RIVER VALLEY HIGH SCHOOL
JC2 PRELIMINARY EXAMINATIONS

H2 PHYSICS 9749
PAPER 1
23 SEP 2022

1 HOUR

CANDIDATE NAME									
CENTRE NUMBER	S					**INDEX NUMBER**				
CLASS	2	1	J						

INSTRUCTIONS TO CANDIDATES

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Read these notes carefully.
Write your name, class and index number above.

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

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done on the Question Paper.

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

Hand in the Optical Answer Sheet.

This document consists of 15 printed pages.

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	$p = \rho gh$
gravitational potential	$\phi = -Gm/r$
temperature	T / K = T / °C + 273.15
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V} < c^2 >$
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	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

For each question, there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider correct and shade your choice in **soft pencil** on the separate **Answer Sheet**.

1 A period T of a type of pendulum is given by

$$T = 2\pi\sqrt{\frac{I}{K}}$$

If I has a unit of kg m^2, which of the following can be a unit of K?

A N m

B N m^{-1}

C kg m^2

D s^{-2}

2 Two stones, X and Y, of different masses are dropped from the top of a cliff. Stone Y is dropped a short time after stone X. Air resistance is negligible. Whilst the stones are falling, the distance between them will

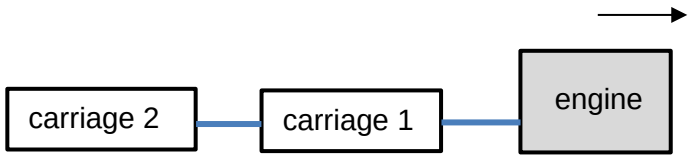
A decrease if the mass of Y is more than the mass of X.

B increase if the mass of X is more than the mass of Y.

C decrease regardless if the mass of X is more than or less than the mass of Y.

D increase regardless if the mass of X is more than or less than the mass of Y.

3 An engine pulls and accelerates two identical carriages to the right as shown below.



If the tension in the towbar between the engine and carriage 1 is T, what is the tension between carriages 1 and 2? Ignore drag and resistive forces.

A T **B** $\frac{T}{2}$

C $2T$ **D** $\frac{T}{3}$

4 A man stands on a weighing scale in a lift moving upwards. When the lift accelerates upwards at 2.0 m s^{-2}, the weighing scale reads *W*.

What is the reading on the weighing scale when the lift decelerates at 2.0 m s^{-2}?

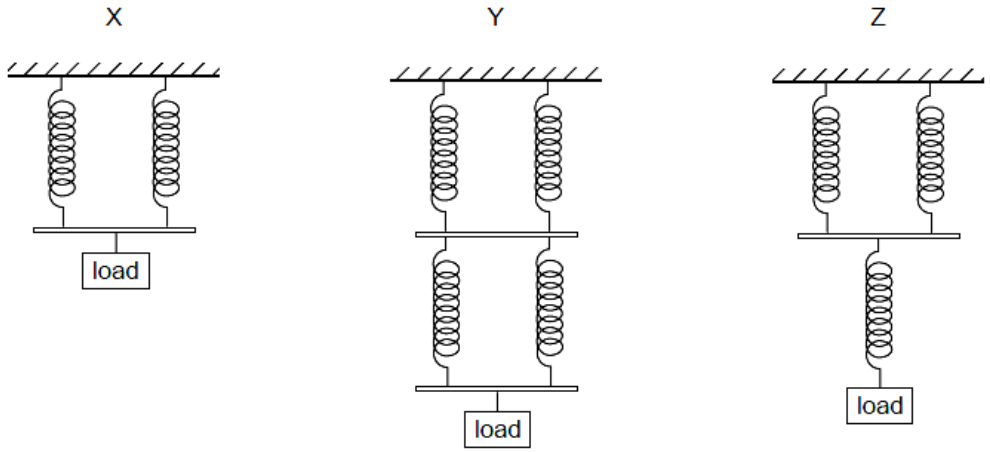
A 1.5*W*

B 1.0*W*

C 0.83*W*

D 0.66*W*

5 A number of similar springs, each having the same spring constant, are joined in three arrangements X, Y and Z. The same load is applied to each.



