RAFFLES INSTITUTION

2024 YEAR 5 PROMOTION EXAMINATION

H2 PHYSICS

9749

2 h 30 min

Section A

INSTRUCTIONS TO CANDIDATES

There are 3 sections in this paper.

Section A consists of **15** multiple-choice 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 Optical Mark Sheet.

You are advised to attempt Section A first. The Optical Mark Sheets will be collected after the first **30** minutes.

Section B consists of **5** structured questions. You are to write your answers in the spaces provided.

Section C consists of **1** data-based question and **1** long structured question. You are to write your answers in the spaces provided.

Attempt **all** questions in Sections A, B and C.

Data

speed of light in free space	c	=	3.00×10^{8} m s^{-1}
permeability of free space	μ_0	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space	ε_0	=	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

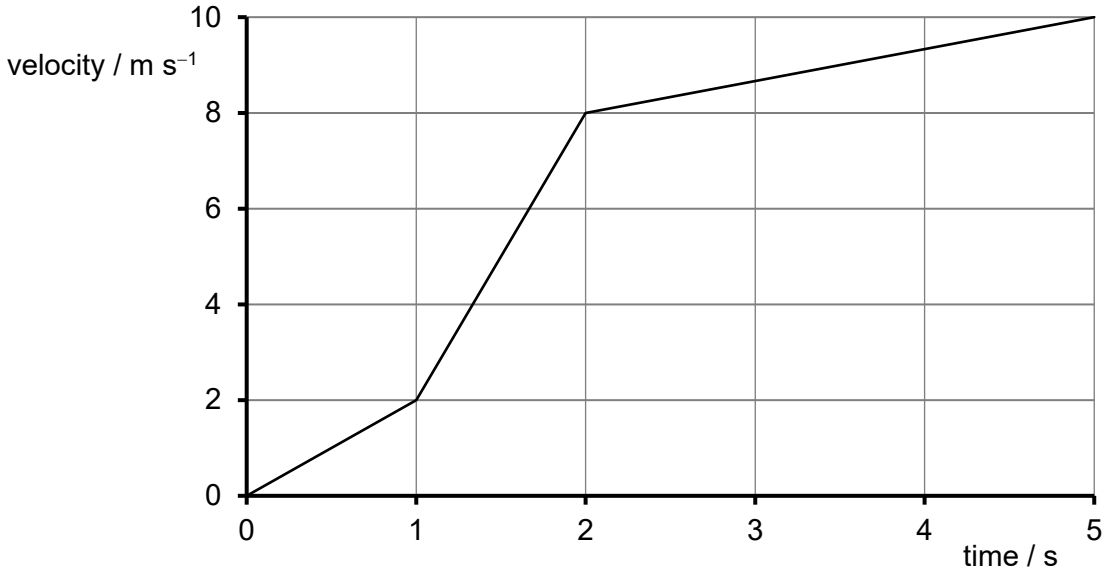
uniformly accelerated motion	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
work done on/by a gas	W	=	$p\Delta V$
hydrostatic pressure	p	=	ρgh
gravitational potential	ϕ	=	$-Gm/r$
temperature	T / K	=	T / °C + 273.15
pressure of an ideal gas	p	=	$\frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
mean translational 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	=	$\ln 2 / t_{1/2}$

1 What is the best estimate of the total weight of eight Singapore one-dollar coins?

A 0.06 N **B** 0.6 N **C** 6 N **D** 60 N

2 An athlete runs along a straight track.

The graph shows the variation of the velocity of the athlete with time for the first 5 s of his run.



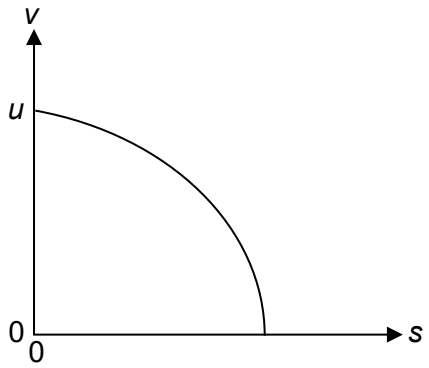
What is the maximum acceleration and the total distance run during these 5 s?

	maximum acceleration / m s^{-2}	total distance / m
A	2	33
B	2	50
C	6	33
D	6	50

3 A car moving in a straight line at speed u undergoes constant deceleration until it stops.

Which graph best represents the variation of the car's speed v, with distance travelled s, measured from the point it starts decelerating?

