H

Anglo-Chinese Junior College

Physics Preliminary Examination
Higher 1

A Methodist Institution
(Founded 1886)

PHYSICS **8867/01**
Paper 1 Multiple Choice 13 September 2024
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name and index number on the Answer Sheet provided.

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 working should be done in this Question Paper.
The use of an approved scientific calculator is expected, where appropriate.

DATA AND FORMULAE

Data

speed of light in free space	c	=	3.00×10^{8} m s^{-1}
elementary charge	e	=	1.60×10^{-19} C
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
the Avogadro constant	N_A	=	6.02×10^{23} mol^{-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	=	$u^2 + 2as$
resistors in series	R	=	$R_1 + R_2 + \ldots$
resistors in parallel	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$

1 The maximum theoretical power P of a wind turbine is given by the equation

$$P = k \rho A v^n,$$

where ρ is the density of air, A is the area swept by the turbine blades, v is the speed of the air and k is a constant with no units.

What is the value of n?

A 1 **B** 2 **C** 3 **D** 4

2 Two measurements for a solid sphere are shown.

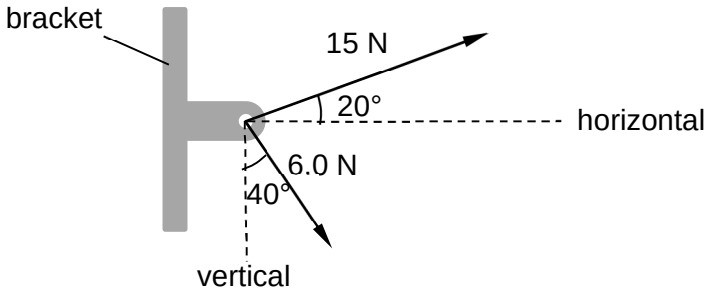
mass = (32.5 ± 0.1) g
diameter = (1.87 ± 0.04) cm

These values are used to determine the density of the sphere.

What is the percentage uncertainty in the density?

A 2.4% **B** 4.6% **C** 6.1% **D** 6.7%

3 Two cables are attached to a bracket and exert forces as shown.



What are the magnitudes of the horizontal and vertical components of the resultant of the two forces?

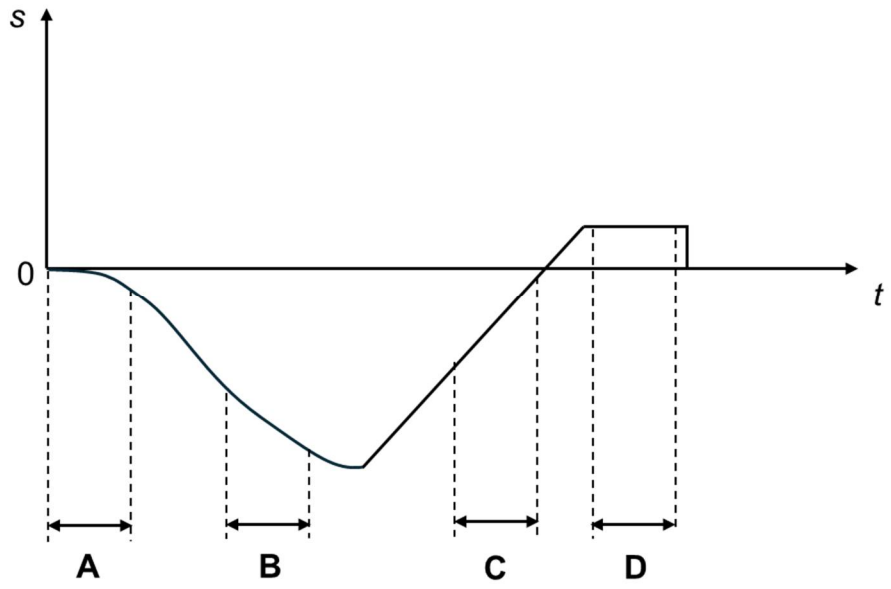
	horizontal component / N	vertical component / N
A	9.7	0.53
B	9.7	11
C	18	0.53
D	18	11

4 A projectile is launched at an angle θ from the vertical.

What fraction of its initial velocity does the projectile have at the top of its trajectory?