What is the order of increasing extension for these arrangements?

	smallest	⟶	largest
A	X	Y	Z
B	X	Z	Y
C	Z	Y	X
D	Y	Z	X

6 A 100 kg block is pulled at a constant speed of 5.0 m s^{-1} across a rough horizontal floor by an applied force of 120 N directed 37° above the horizontal.

What is the rate at which the applied force does work on the block?

A 0

B 360 W

C 480 W

D 600 W

7 Air is enclosed in a cylinder by a gas-tight, frictionless piston of cross-sectional area 3.5×10^{-3} m^2. When atmospheric pressure is 100 kPa, the piston settles 80 mm from the end of the cylinder as shown in Fig. 1.

The piston is then pulled out until it is 160 mm from the end of the cylinder as shown in Fig. 2 and is held there. The temperature of the air in the cylinder is now maintained at half of the original value.

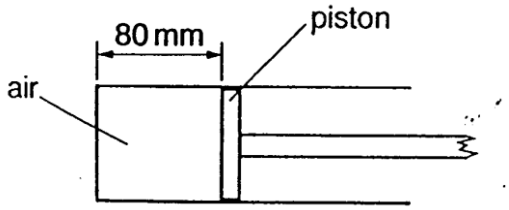


Fig. 1

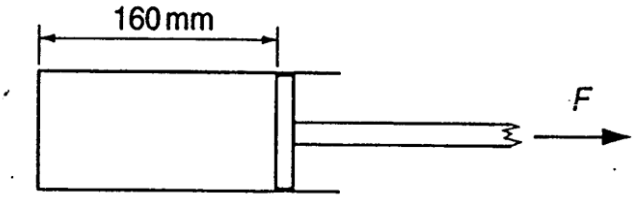


Fig. 2

What is the force *F* required to hold the piston in its new position?

A 88 N

B 260 N

C 350 N

D 440 N

8 Two equal masses of an ideal gas initially at the same temperature and pressure are compressed to half of their initial volumes, one of them isothermally, and the other while thermally isolated from its surroundings.

Which of the following must be the same for both samples of the gas?

A The heat given during compression.

B The internal energy of the compressed gas.

C The density of the compressed gas.

D The work done on the gas during compression.

9 When a frictionless and well-insulated bicycle pump is used to pump up a tyre, the air in the tyre becomes hotter than the surrounding air.

Which of the following statements best explains this observation?

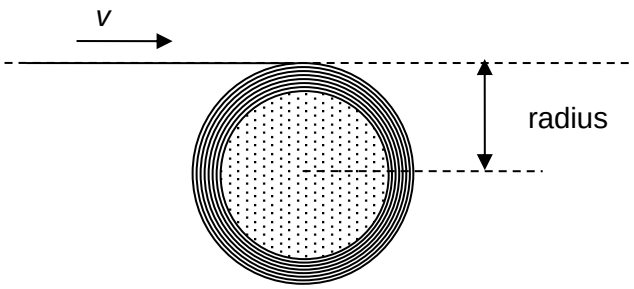
A The internal energy increases because thermal energy is supplied and work is done on the air.

B Work is done on the air and since little thermal energy escapes, the internal energy increases.

C Work is done on the air and the internal energy remains unchanged.

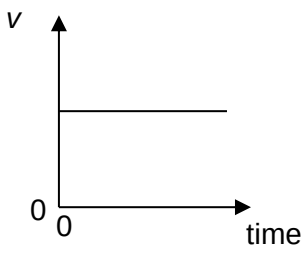
D After compression the air collide more frequently.

10 A straight length of tape winds onto a roll rotating about a fixed axis with constant angular velocity, the radius of the roll increasing at a steady rate.

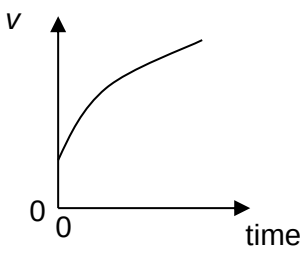


Which of the graphs below correctly shows how the speed *v* at which the tape moves towards the roll varies with time?