A



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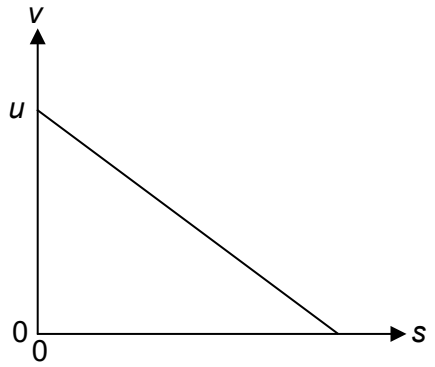
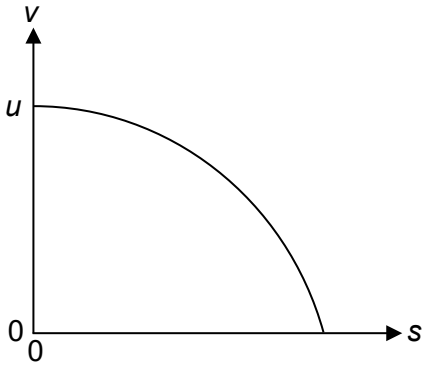
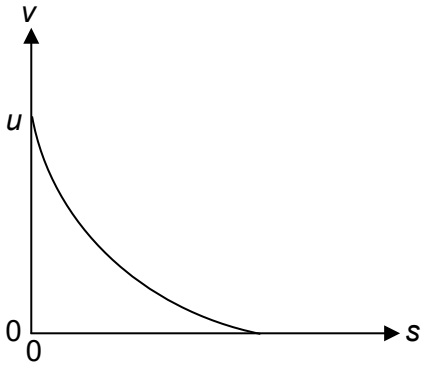


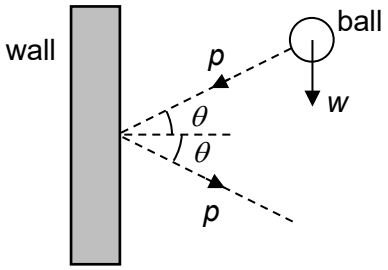
C



D



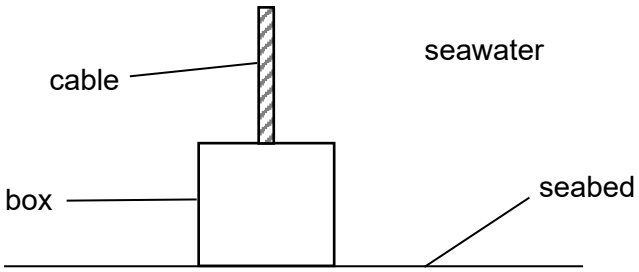
4 A ball of weight w travels with a momentum p and hits a vertical wall at an angle θ to the horizontal. It rebounds at an angle θ as shown.



What is the magnitude of the impulse imparted to the wall?

A $2p \sin\theta$ **B** $2p \sin\theta + w$ **C** $2p \cos\theta - w$ **D** $2p \cos\theta$

5 A crane attempts to lift a sunken cargo box of weight W but is not successful. The magnitude of the force applied by the cable of the crane is T, and the force from the seabed on the box is N. The volume of the seawater displaces by the box has weight S.



Which of the following is correct?

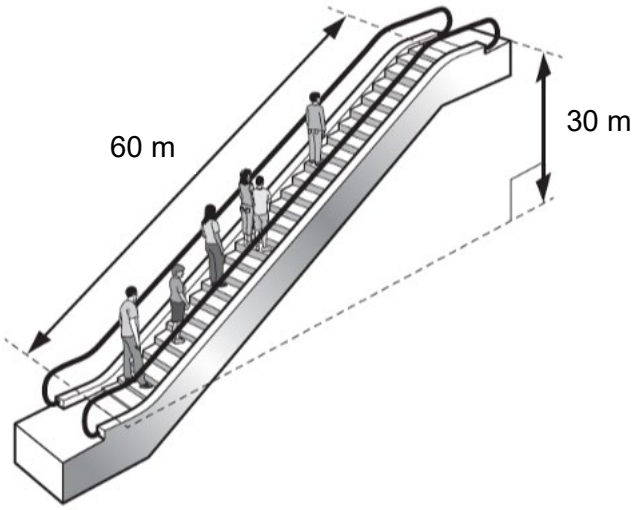
A $W < T + N + S$

B $W = T + N + S$

C $W > T + N + S$

D $W = T + N$

6 An escalator is 60 m long and lifts passengers through a vertical height of 30 m as shown.



A power of 2.0 kW is needed to drive the escalator against the forces of friction when there are no passengers. The average mass of a passenger is 60 kg and the power required to overcome friction remains constant.