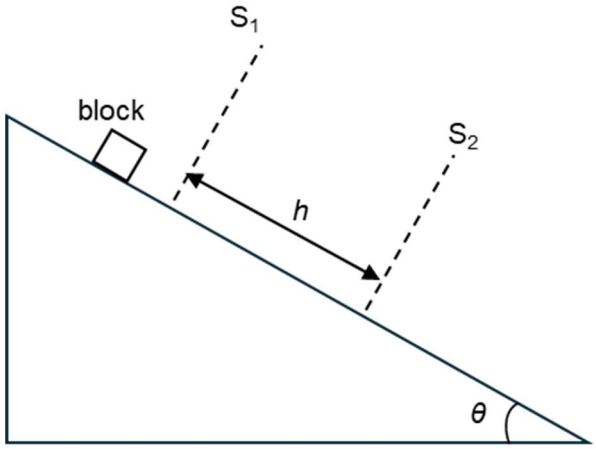
A 0 **B** sin θ **C** cos θ **D** tan θ

5 The graph shows the variation with time *t* of the displacement *s* of an object moving along a straight path.



Which time interval is the magnitude of the acceleration the greatest?

6 A block is released from rest down a frictionless inclined plane of angle θ. The block passes two light sensors S_1 and S_2 at time t_1 and t_2 respectively.



What is the acceleration of free fall?

A $\dfrac{2h}{(t_2^2 - t_1^2)}$ **B** $\dfrac{2h}{(t_2 - t_1)^2}$ **C** $\dfrac{2h}{(t_2^2 - t_1^2)\cos\theta}$ **D** $\dfrac{2h}{(t_2^2 - t_1^2)\sin\theta}$

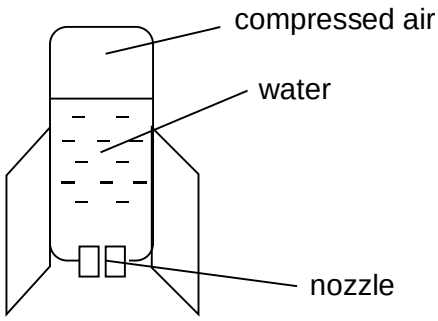
7 A large bucket, lifted by a rope attached to a crane, is used on a building site to raise heavy loads.

The bucket, of total mass m when fully loaded, rises at a uniform speed v before decelerating uniformly to rest in time t.

What is the difference of tension in the rope supporting the bucket between the time when the bucket is moving at uniform speed and the time when the bucket is decelerating?

A $-\dfrac{mg}{t}$ **B** $-\dfrac{mv}{t}$ **C** $m\left(g - \dfrac{v}{t}\right)$ **D** $m\left(\dfrac{v}{t} - g\right)$

8 A toy rocket consists of a plastic bottle which is partially filled with water as shown in the figure below. The space above the water contains compressed air.



At one instant during the flight of the rocket bottle, water of density 1000 kg m^{-3} is forced out of the nozzle of radius 0.012 m at a speed of 10 m s^{-1} relative to the nozzle.

What is the rate of change of momentum of the water?

A 45 N **B** 120 N **C** 3800 N **D** 7500 N

9 Two stationary ice-skaters Charlie and Sam, each of mass 60 kg, are directly facing one another on an ice-skating rink.

Charlie throws a 1.5 kg medicine ball towards Sam with a horizontal speed of 2.5 m s^{-1}. Sam catches the ball and throws it back to Charlie with the same horizontal speed.

What is the speed of Charlie after catching the ball?

A 0 m s^{-1} **B** 0.063 m s^{-1} **C** 0.12 m s^{-1} **D** 0.13 m s^{-1}

10 Two spheres each have the same mass. They approach one another with speeds u_1 and u_2 and collide head-on as shown.

The speeds after impact are v_1 and v_2.

Which equation is correct if the collision is elastic?