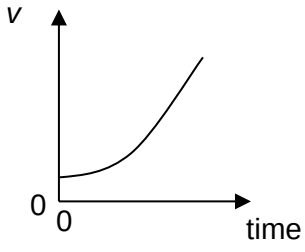
A



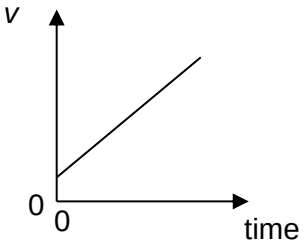
B



C



D



11 A 3.0 kg rock is thrown vertically upwards near the surface of Planet X of mass *m* with a velocity of 45 m s^{-1} and it comes to an instantaneous rest 5.2 s later.

The same rock is now thrown vertically upwards for 15 m near the surface of Planet Y. The difference in gravitational potential between two points that are 4.0 m vertically apart and near the surface of Planet Y is 6.0 J kg^{-1}.

The gravitational field strength can be assumed to be uniform near at the surfaces of both Planet X and Planet Y. If both planets do not have atmosphere, the ratio of the gravitational field strength near the surface of Planet Y to that of Planet X is

A 13

B 5.8

C 0.17

D 0.077

12 Two satellites, A and B, orbiting around Earth have the same kinetic energy. Satellite A has a larger mass than satellite B. Which of the following statements is false?

A Satellite A has a smaller total energy.

B Satellite A has a larger orbital radius.

C Satellite A has a larger period.

D Satellite A has a smaller angular velocity.

13 A mass of 8.0 g oscillates in simple harmonic motion with an amplitude of 5.0 mm at a frequency of 40 Hz.

What is the total energy of this simple harmonic oscillator?

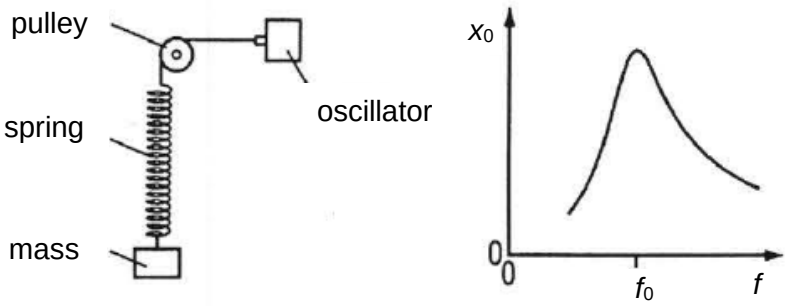
A 0.16 mJ **B** 6.3 mJ

C 13 mJ **D** 640 mJ

14 A mass, suspended from a helical spring, is made to oscillate.

The graph shows the variation with frequency f of the amplitude x_0 of vibration of the mass.

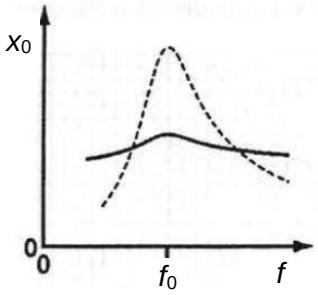
f_0 is the natural frequency of the spring-mass system.



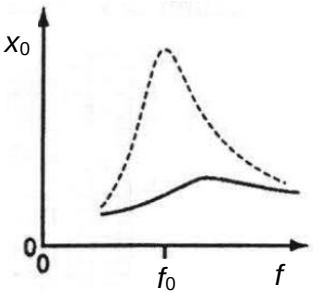
A sheet of cardboard of negligible mass is now fixed to the mass on the spring to cause light damping of the oscillations.

Which graph shows how x_0 will vary with f over the same frequency range?

