases) with increasing distance.

12 **D**



Let the distance from M_1 be r from where it experiences no resultant gravitational force.

At r,

$$\frac{GM_1}{r^2} = \frac{GM_2}{(d-r)^2}$$

Simplifying,

$$r = d\left(\frac{\sqrt{M_1}}{\sqrt{M_1}+\sqrt{M_2}}\right)$$

13 **A** **A** is incorrect as the amount of energy absorbs is equal to the latent heat rather than the specific latent heat.

14 **A** $\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2} \Rightarrow \frac{P_1V_1}{m_1T_1} = \frac{P_2V_2}{m_2T_2}$ since $n = \frac{mass}{molar\ mass}$

As pressure and volume remains constant,

$m_1T_1 = m_2T_2$

$(2.0)(300) = m_2(400)$

$m_2 = 1.5$

Hence mass of gas escaping = 2.0 - 1.5 = 0.50 kg

15 **C** As temperature is constant, the internal energy of the gas is unchanged. Hence A is wrong.

Work is done by the gas during expansion, hence B is wrong.

C is correct as $\Delta U = Q + W \Rightarrow Q = -W$ when $\Delta U = 0$

D is wrong as temperature is unchanged thus root-mean-square speed is unchanged.

16 **C** Positions of the KE = 0 (*at t = 0, T/2 and T*) corresponds to x = amplitude positions.

Positions of max KE corresponds to $x = 0$ positions. Hence **C** is correct.

17 **B** Let the height of the cylinder be h.

$h - 0.835 = \lambda / 4$ ------(1)

$h - 0.171 = 3\lambda / 4$ ------(2)

(2) – (1):

$0.664 = 0.5\ \lambda$

$\lambda = 1.328$ m

$f = v/\lambda = (340)/(1.328)$

$f = 256$ Hz

18 **A**

$$\sin\theta = \frac{\lambda}{b}$$

$$\lambda = (0.05)(0.010 \times 10^{-3}) = 500 \times 10^{-9} \text{ m} = 500 \text{ nm}$$

19 **B**

$$d\sin\theta = n\lambda$$

$$\frac{10^{-3}}{800}\sin 41.0^\circ = 2\lambda$$

$$\lambda = 4.1 \times 10^{-7}\text{m}$$

20 **A** Weight of oil drop = Electric force (vertically upwards) + Force due to air resistance

$Mg = QE + kv$,

Rearranging, $v = \frac{Mg}{k} - \frac{QE}{k}$

A graph of v against E will give a straight line of gradient, $-\frac{Q}{k}$ and y-

intercept, $\frac{Mg}{k}$

21 **A** From the definition of current,

$$I = \frac{Q_{Total}}{T} = \frac{8Q}{2\pi / \omega} = \frac{4Q\omega}{\pi}$$

22 **C**

$$R_{old} = \frac{\rho L}{A} = \frac{4\rho L_{old}}{\pi d_{old}^{\ 2}} = 2.000\ \text{k}\Omega$$

$$R_{new} = \frac{4\rho L_{new}}{\pi d_{new}^{\ 2}} = \frac{4\rho(1.004L_{old})}{\pi(0.99d_{old})^2} = 2.049\ \text{k}\Omega$$

23 **B** Due to symmetry, **A** and **C** will have the same effective resistance, so they cannot be correct answers.

D has one identical resistor, say R, in parallel with the rest, so the effective resistance will be $<R$.

24 **C**

Effective resistance of circuit = $\left(\frac{1}{1+1} + \frac{1}{1+5}\right)^{-1} + 1 = 2.5\ \text{k}\Omega$

Current drawn from cell = $5 / 2.5 = 2.0$ mA

Voltmeter reading = $5 - 2(1) = 3.0$ V

25 **C** By conservation of moments,

magnitude of moment due to force acting on current carrying conductor = magnitude of moment due to paper rider

➔ $B_{coil} IL(15) = W_{rider}(2)$

➔ $\left(\frac{\mu_0 N I_{coil}}{2r}\right) IL(15) = W_{rider}(2)$

$$\rightarrow \left(\frac{\left(4\pi \times 10^{-7}\right)1000I_{coil}}{2(12.5/100)}\right)(5)(4/100)(15/100) = \left(\frac{5}{1000}9.81\right)(2/100)$$

$$\rightarrow I_{coil} = 6.5 \text{ A}$$

26 **D** Component of weight parallel to slope = $mg\sin\theta$

Component of magnetic force acting of rod in the opposite direction

$$= BIL\cos\theta = B\left(\frac{E_{induced}}{R}\right)L\cos\theta = B\left(\frac{BLv\cos\theta}{R}\right)L\cos\theta$$

Thus, $mg\sin\theta = \frac{B^2L^2v\cos^2\theta}{R}$

$$\rightarrow v = \frac{mgR\tan\theta}{B^2L^2\cos\theta}$$

27 **D** The equation is $I = I_0\sin(\frac{2\pi t}{T}) = I_0\sin(\frac{2\pi t}{0.0025}) = I_0\sin(800\pi t)$

28 **B** $\langle P\rangle = I_{rms}^2R = (I_0/\sqrt{2})^2R = (2.0/\sqrt{2})^2(200) = 400$ W

29 **A** Since the target is unchanged, the wavelengths of the peaks will remain the same.

However, with an increase in the p.d. between the target and cathode, the target will be bombarded with electrons of higher energy. These electrons will have a higher chance to remove an inner shell electron from the target, resulting in more de-excitations between energy levels and hence higher intensity of the peaks.

30 **A**

$Bqv = qE$

$v = E / B = 1400 / (2.0 \times 10^{-3}) = 7.0 \times 10^{5}$ m s^{-1}

$hf = \phi + \frac{1}{2}mv^2$

$\phi = \frac{hc}{\lambda} - \frac{1}{2}mv^2 = \frac{(6.63 \times 10^{-34})(3 \times 10^{8})}{450 \times 10^{-9}} - \frac{1}{2}(9.1 \times 10^{-31})(7.0 \times 10^{5})^2$

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

~ THE END ~