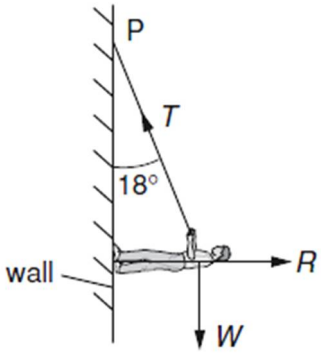
A $u_1 - u_2 = v_2 - v_1$

B $u_1 - u_2 = v_2 + v_1$

C $u_1^2 - u_2^2 = v_1^2 + v_2^2$

D $u_1^2 + u_2^2 = v_1^2 + v_2^2$

11 A climber is supported by a light rope on a vertical wall as shown.

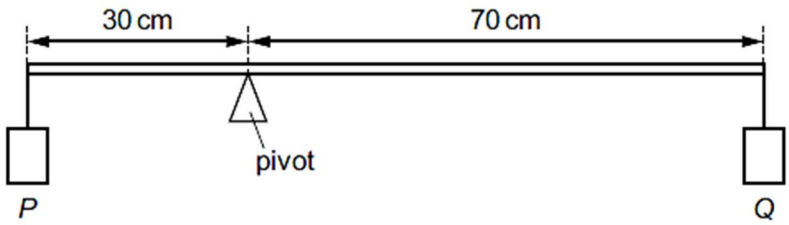


The weight W of the climber is 520 N and the reaction force R acts at right angles to the wall. The climber is in equilibrium.

Which row shows the value of the tension T in the rope and R.

	T / N	R / N
A	500	150
B	500	480
C	550	170
D	550	520

12 A beam on a pivot supports a load *P* at one end and a load *Q* at the other end.



The weight of the beam is negligible and the beam is maintained in a horizontal position as shown.

Which row gives possible values for *P* and for *Q*?

	P / N	*Q* / N
A	3	7
B	49	7
C	21	9
D	27	9

13 Which pair of forces is an example of Newton's third law?

A The weight of a box and the normal contact force acting on it.

B The weight of a truck and the gravitational pull of the truck on earth.

C The driving force of the engine of a car and the resistive force against the car.

D The weight of a parachutist and the air resistance acting against his motion at terminal velocity.

14 A skydiver of mass 60 kg is falling vertically with a terminal speed of 240 km h^{-1}.

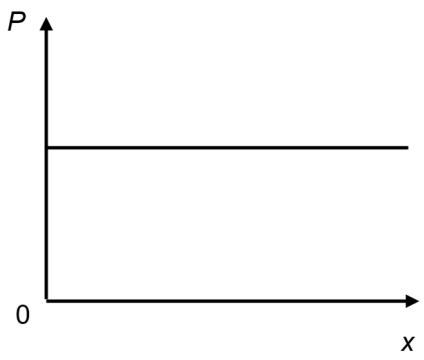
What is the rate at which the skydiver is losing his mechanical energy?

A 39 kW **B** 130 kW **C** 170 kW **D** 510 kW

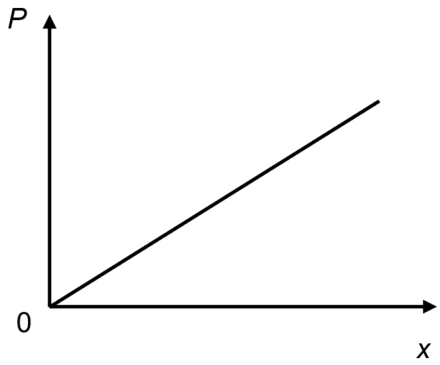
15 A constant force is applied on an object initially at rest on a horizontal frictionless surface.

Which graph best represents the variation of power supplied *P* with distance *x* moved by the object?