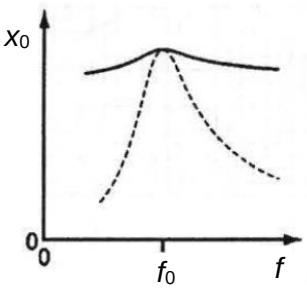
A



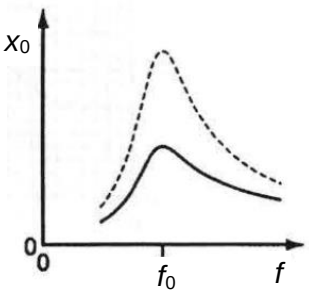
B



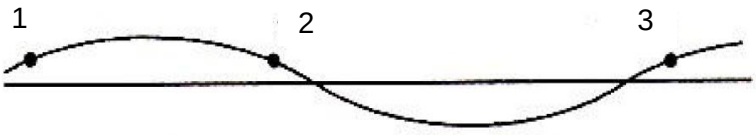
C



D



15 The diagram below shows an instantaneous position of a string as a transverse progressive wave travels along it from left to right.



Which one of the following correctly shows the directions of the velocities of the points 1, 2 and 3 on the string?

	1	2	3
A	→	→	→
B	↓	↓	↓
C	↓	↑	↓
D	↑	↓	↑

16 A taut wire is set into resonance with a node at either end as well as another single node at the centre of the wire.

Which one of the following statements is *not* correct?

A The wavelength of the wave on the wire is equal to the length of the wire.

B All points to one side of the centre vibrate in phase with one another.

C Any two points on either side of the centre have a phase difference of 90°.

D Two points equidistant from the centre on either side of the centre have the same amplitude of vibration.

17 Fringes of separation x are observed in a plane 1.00 m away from a Young's double-slit arrangement illuminated by yellow light of wavelength 600 nm.

At what distance from the slits would fringes of the separation $2x$ be observed when using blue light of wavelength 400 nm?

A 1.00 m **B** 1.50 m

C 1.33 m **D** 3.00 m

18 A car battery of e.m.f. 12 V and internal resistance 0.20 Ω is connected to a load of 4.0 Ω. If the potential difference across the load is 10 V, what is the power lost in the connecting wires?

A 3.0 W **B** 3.8 W

C 4.2 W **D** 6.0 W

19 An alpha particle and a proton are moving perpendicularly to a uniform electric field. The speed of alpha particle is 4.0 times the speed of proton.

Determine the ratio $\frac{\text{component of speed of alpha particle parallel to electric field}}{\text{component of speed of proton parallel to electric field}}$ after time *t*. Ignore the effects due to gravitation field.

A 0.5 **B** 1.0

C 1.5 **D** 2.0

20 In the direction opposite of an electric field line, which of the following must be true?

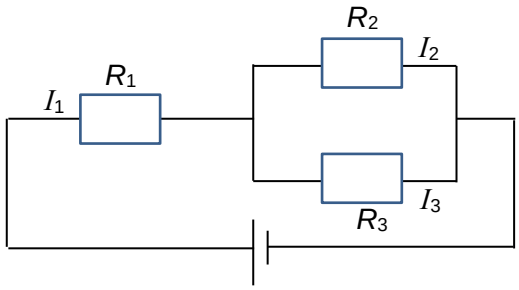
A The potential must decrease.

B The potential must increase.

C The electric field strength must decrease.

D The electric field strength must increase.

21 Three resistors are connected to a battery with negligible internal resistance as shown below. The current through R_1, R_2 and R_3 are I_1, I_2 and I_3 respectively.



What is the ratio $\frac{I_3}{I_1}$?

A $\frac{R_3}{R_1}$

B $\frac{R_2}{R_3}$

C $\frac{R_3}{R_2 + R_3}$

D $\frac{R_2}{R_2 + R_3}$

22 An overhead power cable carries an alternating current of 2000 A r.m.s.

At what perpendicular distance would the peak magnetic flux density due to the current in the cable be 100 μT?