What is the power required to drive the escalator when it is traveling at 0.60 m s^{-1} and carrying 15 passengers?

A 2.2 kW **B** 2.6 kW **C** 4.3 kW **D** 4.6 kW

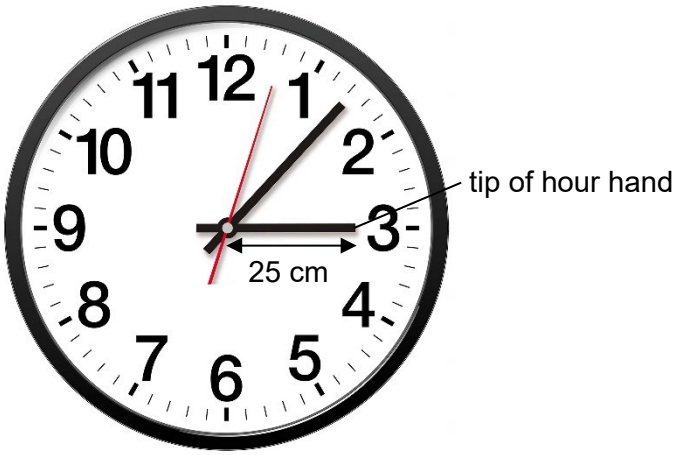
7 A hydroelectric power station uses the gravitational potential energy of water to generate electrical energy. In one such power station, the mass of water flowing per unit time is 1.5×10^5 kg s^{-1}. The water falls through a vertical height of 120 m.

The electrical power generated is 100 MW.

What is the efficiency of the power station?

A 0.57 % **B** 43 % **C** 57 % **D** 77 %

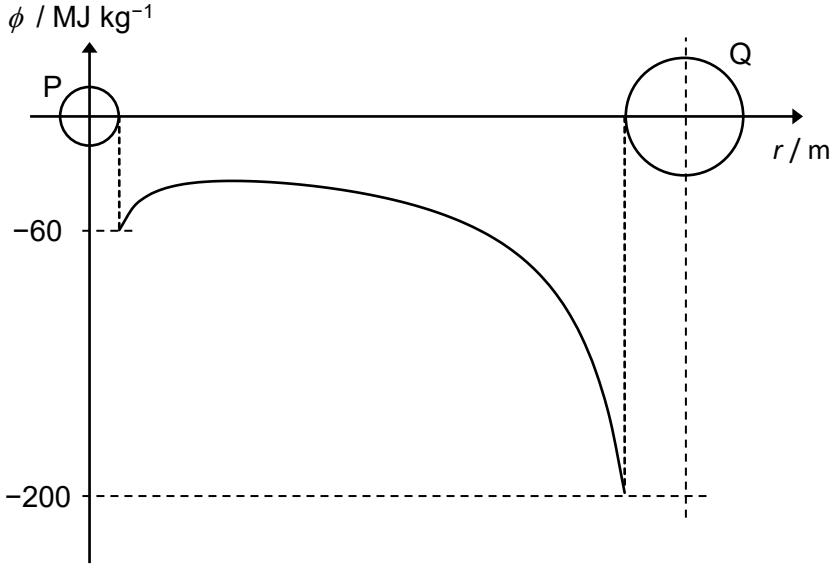
8 The tip of the hour hand of the clock is 25 cm from the centre of the clock.



What is the linear speed of the tip of the hour hand?

A 1.8×10^{-5} m s^{-1} **B** 3.6×10^{-5} m s^{-1} **C** 4.4×10^{-4} m s^{-1} **D** 1.3×10^{-1} m s^{-1}

9 A spherical body P orbits another spherical body Q. The figure below shows the variation of the gravitational potential ϕ with distance r from the centre of body P.



The minimum amount of energy required to project a 1.0 kg mass from the surface of P to the surface of Q is E.