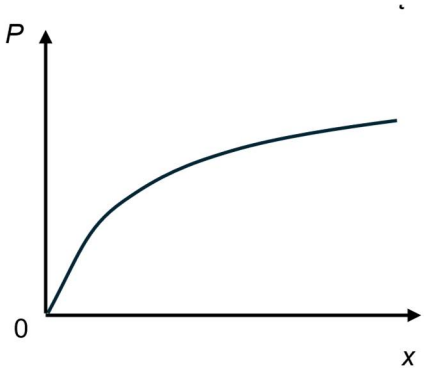
A



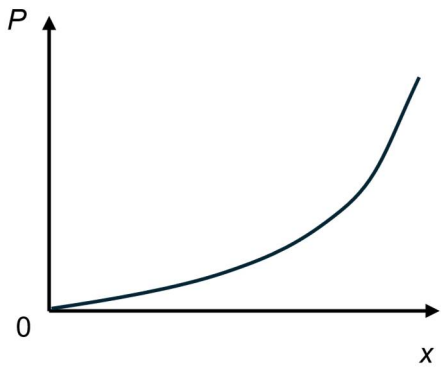
B



C



D



16 A motor driving a pump raises 0.20 m^3 of water through a vertical height of 10 m in 5.0 minutes. The efficiency of the motor is 40 % and the density of water is 1000 kg m^{-3}.

What is the power generated by the motor?

A 26 W **B** 65 W **C** 160 W **D** 9800 W

17 The hour hand of a large clock is 2.5 m long.

What is the average angular speed of this hand?

A 1.5×10^{-4} rad s^{-1}

B 3.0×10^{-4} rad s^{-1}

C 1.8×10^{-3} rad s^{-1}

D 1.0×10^{-1} rad s^{-1}

18 A sphere moves in a horizontal circle with constant angular speed.

What is its linear speed and its centripetal acceleration when the radius of the horizontal circle is halved and angular speed is doubled?

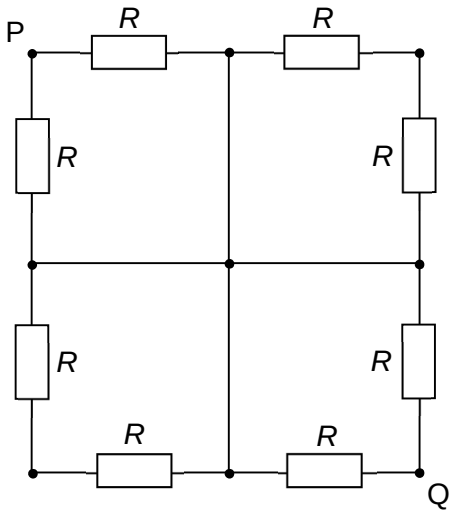
	linear speed	centripetal acceleration
A	halved	constant
B	halved	doubled
C	constant	constant
D	constant	doubled

19 The figure below shows a group of three planets. The mass of planet 2 is about 80 times that of planet 1 while the mass of planet 3 is about 350 000 times that of Planet 2. The neutral point in the gravitational field is the point at which the resultant gravitational field due to the three planets is zero.

(not to scale)

Which position is a possible neutral point?

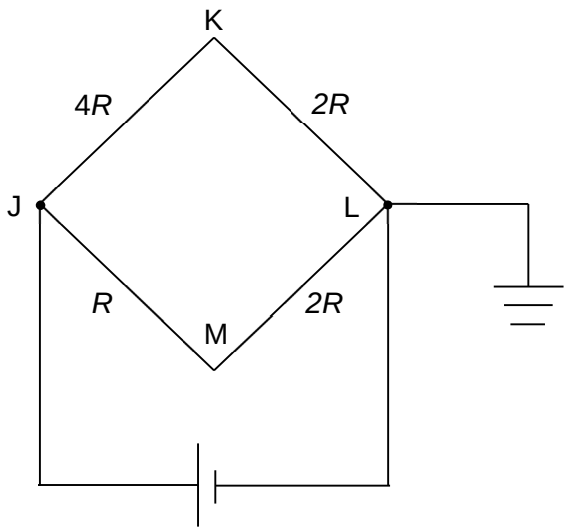
20 Eight identical resistors, each of resistance R, are connected in a network as shown below.



What is the effective resistance between terminals P and Q?