A 2.8 m

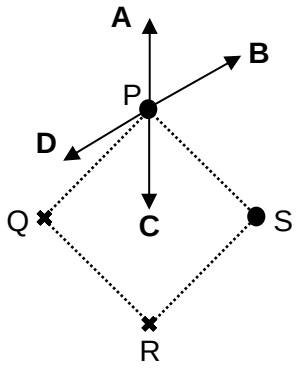
B 4.0 m

C 5.7 m

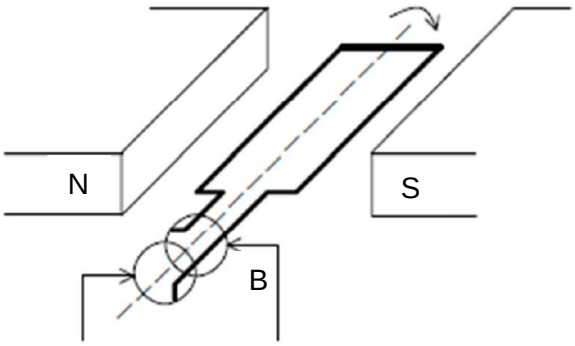
D 8.0 m

23 Four parallel wires, carrying equal currents either into or out of the plane of the page, pass vertically through the four corners of a square.

Which of the vectors denote the resultant force acting on the wire placed at P?



24 A simple electric generator is shown below. A single coil is rotated as indicated between magnetic poles N and S. Electrical contact between coil and external circuit is maintained through brushes B touching the rings.



At the instant when the rotating coil is oriented as shown, the output of the generator

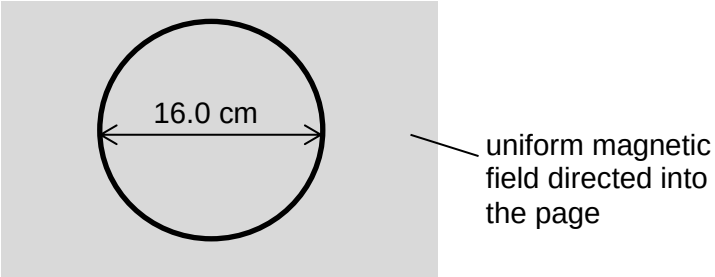
A has its maximum value.

B reverses its direction.

C has the same value as in any other orientation of the coil.

D is zero.

25 A circular coil of diameter 16.0 cm and resistance 4.00 Ω is placed in a uniform magnetic field of flux density 5.00 T directed perpendicularly into the coil.



If the magnetic flux density is reduced to zero at a constant rate over 10.0 ms, what can be deduced about the current flowing in the coil during this change?

	magnitude of current / A	**direction**
A	2.51	clockwise
B	2.51	anticlockwise
C	10.1	clockwise
D	10.1	anticlockwise

26 A transformer has 500 primary turns and 10 secondary turns. A resistor of 15 Ω is connected in the secondary coil.

If the root-mean-square voltage across the primary coil is 120 V, what is the root-mean-square current in the primary coil?

A 0.0032 A **B** 0.16 A

C 2.4 A **D** 8.0 A

27 Which of the following phenomenon provides the evidence for wave nature of electrons?

A photoelectric effect

B x-ray diffraction

C electron diffraction

D deviation of electrons by electric and magnetic fields

28 An electron and a proton are accelerated across a potential difference of 15.0 kV.

What is the ratio $\frac{\text{de Broglie wavelength of the proton}}{\text{de Broglie wavelength of the electron}}$?

A 5.45×10^{-4} **B** 2.34×10^{-2}

C 42.8 **D** 1.83×10^{3}

29 A detector of ionising radiation gives a background count rate of 24 per minute.

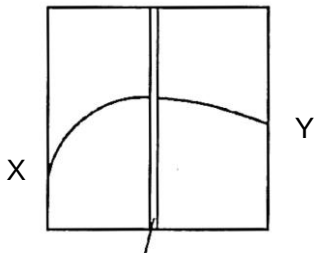
A radioactive source is placed near the detector and the reading is 532 counts per minute.

What will the reading be after two half-lives of the source?

A 127 **B** 133

C 151 **D** 157

30 Radiation from a radioactive source enters an evacuated region in which there is a uniform magnetic field perpendicular to the plane of the diagram. This region is divided into two by a sheet of aluminium about 1 mm thick. The curved path followed by the radiation is shown in the figure below.



Which of the following correctly describes the type of radiation and its point of entry?

	type of radiation	point of entry
A	alpha	X
B	alpha	Y
C	beta	X
D	beta	Y

END OF PAPER