Which of the following is correct?

A $E < 60$ MJ

B $E = 60$ MJ

C 60 MJ $< E <$ 140 MJ

D 140 MJ $< E <$ 200 MJ

10 A mass of 0.25 kg is suspended from a light spring. When the mass is displaced through a vertical distance of 0.050 m and released, it undergoes simple harmonic motion with a period of 0.64 s.

What is the maximum kinetic energy of the mass?

A 0.76 mJ **B** 3.1 mJ **C** 12 mJ **D** 30 mJ

11 Which of the following is **not** an example of forced oscillations?

A a footbridge oscillating as people walk on it

B a loudspeaker connected to a signal generator producing a continuous note

C a pendulum bob oscillating in air after having been initially displaced

D a washing machine oscillating as its drum rotates at high speed

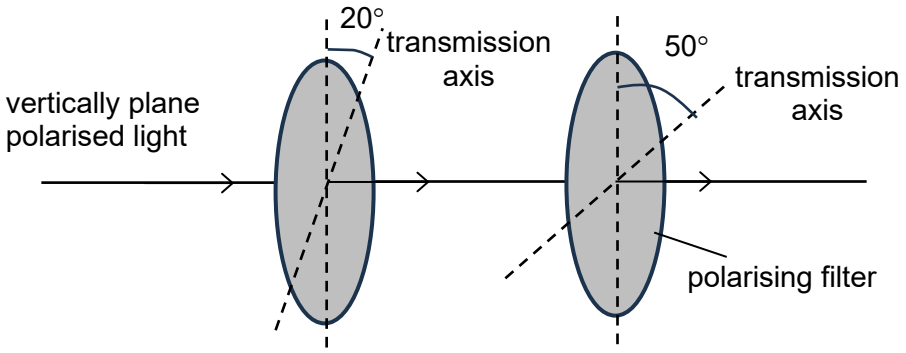
12 A person stands at a distance 3.0 m away from a speaker. The speaker is assumed to be a point source.

The effective area of the person's ear is 0.60 cm^2 and the power of the sound received by the person's ear is 2.9×10^{-6} W.

What is the power of the speaker?

A 1.4×10^{-4} W **B** 5.5×10^{-4} W **C** 1.4 W **D** 5.5 W

13 Vertically plane-polarised light of intensity I_o passes through two polarising filters as shown.

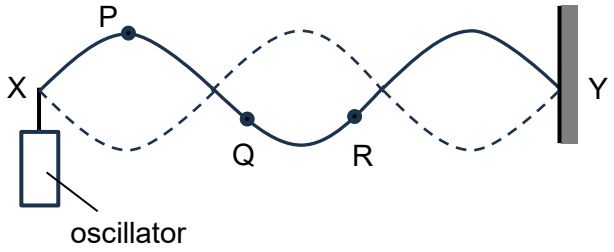


The transmission axis of the first filter is at an angle of 20° to the vertical.
The transmission axis of the second filter is at an angle of 50° to the vertical.

What is the intensity of the light that emerges from each polarising filter?

	intensity of light emerged from first filter	intensity of light emerged from second filter
A	0.88 I_o	0.36 I_o
B	0.88 I_o	0.66 I_o
C	0.94 I_o	0.60 I_o
D	0.94 I_o	0.81 I_o

14 A stationary wave on a stretched string is set up between two points X and Y.



Points Q and R are both at a distance of one-eighth of a wavelength from the nearest antinode.

Which statement about the stationary wave is **not** correct?

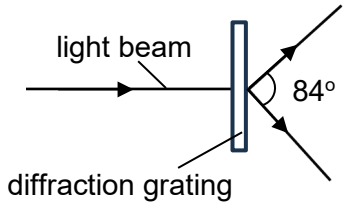
A Points P and R vibrate in antiphase.

B Points Q and R have the same amplitude.

C The phase difference between point Q and R is 90°.

D The maximum speed of point P is greater than that of point Q.

15 A beam of light from a laser is incident normally on a diffraction grating with 500 lines per mm. The second-order maxima that are produced are shown.



The angle between the two second-order maxima is 84°.

What is the wavelength of the light?

A 6.7×10^{-7} m **B** 9.9×10^{-7} m **C** 1.3×10^{-6} m **D** 6.7×10^{-6} m