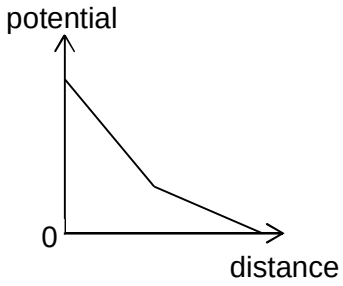
A $0.5R$ **B** R **C** $2R$ **D** $4R$

21 Four wires, JK, KL, JM, and LM (of equal length) are joined as shown in the figure below and a battery is connected between J and L. Point L is earthed. The resistance of each wire, in terms of *R* is indicated in the figure.

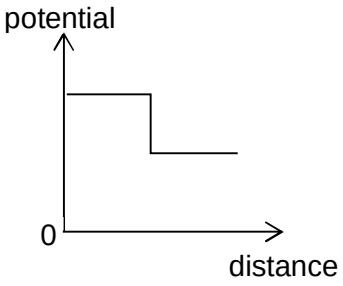


Which graph best shows how the electric potential varies with distance from J along the path JML?

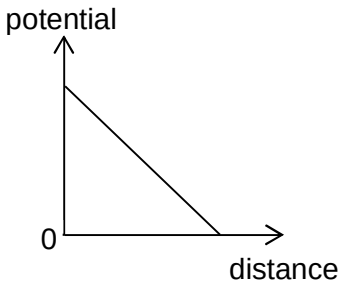
A



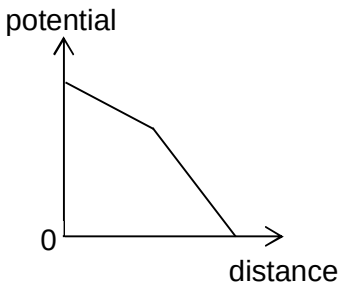
B



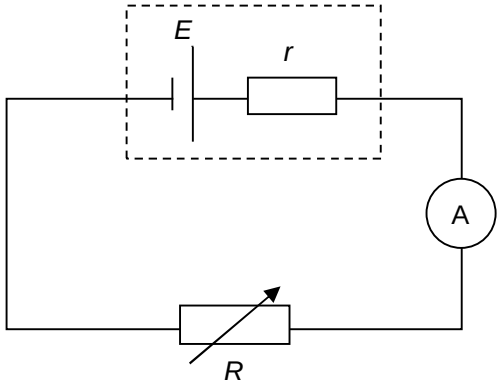
C



D



22 A battery of e.m.f. *E* and internal resistance *r* delivers a current I through a variable resistance *R*.



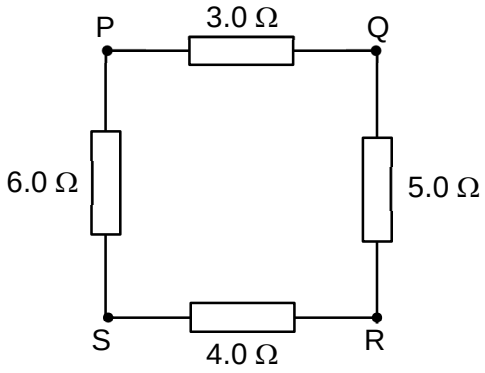
R is set at two different values and the corresponding currents I are measured using an ammeter of negligible resistance.

R / Ω	I / A
3.0	1.00
12.0	0.40

What is the value of the internal resistance *r* ?

A 1.3 Ω **B** 3.0 Ω **C** 6.0 Ω **D** 13 Ω

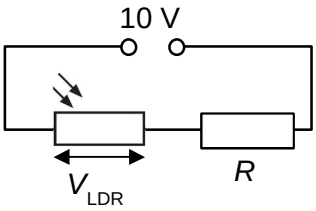
23 A battery of negligible internal resistance may be connected between any two points P, Q, R and S of the network of resistors shown.



Which connection will give the largest current in the battery?

A PQ **B** PR **C** PS **D** QS

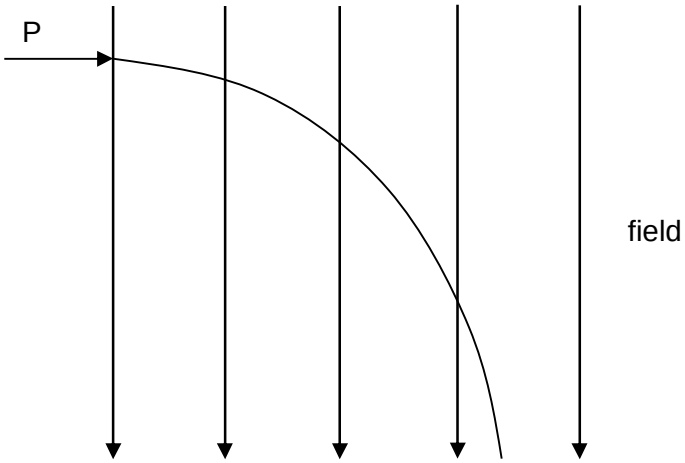
24 A light-dependent resistor (LDR) is connected in series with a fixed resistor of resistance R and a 10 V power supply shown below. At a particular light intensity, the resistance of the LDR is 5.3 Ω and the potential difference V_{LDR} across it is 4.5 V.



What is V_{LDR} if the light intensity is increased such that the resistance of the LDR is 3.1 Ω?

A 1.5 V **B** 2.6 V **C** 3.2 V **D** 3.5 V

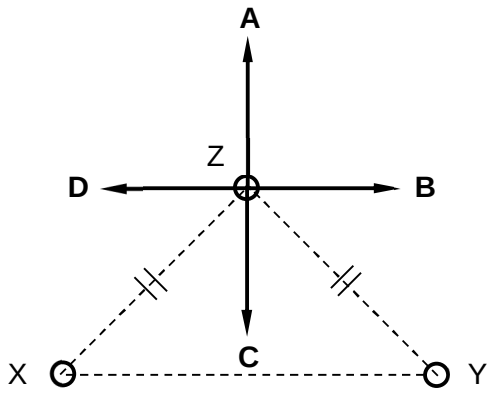
25 A charged particle is projected horizontally at P into a uniform vertical field. The particle follows the path show below.



Ignoring gravitational effects, what describes the charge of the particle and the nature of the field?

	charge	field
A	negative	electric
B	negative	magnetic
C	positive	electric
D	positive	magnetic

26 Three parallel wires, carrying equal currents into the plane of the page, pass vertically through the three corners of a right-angled isosceles triangle XYZ, where XZ = YZ.



Which vector shows the resultant force acting on the wire placed at Z?

27 A particle X of charge q is moving in a uniform magnetic field of flux density B in a circle of radius r at a speed v. Another particle Y of charge $2q$ has the same mass as X and moves at the same speed as X.

What is the flux density required for Y to move in a circle with the same radius r?

A $\frac{B}{4}$ **B** $\frac{B}{2}$ **C** $2B$ **D** $4B$

28 The Rutherford scattering experiment found that most of the alpha-particles passed through the gold foil with no significant deviation, although a very tiny minority were deflected through large angles, and some were even back-scattered.

The experiment is repeated with a foil made from a heavier isotope of gold.

How would the results be different?

A There would be no significant change.

B A much greater proportion of the alpha-particles would be back-scattered.

C A much greater proportion of the alpha-particles would be deflected through a large angle.

D A greater proportion of the alpha-particles would pass through with no significant deviation.

29 A nucleus of element X absorbs a neutron and undergoes nuclear fission to give a nucleus of element Y and a nucleus of element Z.

Which row gives the correct relation of the binding energy per nucleon of the respective nuclei?

	$\frac{\text{binding energy per nucleon of Y}}{\text{binding energy per nucleon of X}}$	$\frac{\text{total binding energy per nucleon of Y and Z}}{\text{binding energy per nucleon of X}}$
A	greater than 1	greater than 1
B	greater than 1	less than 1
C	less than 1	greater than 1
D	less than 1	less than 1

30 A pure sample of nuclide A and a pure sample of nuclide B have the same activity at time $t = 0$. Nuclide A has a half-life of T while nuclide B has a half-life of $2T$.

What is the ratio of $\frac{\text{activity of A}}{\text{activity of B}}$ when $t = 4T$?

A 0.25 **B** 0.50 **C** 2.0 **D** 4.0

End of Paper